2010
Specialty Crop Block Grant Program – Farm Bill (SCBGP-FB)
FINAL PERFORMANCE REPORT

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California Department of Food and Agriculture
2010 Specialty Crop Block Grant Program – Farm Bill
Final Performance Report
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CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 1	**Project Title:** California Invasive Species Advisory Committee	
Grant Recipient: California Farm Bureau Federation	**Grant Agreement No.:** SCB10001	**Date Submitted:** December 2013
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Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The California Invasive Species Advisory Committee created an on-line "living" list of invasive species that could pose a threat to California specialty crops. The list includes over 1,700 species of vertebrates, insects and other invertebrates, plants and diseases. Some of these species are already found in the state, and others are considered likely to cause problems if introduced in the future. The focus has been on the top 200 species and work has carried on for further refining of the list. Members of the taxonomic working groups (CISAC members working as volunteers) revise the list on an ongoing basis, and to prepare scorecards allowing the comparison of species based on a consistent standard.

CISAC also prepared a Strategic Framework for protecting California specialty crops from invasive species (formally adopted by the Invasive Species Council of California on August 2, 2011), printed 2000 copies, and distributed it widely beginning in January 2012.

The Ag in the Classroom *Invasive Species Fact Sheet,* a teaching tool for middle school to high school classrooms, was finalized, printed, and made available.

Since early 2012 the efforts CISAC Communications and Outreach subcommittee have concentrated on creating an outreach campaign focused on a brochure to be distributed at Farmer's Markets. Subcommittee members worked closely with a communications consultant and graphic designer to finalize text accuracy, obtain appropriate, visually compelling graphics, and maximize messaging designed to appeal to the general public. A final version of the brochure was completed in January and an initial print run of 22,000 copies, plus 500 accompanying posters, was distributed beginning in late February 2013.

In the fall of 2012, CISAC also partnered with the California Agricultural Commissioners and Sealers Association (CACASA) to distribute the brochures and associated posters at some 50 farmers markets in diverse locations throughout the state. The final element of the outreach campaign involved surveying the public to assess their knowledge of and attitudes towards invasive species, with special focus on possible changes brought about through exposure to the brochure. CACASA conducted in-person interviews in at least five representative farmers markets where the brochure was distributed. The key questions to ask the public were determined, keeping in mind that many people frequenting the markets may have never heard the words "Invasive Species."

CISAC also posted an online survey to enable members of the public to participate in the survey. The survey was finalized in April and CACASA began the task of asking the survey questions at the farmers markets. The final survey answers were sent to the communications consultant who compiled the answers and with the input from the committee members drafted the final report titled, *The California Invasive Species Advisory Committee Survey Report 2013*. (Attachment 1)

In the fall of 2012 CISAC began a process of assessing the implementation status of the 46 specific recommendations contained in the Strategic Framework. Preliminary discussion during the September 2012 meeting produced a tentative priority list, and during the November 2012 and January 2013 meetings the committee separated into working groups to prepare a first draft of a summary implementation report. As edited by the Executive Committee, this report was revised further during an extended discussion at the April 2013 CISAC meeting. It was presented to ISCC before June 30, 2013 as the final outcome of this project.

The CISAC convened six well-attended meetings in 2012, and the committee decided to reduce the meeting frequency for 2013 from six to four meetings. The meetings were well-attended and featured presentations by guest experts in various aspects of invasive species issues. Combined with regular updates from ISCC member agency staff and CISAC members, these presentations provided an opportunity for the exchange of cutting edge information among many diverse partners including members of the public: all CISAC meetings are webcast, with conference telephone capability that provides an opportunity for dialog.

Finalization of the Farmers Market brochure took longer than expected because of the difficulty of addressing such complex issues in abbreviated brochure format, so distribution did not begin until a month later than originally scheduled. Since few farmers markets a open during this period (Jan-Feb) the delay did not significantly impede the project. It was also a long process to develop the survey as well, with a great deal of consultation between the contributing parties and the communications consultant to refine the survey questions.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Activities and tasks:

1. Prepared a strategic plan for invasive species management (Stopping the Spread: A Strategic Framework for Protecting California from Invasive Species; adopted August 2011).
2. Held 17 meetings where cutting edge issues regarding invasive species were discussed; meetings were webcast and public participation invited.
3. Created Ag in the Classroom Invasive Species Fact Sheet.
4. Updated the online living list of invasive species (creation of the list predated the grant period).
5. Created an outreach brochure on invasive species, distributed it (through CACASA) at farmers markets throughout the state. Followed up with a survey to assess impacts, and prepared a summary of results.

6. Assessed implementation of Strategic Framework provisions, and presented a report with recommendations to ISCC.

Partner contributions: The diverse nature of the CISAC means that individual partner contributions were too varied and constant to measure. Aside from committee activities, significant and productive partnerships were formed with UC Davis (for living list creation and management); CDFA (staff support and website hosting); California Farm Bureau Federation (Ag in the Classroom fact sheet); and CACASA (farmers market brochure distribution and survey administration).

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Long term goals are to minimize the impact of invasive species on California's specialty crop agriculture and environment. Creation of the IS list and Strategic Framework significantly strengthened the ability to meet that goal, as has been the ongoing stakeholder forum represented by the CISAC. Other CISAC activities during the grant period represented an ongoing effort to create and implement partnerships, and to educate and engage the public. The four outputs listed below have been fulfilled:

1. Develop a statewide list of invasive species (http://ice.ucdavis.edu/invasives)
2. Develop a statewide strategic action plan for invasive species (http://www.iscc.ca.gov/docs/CISAC-Strategic-Framework.pdf)
3. Develop and implement an outreach campaign on the impact of invasive species on specialty crops (http://www.iscc.ca.gov/publications/ISCC_trifold_LR.pdf; http://www.learnaboutag.org/factsheets/pdf/InvasiveSpecies.pdf)
4. Deliver a one-year implementation assessment of the strategic action plan (http://www.iscc.ca.gov/docs/reports/Framework-Iimplementation-Rpt-approved-071713.pdf)

These completed activities will strengthen the ability to respond to the introduction and spread of invasive species that threaten California specialty crops, reducing the impacts of invasive species on California specialty crops in the future.

With 109 respondents in five counties surveyed, the results are summarized as follows:

1. Knowledge about invasive species in general.
   a. A lot: 15%
   b. A little: 62%
   c. Nothing: 23%

2. Aware that invasive species affect California's food and environment.
    a. Yes: 75%
    b. No: 22%
    c. Other: 3%

3. Know that invasive species can affect food at farmers' market
    a. Yes: 57%
    b. No: 38%
    c. Other: 5%

4. Looking at the brochure taught me something new about invasive species' effect on agriculture
    a. Yes: 85%
    b. No: 8%
    c. Other: 9%

The outreach campaign is considered successful as 85% stated that new knowledge was gained from the outreach brochures.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

This project has benefited virtually all of California's specialty crop farmers, from citrus to horticulture, from vineyards to vegetable crops. The Center for Invasive Species Research at UC Riverside estimates that every 60 days California gains a new and potentially damaging invasive species, with annual economic losses at $3 billion per year. By strengthening programs and policies aimed at stopping the introduction and spread of invasive species, this project will reduce these impacts in the future and benefit all specialty crop producers.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The most important lesson learned was that broad collaboration of a diverse stakeholder network produces remarkable results.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Pathways Analysis report: http://www.iscc.ca.gov/reports.html (SCBGP funds were not used for this report.)

USDA Project No.: 2	Project Title: Olive fruit fly: Managing an ancient pest in modern times	
Grant Recipient: The Regents of the University of California, Berkeley	**Grant Agreement No.:** SCB10002	**Date Submitted:** December 2013
Recipient Contact: Kent M. Daane	**Telephone:** 559-284-5931	**Email:** kdaane@ucanr.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Table and oil olives are unique California specialty crops that are now threatened by olive fruit fly (OLF), which invaded the state around 1998. Table olives have a near zero tolerance for the fly but are primarily located in the Central Valley, where the summer heat helps suppress this pest's populations. Oil olive acreage has increased tremendously over the past decade, with many orchards located in the cooler coastal regions where fly populations build in excessive numbers if left untreated. Management strategies have relied on frequent applications of insecticide bait sprays, which increase control costs and have non-target impacts. Moreover, the effectiveness of insecticide-based programs is limited by abandoned and residential olive trees that act as reservoirs for fly populations. For these reasons, classical bio-control programs were initiated in 2003 to introduce more effective natural enemies. Four parasitoid species, all from Africa, were screened via a quarantine process, and selected for mass production, statewide field release, and evaluation. Through this project, these exotic parasitoids were released and evaluated in order to improve sustainable table and oil olive management practices.

The major objectives of this project were to (1) evaluate new olive fruit fly (OLF) parasitoids that may have better behavioral or ecological traits than two released parasitoids that are already approved for field release (*Psyttalia lounsburyi* and *P. humilis*); (2) develop models to predict the potential distributions and impacts of these two selected parasitoids and other potential parasitoid species (dependent on Objective 1); and (3) conduct a statewide field-release of *Psyttalia lounsburyi* and *P. humilis* and monitor their establishment.

Objective 1: Evaluate new olive fruit fly (OLF) parasitoids.

Layman's summary: Imported natural enemies are typically 'specialists,' meaning they are natural enemies that can only attack the targeted pest and its very close relatives. In the quarantine, potential natural enemies are screened for their effectiveness against the targeted pest species, as well as any possible non-target effects to native insects. Only those natural enemies that are both effective at suppressing the pest and have no negative impact are selected for release from quarantine into California. The quarantine process is often a tedious comparison of parasitoid biology and interspecific interactions. Project staff previously screened 11 parasitoid species and selected two (*Psyttalia* *lounsburyi* and *P. humilis*) for release in California. In this current study, three novel parasitoids were screened (*Fopius ceratitivorus*, *Psyttalia cosyrae*, and *Psyttalia ponerophaga*) and compared them against *Psyttalia lounsburyi* and *P. humilis*, as well as nontarget insects. From this work, *P. ponerophaga* was selected as an additional parasitoid for release.

Objective 2: Develop models to predict the potential distributions and impacts of these two selected parasitoids and other potential parasitoid species

Layman's summary: Once permission is granted to release a parasitoid from Quarantine, material is mass produced in the insectary and released in field cages or in open field releases (e.g., no containment); during this process the impact of the natural enemy is evaluated. This is a costly process, especially because the reared natural enemy may not perform well in all regions of California. There are also interactions among parasitoid species to be considered. In order to make each release most efficient, a series of laboratory trials were conducted on parasitoid biology and species interaction. With these data, a model is being built to help determine where the natural enemies might best be released in California. The details provided in this report and from the initial model can easily be summarized by stating that both *P. humilis* and *P. lounsburyi* can be released together. While there are slight differences in their temperature tolerances, the studied parasitoids appear to perform better in cooler than warmer climates. For this reason, future parasitoids releases will be concentrated in coastal regions.

Objective 3: Conduct a statewide field-release of *Psyttalia lounsburyi* and *P. humilis*.

Layman's summary. A number of introduced parasitoids were evaluated during the six years and identified the two most promising parasitoids: *P. humilis* and *P. lounsburyi*. Prior to the field release, laboratory or field cage evaluations were conducted to determine the effects of seasonal temperatures (low overwintering and high summer temperatures) on the survival of OLF, *P. humilis* and *P. lounsburyi*. These studies suggest that these two parasitoids will likely be more successful in coastal olive growing regions in California, where the climate is milder than in the Interior Valleys. Thus, field releases of both parasitoids were conducted at several coastal sites. After both selected parasitoids were released in 2010 and 2011, *P. lounsburyi* has been recovered consistently in the following fruit season in two costal California locations (San Luis Obispo County and San Mateo County). But *P. humilis*, which is less cold tolerant than *P. lounsburyi*, was not recovered in 2012 after the 2011 field releases. In 2013, *P. lounsburyi* was recovered from both locations. Project staff has assessed some major ecological factors that could potentially impede the permanent establishment of introduced olive fruit fly parasitoids in California. Project staff demonstrated, for the first time, establishment of an introduced parasitoid (*P. lounsburyi*) that attacks fly maggots. The successful establishment of *P. lounsburyi* is the first successful use of this parasitoid here, or in Europe.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Activities and tasks performed (research details)

Objective 1: Evaluate new olive fruit fly (OLF) parasitoids. Three novel parasitoids (*Fopius certitivorus*, *Psyttalia cosyrae*, and *Psyttalia ponerophaga*) were evaluated in quarantine in terms of their effectiveness and, if warranted, non target impact.

(a) *Fopius certitivorus* Two new fruit fly parasitoids, *Fopius ceratitivorus* and *Psyttalia cosyrae*, both originated from Kenya and reared at the USDA-APHIS-PPQ, MOSCAMED Parasitoid Rearing Facility at San Miguel Petapa, Guatemala, were introduced into the University of California Berkeley's (UCB) quarantine facility for the evaluation of their potential as biological control agents against OLF. Three shipments of each parasitoid species were sent to the quarantine facility in 2010. First, experiments were conducted to determine if both parasitoids could successfully attack and develop from various stages of olive fruit fly (i.e. host location and acceptance).

Under quarantine conditions (23 ± 2ºC), infested olives containing different developmental stages of OLF (egg, 1st instar, 2nd instar, young 3rd instar, old 3rd instar) were exposed respectively (i.e. no choice test) to individual females of *F. ceratitivorus* in cages (15 x 15 x 20 cm) for 24 h. Part of the exposed fruit were dissected 48 h later to determine if the hosts were parasitized and the parasitoid eggs had developed, while the rest of the exposed fruit were reared to determine the emergence of the parasitoids. There were only 3 host larvae parasitized by *F. ceratitivorus* among 150 dissected hosts (the parasitoid larvae were 1st or 2nd instars) and only 3 adult wasps (1 male and 2 females) emerged from about 2000 exposed olives to *F. ceratitivorus*. Project staff concluded that *F. ceratitivorus* is not an effective parasitoid on *B. oleae*, although it could develop from this fruit fly, and this parasitoid was not further evaluated.

(b) *Psyttalia cosyrae*. Using the same conditions as described for *F. ceratitivorus P. cosyrae* was initially tested as a parasitoid of olive fruit fly. Both dissection and rearing of exposed hosts showed that *P. cosyrae* readily accepted and developed from *B. oleae,* but clearly preferred the third larval instars (Attachment 1 Fig.1).

At the quarantine room conditions, the developmental time from egg to adult was 22.7 ± 0.24 days (n =135) for males and 25.8 ± 0.24 days (n= 90) for females; which were similar to *P. humilis* (see results in Objective 2).

(c) *Psyttalia ponerophaga*. Prior to the current project, it was shown that *P. ponerophaga* could attack olive fruit fly. This project evaluated the effectiveness and potential non-target effects of *P. ponerophaga*.

The thermal performance (i.e. developmental time and survival) of *P. ponerophaga* was evaluated at six constant temperatures (12, 18, 22, 25, 28, and 30 °C). Infested fruit containing 3–5 third instar OLF larvae were exposed to gravid female parasitoids in holding cages for up to 24 h at room temperature (24 ± 2°C) and the exposed fruit were assigned to each temperature treatment. There were 10–15 replicates for each temperature, with each replicate consisting of 10–20 exposed fruit. The developmental time, number, and sex of emerged wasps or flies were recorded.

P. ponerophaga successfully developed from 12 to 28 ºC and the developmental rate from egg to adult increased linearly with this temperature range (Attachment 1 Fig. 2A). The estimated lower developmental threshold and day-degree are 10.4 ºC and 322.6 DD. However, a few individuals were observed still in larval stage after > 3 months under 18 ºC, suggesting a possible facultative diapause at low temperatures. Temperature effected the survival of OLF ($F_{5,83}$ = 4.8, $P < 0.05$) and *P. ponerophaga* ($F_{5,83}$ = 4.4, $P < 0.05$); survival rate increased with temperature, peaked around 25 ºC, and then decreased (Attachment 1 Fig. 2B). No wasp developed at 30 ºC. This parasitoid has a similar temperature range to *P. lounsburyi*.

From this work, project staff believes that P. ponerophaga can attack olive fruit fly under similar environmental conditions as *P. lounsburyi*, but may have better cold tolerance than either *P. lounsburyi* or *P. humilis* – enabling it to better survive in California's Central Valley during the winter.

A final hurdle for *P. ponerophaga*'s release from quarantine was the non-target study. A previous application for its release was issued and then withdrawn by USDA-APHID-PPQ, with a request for more non-target tests. Therefore, additional non-target tests were conducted in the September and October 2011 and 2012. The non-target test in 2011 largely failed because collected non-target host fruit did not contain enough non-target flies (the black cherry fruit fly, *Rhagoletis fausta*). Presumably all fly larvae might have exited the fruit prior to the collection of the fruit in the field. In September 2012, the native non-target black cherry fruit fly was again collected from bitter cherry fruit in Sierra Nevada Mountains (Fresno County). Branches bearing the cherry fruit with fly infestation were bought to the Berkeley Quarantine for immediate use. 30 infested fruit were exposed to one female *P. ponerophaga* for 24 h in a small cage, and as a control, 30 infested fruit were unexposed to the parasitoid. There were 9 replicates for each treatment. All exposed fruit were kept separately for each replicate in one container until the emergence of wasps or flies.

On average, 6.2 ± 1.5 and 9.0 ± 0.7 *R. fausta* pupae emerged per replicate for the exposed and unexposed treatment, respectively. The number was not significantly different between the treatment and control ($F_{1,16}$ =2.8, P = 0.113, t-test). Only was one wasp emerged from the control treatment (the species is still under identification), but 9 *P. ponerophaga* adults emerged from the exposed treatment. The results suggest that *P. ponerophaga* is able to attack and develop from the non-target host under the quarantine condition. However, *R. fausta* is a univoltine species (one generation per year). It is unlikely that the parasitoid (multivoltine) would be able to complete life history on this non-target host in the nature.

Project staff concludes that under artificial quarantine conditions, P. ponerophaga could attack cherry fruit fly – the most closely similar fruit fly that we can find in California. However, non-target impacts are likely to be non-existent because the cherry fruit fly and its common relatives inhabit the Sierra mountain range, where *P. ponerophaga* would not survive.

Objective 2: Develop models to predict the potential distributions and impacts of these two selected parasitoids and other potential parasitoid species.
A series of laboratory trials were conducted, primarily to test the effectiveness and temperature tolerances of *P. lounsburyi* and two strains of *P. humilis*. Most of this work has been published (see Appendix) and herein some of the highlights are provided from the three years of study.

(a) Comparison of the thermal performance of the olive fruit fly and its co-adapted parasitoids.

This study compared three major thermal performance profiles (development, survival, and reproduction) across a wide range of temperatures (10–34°C) among a Californian population of the olive fruit fly and two African parasitoids, *Psyttalia lounsburyi* (Silvestri) and *Psyttalia humilis* (Silvestri), believed to have co-adapted with the fruit fly in its native range.

The *P. lounsburyi* colony was established from parasitoids reared from olive fruit flies infesting wild olives collected in the Burguret Forest on the slope of Mount Kenya (elevation 1,960–2,062 m). Two different populations of *P. humilis* were tested, one originated from Kenya (hereafter referred to as *P. humilis* KA) and the other from Namibia (hereafter referred to as *P. humilis* NA). The *P. humilis* KA colony was established with material reared from Medfly infesting coffee berries collected in 2000 in the central highlands of Kenya. The *P. humilis* NA colony was established with material reared from olive fruit fly's infesting wild olives collected in 2008 in Grootfontein and Meteorite, Namibia.

Developmental time, survival, and reproduction were determined for the olive fruit fly, *P. lounsburyi*, *P. humilis* NA, and *P. humilis* KA at nine constant temperatures (10, 12, 14, 18, 22, 26, 30, 32, and 34 °C). An additional temperature of 28 °C was later added for the developmental time of *P. lounsburyi*. Fruit fly trials were initiated by exposing ripe olive fruit, from Sevillano *cv*., to gravid females in the holding cages for up to 12 h, until each fruit had 3–5 oviposition scars.

Results showed olive fruit fly developed from 10–30 °C, and failed to complete development at 32 and 34 °C. *Psyttalia humilis* (KA and NA) developed from 14–32 °C, and failed to complete development at 10, 12, and 34°C. *Psyttalia lounsburyi* developed from 10–28 °C, and failed to develop above 30 °C.

A nonlinear developmental model was used to describe the relationship between developmental rate and temperature:

$$D(T) = nT(T - T_b)(T_L - T)^{\frac{1}{m}} \quad [1]$$

Where $D(T)$ is the developmental rate at temperature T, with T_b, and T_L being the lower and upper thermal threshold of development, and n and m are empirical constants. The operative temperature range, defined as the difference between T_b and T_L, and the optimum temperature, defined as the temperature at which the insect develops at its maximal rate, were determined. Data in mid-range of the nonlinear developmental rate model were selected to determine the best-fit by linear regression analysis:

Temperature dependent survival (%) for each species was described by a polynomial model:

$$Y = a + bX + cX^2 + dX^3 \qquad [2]$$

Where Y is the developmental success rate from egg to adult at temperature T (°C), and a, b and c are estimated constants.

Response variables of 2-day fecundity were fitted to a nonlinear, extreme-value model:

$$F(T) = k \exp\left[1 + \frac{T_{\max} - T}{\rho} - \exp\left(\frac{T_{\max} - T}{\rho}\right)\right] \qquad [3]$$

Where $F(T)$ is 2-day fecundity at temperature T (°C), k is the maximum value at optimum temperature ($T_{\max}$), and ρ is a shape parameter. Parameter estimates of the regression models were obtained by using the TableCurve 2D Program.

The temperature-dependent developmental rates were described by the nonlinear model (Fig. 3). The estimated lower temperature thresholds and optimum temperatures were similar between *B. oleae* and *P. lounsburyi*, which were lower than that of *P. humilis*. The calculated upper temperature threshold for *P. lounsburyi* was below that of the fly, whereas the calculated upper temperature threshold of *P. humilis* was above that of the fly. The calculated lower temperature thresholds (linear model) were also similar between *B. oleae* and *P. lounsburyi*, which were lower than that of *P. humilis*. The thermal requirements (DD) to complete immature development were estimated to be 380.8, 343.9, 259.7, and 252.2 DD for the olive fruit fly, *P. lounsburyi*, *P. humilis* KA, and *P. humilis* NA, respectively.

Two-day fecundity was used to estimate reproductive success. For the olive fruit fly, 2-week old gravid females were taken from the holding cages and placed individually in ventilated cylindrical acrylic cages (20×15×15 cm) provisioned with 10 Sevillano *cv.* fruit for oviposition, as well as water, honey, and yeast for adult diet. The cages were randomly assigned to temperature treatments. After a 2-day exposure period, the exposed fruit were examined and the number of oviposition scars was used to estimate oviposition activity, after which the olives were transferred to the plastic rearing containers and held at 24 ± 2 °C until the emergence of adult flies.

Using dissections it was confirmed that the majority of the olive fruit fly eggs hatched at 32 °C, but the larvae died during the early stages, and most eggs died at 34 °C. However, in the parasitoid studies, where more mature fly larvae were exposed to higher temperatures, the fly larvae were observed to successfully exit the fruit for pupation at 32 °C, suggesting that the mature larvae are less sensitive to the high temperature. Survival rates were similar among the parasitoid species in the mid-range (14–26 °C) temperature regime. The suitable temperatures for survival were 18–30 °C for *P. humilis*, and 14–26 °C for the olive fruit fly and *P. lounsburyi*. The relationship between survival rate and temperature was described by the nonlinear model for each species tested (Fig. 4).

Project staff found that olive fruit fly oviposition was most active between 22 and 30 °C, with few eggs laid at temperatures below 12 °C or above 32 °C. *Psyttalia lounsburyi* oviposition was most active between 18 and 26 °C, with few hosts parasitized below 14 °C or above 26 °C, whereas *P. humilis* was most active between 18 and 32 °C. The nonlinear model provided an excellent fit ($r^2 > 0.93$) for the relationship between reproduction success and temperature for each species tested.

(b) Parasitoid Interactions.

Six laboratory studies were used to compare the relative effectiveness and potential interactions between *P. humilis* and *P. lounsburyi*. In the first three tests, five infested olives containing third instar OLF larvae were exposed to two female *P. humilis* or two female *P. lounsburyi* only or to one female of each species simultaneously for 48 h. In the last three tests 10 or 20 infested olives containing third instar OLF larvae were exposed first to 10 or 20 females of either species for 48 h and then half of the previously exposed fruit were subsequently exposed to 5 or 10 female parasitoid of the other species. Host density varied among different tests to manipulate the parasitism and the degree of possible competition.

Parasitism by *P. humilis* was always higher than *P. lounsburyi* when the hosts were exposed to each species alone (Test1: $F_{1,72} = 41.1$, $P < 0.0001$; Test2: $F_{1,72} = 18.3$, $P < 0.0001$; Test3: $F_{1,38} = 54.1$, $P < 0.0001$) or exposed to both species simultaneously (Test1: $F_{1,76} = 148.8$, $P < 0.0001$; Test2: $F_{1,76} = 58.5$, $P < 0.0001$; Test3: $F_{1,38} = 47.7$, $P < 0.0001$). This suggests that *P. humilis* is more effective than *P. lounsburyi* under the laboratory conditions. Parasitism by *P. humilis* or *P. lounsburyi* was not affected by another species followed the subsequent exposure when the previous parasitism was low (Test 5, *P. humilis*, $F_{2,48} = 1.7$, $P = 0.19$; *P. lounsburyi*, $F_{2,48} = 0.2$, $P = 0.89$) or medium (Test 6, *P. humilis*: $F_{2,57} = 1.1$, $P = 0.35$; *P. lounsburyi*: $F_{2,57} = 0.8$, $P = 0.45$). However, when the previous parasitism was high (Test 4, *P. humilis*: $F_{2,27} = 1.5$, $P = 0.24$; *P. lounsburyi*: $F_{2,27} = 3.5$, $P = 0.04$), subsequent exposure to *P. humilis* reduced the parasitism by *P. lounsburyi*, suggesting that *P. humilis* seems to be more aggressive than *P. lounsburyi* in the laboratory tests.

Additionally, potential interaction between the released larval endoparasitoid *P. humilis* and one major resident ectoparasitoid, *Pteromalus kapaunae* (Pteromalidae) was investigated. A choice test was conducted to determine if female *P. kapaunae* could discriminate against OLF larvae that were parasitized by *P. humilis*. Olive fruit were first exposed to OLF in the fly's holding cage until each fruit contained 2−3 stings. The stung fruit were kept under controlled insectary conditions (≈ 24 ºC) for 8−9 d to allow the fly larvae to develop into early third instars. Half of these infested fruit were then exposed to female *P. humilis* individually for 24 h. Finally, one *P. humilis*-exposed fruit and one unexposed (OLF infested) fruit were exposed to one female *P. kapaunae* for 48 h. Each exposed olive was dissected to count the number of larvae inside the fruit. All OLF were dissected to determine if they had been parasitized by *P. humilis*. Larvae attacked by *P. kapaunae* were obviously paralyzed or contained eggs on the host surface. There were 40 valid replicates.

OLF host density was similar between the two groups of fruit ($F_{1,52} = 0.1$, $P = 0.735$). Percentages of attacked hosts on both fruit were not different ($F_{1,52} = 3.6$, $P = 0.064$) (Fig. 5). As expected, *P. kapaunae* indiscriminately attacked hosts previously parasitized by *P. humilis*, and may negatively affect introduced endo-parasitoids.

Objective 3: Conduct a statewide field-release of *Psyttalia lounsburyi* and *P. humilis* and monitor their establishment.

(a) Released Parasitoids.

The *P. lounsburyi* colony was initially established at European Biological Control Laboratory (EBCL) in 2002, with field-collected parasitized *B. oleae* from wild olives in Kenyan Burguret Forest (hereafter referred to *P. lounsburyi* (B)). A few number of *P. lounsburyi* that was originally collected in 2005 from South Africa and maintained on *C. capitata* at EBCL was also sent to California for field release.

The *P. humilis* (N) colony was initially established at EBCL with material reared from *B. oleae* collected in wild olives in Grootfontein and Meteorite, Namibia in 2007, with additional collections in 2008. The *P. humilis* (K) colony, originally established with parasitoids collected from tephritids infesting coffee in Kenya. *P. humilis* and *P. concolor* are morphologically distinguishable, but recent genetic analysis showed separation of these populations, suggesting *P. humilis* an available name for the sub-Saharan populations. During the study, molecular methods were used to confirm the origins of these populations after their arrival in California.

Both *P. humilis* (Namibian origin, hereafter referred to *P. humilis* (N)) and *P. lounsburyi* used in field release were supplied by the USDA-ARS EBCL in Montferrier, France prior to 2009, and then by the Israel Cohen Institute of Biological Control (ICIBC) in Bet Dagan, Israel after 2009. In 2010, additional *P. humilis* (Kenyan origin, hereafter referred to *P. humilis* (K)) were supplied by the USDA-APHIS-PPQ, MOSCAMED Parasitoid Rearing Facility at San Miguel Petapa, Guatemala.

(b) Field release sites

Based on laboratory studies of best locations for parasitoid establishment, field releases were made in San Luis Obispo County and San Mateo County, CA (Fig. 6). Four sites were selected in urban or rural San Luis Obispo area: (1) the Broad Street site was consisted of an ≈ 300 m^2 parking lot by the street; (2) The Cal Poly site was located on the Southwestern corner of the California Polytechnic State University campus, with olive trees distributed within 300 m on Grant Avenue, Deer Road, and the nearby foot hills; (3) The Avila Beach site was consisted of three neighboring home yards on the Avila Valley Drive; and (4) The Righetti Road site was located at the end of the road with olive trees lined up along a road side. These four sites were at least 5–16 km apart from each another. In San Mateo County, the site was consisted of the 131 acre Cañada College campus in the eastern foothills of the Santa Cruz Mountains, Redwood City, CA. Olive trees distributed along roadsides, parking lots, buildings, and in an unmanaged olive grove in the west of the campus, mixed with oak and other trees. In all these sites, the olives were matured and mixed varieties of trees naturally infested by *B. oleae*.

Because olive phenology, varieties, site size, number of trees, tree size, fruit load, fruit maturity, host density, or microclimates all could vary among different sites, it was difficult to quantitatively compare percentage parasitism by the parasitoids among different sites. Furthermore, quality of received parasitoids could also vary among different shipments. Therefore, the major aim for the field release was to determine the recovery and establishment of released parasitoids.

(c) Field release and recovery of parasitoids

Over the three year period (2009-2012), 30,328 female parasitoids were released, with 7,793 *P. lounsburyi* from Kenya, 2,200 *P. lounsburyi* from South Africa, 5,300 *P. humilis* from Kenya, and 15,035 *P. humilis* from South Africa. In San Luis Obispo, two, six, five, and two releases of both *P. humilis* and *P. lounsburyi* were conducted at the Broad Street, Cal Poly, Avila Beach and Righetti Road sites, respectively, from 2008 to 2012. In San Mateo, four, three and one releases were conducted in the north, south, and west of the Cañada College campus from 2010 to 2012. The number of parasitoids released (ranged from 200 to 3700 females) each time was based on quantities received in the shipment.

Methods used for different releases were similar. Upon arrival in California, all parasitoids were held in Bug Dorm 2 cages with water and honey for 1–2 d prior to the release. Parasitoids were then aspirated into vials in a group of 40 females and 10 males. A piece of moist tissue paper was placed on the bottom of the vial to provide water and serve as a pad to reduce possible injury to the parasitoids when they were sucked into the vial. Honey was streaked on the vial lid. Not all received males were used, as the female and male parasitoids had been hold together for at least one week from emergence, shipped to California, and prepared for the release. All females were thus assumed to have mated already by time of release. The vials were hung on tree branches to allow the parasitoids walking out to search infested olives, and distributed evenly among 3-12 selected trees for each release, depending on the site size.

A pre-release sampling was conducted immediately prior to each release to determine the presence or absence of any parasitoid species. Post-release monitoring of parasitoids was taken as early as one week later following each release, and then continued about once per month throughout the fruit seasons. Olives were picked up randomly from different trees with no preference given to infestation level and physical appearance for the pre-releasing sampling, or collected at random in the immediate vicinity of the same trees in which the parasitoids were released for the post-release sampling. Collected fruit from each tree were separated, placed in plastic containers (11×11 cm) covered with organdy cloth and fitted with a raised metal grid (2 cm high) on the bottom (which suppressed mold formation and allowed pre-pupal flies to drop to the bottom of the container, where they could be easily collected), and transported to the laboratory in insulated coolers. Host density was calculated based on the total number of emerged host pupae while parasitism was estimated based on the numbers of emerged flies and wasps.

Results from post release (including sites where new releases overlapped past releases) found fruit fly density varied at different sites and time, and generally increased in the fall and then decreased in later fruit seasons. *P. humilis* were recovered within the fruit season following the releases at all sites, and parasitism was below 23.9%. However, *P. humilis* was not recovered consistently.

At Cal Poly1, 21 *P. humilis* were recovered on 8 February 2011, representing the only recovery after winter of this species in San Luis Obispo. Before 2011, only 200 female *P. lounsburyi* were released at the Broad Street site, and the parasitoid was not recovered in the following fruit seasons. In 2011, after release of 5393 female *P. lounsburyi* at the Cal Poly site, the parasitoid was recovered in the fall 2012, marking the first following fruit season recovery of this parasitoid in San Luis Obispo. The parasitoid was not recovered in spring 2013, however, host populations were very low and limited sampling was conducted in order to not remove any established parasitoids.

Most parasitoids emerged from the hosts pupated during the first week following the field collection under laboratory conditions, and very few emerged from pupae collected 3 wk later. This pattern was similar for both parasitoid species (week: $F_{2,51} = 10.54$, $P < 0.001$; species: $F_{1,51} = 0.52$, $P = 0.603$). Developmental time of the emerging adult parasitoids was different between parasitoid species or sex; males emerged earlier than female for each species, and *P. humilis* emerged earlier than *P. lounsburyi* (species: $F_{2,595} = 9.05$, $P < 0.001$; sex: $F_{2,595} = 2.68$, $P < 0.01$, species × sex: $F_{3,595} = 0.49$, $P = 0.622$). This also reflected the cumulative emergence patterns.

Two resident parasitoids *P.* nr. *myopitae* and *Eupelmus* sp. were recorded from San Luis Obispo. *P.* nr. *myopitae* was common during the pre- or post-release samplings, and parasitism varied among sites and seasons (ranged from 0 to 40.8%).

At San Mateo County sites, *P. humilis* was recovered within the same fruit season but was not recovered after the summer and before the new release, while *P. lounsburyi* was also recovered prior to the new release each year at all spots. This showed that *P. lounsburyi* dispersed and persisted through the spring and early summer despite the low number of wasps released in 2010.

Monthly sampling showed the presence of *B. oleae* as long as fruit were available throughout the sampling. The fly density generally increased in the fall but decreased after the spring (Attachment 1 Fig. 7). Similarly, the month sampling also showed that *P. humilis* was recovered only within the same fruit seasons, while *P. lounsburyi* were recovered after the summer including the 2012 fall (Attachment 1 Fig. 7). Parasitism by *P. lounsburyi* substantially increased followed the 2011 release. *P.* nr. *myopitae* were collected from this coastal site (Attachment 1 Fig. 7).

(d) Field Dispersal of Released Parasitoids

It was feasible to monitor the field dispersal of *P. humilis* and *P. lounsburyi* at the Righetti Road site in San Luis Obispo, because this site was located in a rural area, and surrounded by grape and avocado orchards. Several olive patches with similar varieties and physical appearance of olive trees were grown at the edges of different avocado orchards. Initially, *P. humilis* (N) were released in the fall of 2008 at this site, but samplings in 2009 and 2010 did not recover this parasitoid. On April 15, 2011, 7 out of the 23 trees were found to still bear clusters of infested olives from 2010, and both parasitoids were then released into these trees (Table 2). These old fruit from 2010 all dropped by May or June 2011 and new olives become available in late July.

Three patches located at different radical distances (≈ 250, 500, 1000 m) from the original release site were sampled from August to November 2011 to estimate possible survival and dispersal of the released parasitoids in April. The sampling was ended by the end of November after all fruit dropped. Four to six trees were sampled at each spot. Mean parasitism was estimated based on the emerged number of flies and parasitoids form the field collection.

Following the release in April 2011 at the Righetti Road site, both *P. humilis* and *P. lounsburyi* were recovered in the fall 2011 in the original release site and two other sites located approximately 250 and 500 m away from the original release site. Additionally, 2 *P. lounsburyi* were also recovered on 25 November 2011 from another site located about 1000 m away from the original release site. At each spot, parasitism by both parasitoids increased over the fall fruit season (Patch 1: *P. humilis*, $F_{2,10} = 62.7$, $P < 0.001$; *P. lounsburyi*, $F_{2,10} = 5.3$, $P = 0.027$; Patch 2: *P. humilis*, $F_{1,7} = 42.1$, $P < 0.001$; *P. lounsburyi*: $F_{1,7} = 44.3$; Patch 3: *P. humilis*: $F_{2,11} = 49.6$, $P < 0.001$; *P. lounsburyi*: $F_{2,11} = 109.2$, $P < 0.001$). Because all old fruit from 2010 dropped by May or June, both parasitoids sustained on *B. oleae* in infested old olives for long periods of time when hosts were rare, and dispersed from the April release site to new sites; thereby bridging a gap between populations of olive fruit fly developing on 2010 fruit and those infesting 2011 fruit. Recoveries were also made in 2012 and 2013 at the release site and beyond.

This project represented a true collaboration from different research agencies and the public sector. UC Berkeley coordinated and conducted the Quarantine activities and field release and monitoring in California.

Field releases were accomplished only with the assistance of individual olive farmers and landscape managers that allowed releases of parasitoids on their property and accepted a no-spray policy in order for the pest and natural enemy populations to be studies. Cañada College was a key collaborator for releases in San Mateo County, and students often assisted with release and recovery efforts.

One of the program's major accomplishments was just getting the parasitoid material from foreign locations and into quarantine and then insectary colonies. This was a major hurdle that has hampered past biological control efforts against olive fruit fly. CDFA, USDA, and the Israel Cohen Institute of Biological Control, Bet Dagan, Israel coordinated the various aspects of foreign exploration, insectary, and rearing and shipping operations.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The major activities of this project were to (1) evaluate new olive fruit fly (OLF) parasitoids that may have better behavioral or ecological traits than two released parasitoids that are already approved for field release (*Psyttalia lounsburyi* and *P. humilis*); (2) develop models to predict the potential distributions and impacts of these two selected parasitoids and other potential parasitoid species (dependent on Objective 1); and (3) conduct a statewide field-release of *Psyttalia lounsburyi* and *P. humilis* and monitor their establishment.

All of the stated activities were accomplished within the project period.

The short term goal was to select natural enemies, rear and release the best suited species, and get parasitoids established in California. This was accomplished.

The long term goal is now to monitor continued establishment and continued rearing and release of *P. lounsburyi* – the parasitoid that was most recovered – and *P. ponerophaga* – the parasitoid that showed the most promise in the Quarantine.

During the project, there were 14 peer-reviewed articles published, far exceeding our initial expectation, and more articles are being drafted or have been submitted. The key article "Olive fruit fly: managing an ancient pest in modern times (KM Daane, MW Johnson, Annual Review of Entomology 55, 151-169)" has been cited 68 times (Google Scholar).

Grower outreach was also a component of this study, although less productive only because the research detailed that there were no actionable parasitoid species that would help provide control for olive fruit fly in California's Central Valley. Presentations were made at the key olive grower meetings in California's more southern San Joaquin Valley meeting in Tulare, with an attendance of approximately 80 olive growers and PCAs, and at the more northern Sacramento Valley conference, with an attendance of approximately 120 olive growers. The attendance indicates the farmers' interest in this work and the continuing importance of this pest. Current studies are investigating other natural enemies that might survive better in these interior valley olive regions.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

California coastal olive oil producers are the primary beneficiaries. Interior Valley table and oil olive growers also benefited, but primarily through the increase knowledge of olive fruit fly biology. Home owners with olive trees also will benefit.

Project staff does not have quantitative data on the effects of this project. With continued work, the long term goals are to reduce the need to treat for olive fruit fly, especially in coastal areas. This outcome would be quantifiable through pesticide reductions.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The successful recovery of both parasitoids in the last fruit season may be attributed to the fact that the release sites were located along the coastal areas of California with milder summer temperatures, and some olive fruit are still available in early spring. In particular, the recovery of *P. lounsburyi* in 2011 and 2012 following a small number release in 2010 in Cañada College seems to suggest that this species has a better chance to permanently establish in California. One of the most serious challenges to establishment of introduced parasitoids for control of OLF in California and elsewhere is host continuity. To bridge the seasonal fruit gap project staff are suggesting the use of a mix of olive tree cultivars, including some capable of carrying fruit on the tree late into the spring. Parasitoids such as *P. ponerophaga* that seems to enter diapause at low temperature may also have a better chance to bridge this gap. Further study will conduct more non-target risk evaluation of *P. ponerophaga* to get a release permit (still pending on more evaluations) and a thorough study on possible factors inducing the parasitoid's diapause. Monitoring the establishment of released parasitoids, and develop model to predict their potential and distribution will also be continued.

The costs and difficulties in rearing the parasitoids, especially *P. lounsburyi* and *P. ponerophag*a limited the numbers that could be released and studied. The release from Quarantine of *P. ponerophaga* has also been disappointing, and project staff will continue to work towards that goal.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

A list of current publications (additional publications are planned):

Daane, K.M., Johnson, M.W., Pickett, C.H., Sime, K.R., Wang, X.G., Nadel, H., Andrews, J.W., Hoelmer, K.A. 2011. Biological control of the olive fruit fly in California. *California Agriculture* 65: 21–28.

Daane, K.M., Wang, X.G., Johnson, M.W., and Cooper, M.L. 2013. Low temperature storage effects on two olive fruit fly parasitoids. *BioControl* 58: 175-185.

Daane, K.M., Wang, X.G., Nieto, D., Johnson, M.W., Pickett, C.H., Hoelmer, K.A., Kirk, A.A. 2013. Classical biological control of olive fruit fly in California: field release, establishment and potential interspecific interactions of parasitoids. *Environmental Entomology* (submitted).

Hoelmer, K.A., Kirk, A.A., Pickett, C.H., Daane, K.M., and Johnson, M.W. 2011. Prospects for improving the biological control of olive fruit fly, *Bactrocera oleae* (Diptera: Tephritidae), with introduced parasitoids (Hymenoptera). *BioControl Science and Technology* 21(9): 1005–1025.

Johnson, M.W., Wang, X.G., Nadel, H., Opp, S.B., Lynn-Patterson, K, Stewart-Leslie, S., Daane, K.M., 2011. High temperature impacts on olive fruit fly populations in California's Central Valley. *California Agriculture* 65: 29–33.

Johnson, M.W., Daane, K.M., Wang, X.G., Yokoyama, V.Y., Pickett, C.H., Hoelmer, K.A., Kirk, A.A. 2012. Biological control of olive fruit fly. *IOBC-WPRS Bulletin* 79: 79–85.

Pickett, C. H., Bon, M. C., Hoelmer, K. A., Kirk, A. A. He, Y., Rehman, A., and Daane, K. M. 2013. Phylogeography of the olive fruit fly, *Bactrocera oleae* (Diptera: Tephritidae), and foreign exploration for its natural enemies in the foothills of Himalayan Asia. *Annuals of the Entomological Society of America* (in press)

Wang, X.G., Johnson, M.W., Opp, S.B., Krugner, R., Daane, K.M. 2011. Honeydew and insecticide bait as competing food resources for a fruit fly and common natural enemies in the olive agroecosystem. *Entomologia Experimentalis et Applicata* 139: 128–137.

Wang, X.G., Johnson, M.W., Yokoyama, V.Y., Pickett, C.H., and Daane, K.M. 2011. Comparative field evaluation of two olive fruit fly parasitoids under different climatic conditions. *BioControl* 56: 283–293.

Wang, X.G., Levy, K., Son, Y., Johnson, M.W., and Daane, K.M. 2012. Comparison of the thermal performance between a population of the olive fruit fly and its co-adapted parasitoids. *Biological Control* 60: 247–254.

Wang, X.G., Levy, K., Nadel, H. Johnson, M. W., Blanchet, A. Argov, Y, Pickett, C. H., and Daane, K. M. 2013. Overwintering survival of olive fruit fly and two introduced parasitoids in California. *Environmental Entomology* 42(3):467-476.

Yokoyama, V.Y., Rendón, P.A., Wang, X.G., Opp, S.B., Johnson, M.W., Daane, K.M. 2011. Response of *Psyttalia humilis* (Hymenoptera: Braconidae) to olive fruit fly (Diptera: Tephritidae) and conditions in California olive orchards. *Environmental Entomology* 40: 315–323.

Yokoyama, V.Y., Wang, X.G., Aldana, A., Cáceres, C.E., Yokoyama-Hatch, H., Rendón, P.A., Johnson, M.W., Daane, K.M. 2012. Performance of *Psyttalia humilis* (Hymenoptera: Bracondidae) reared from irradiated host on olive fruit fly (Diptera: Tephritidae) in California. *Environmental Entomology* 41: 497–507.

List of national and international conference presentations from this project:

Johnson, M.W., Daane, K.M., Wang, X.G., Yokoyama, V., Pickett, C.H., Hoelmer, K.A., Kirk, A.A. Biological control of olive fruit fly. 5th IOBC/ WPRS working group, Integrated Protection of Olive Crops. Jerusalem, Israel, 15-20 May 2011.

Daane, K. M. et al. Biological control of the olive fruit fly. *UCCE Insect Management on Olives*. Tulare, CA. Jun. 2011.

Daane, K.M., Wang, X.G., Johnson, M.W., Pickett, C.H., Hoelmer, K. Biological control of the olive fruit fly: when parasitoid evolution and crop domestication interfere with a beautiful plan. 98th Annual Pacific Branch Meeting, Entomological Society of America, Tahoe, NV, 7-10 April 2013.

USDA Project No.: 3	Project Title: Areawide mating disruption for vine mealybug in grapes	
Grant Recipient: University of California, Berkeley	**Grant Agreement No.:** SBC10003	**Date Submitted:** December 2013
Recipient Contact: Kent M. Daane	**Telephone:** 559-284-5931	**Email:** kdaane@ucanr.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The vine mealybug (VMB) is an invasive vineyard pest (ranked first in pest importance by the American Vineyard Foundation in 2006) and is a vector of grapevine leafroll-associated viruses (GLRaV) (ranked first in pest importance in the 2008 American Vineyard Survey). Although University and industry researchers had developed chemical and biological controls for VMB, none had resulted in the exceptionally low 'vector' densities needed to eliminate GLRaV spread. Mating disruption or the 'use of the sex pheromone to reduce mating' was tested as an additional control tool. Areawide application of mating disruption (MD) was tested in Napa County, with a coalition of 29 different vineyards and using plastic pheromone dispensers (Checkmate® Suterra Inc., Bend, OR; 150 mg a.i. per dispenser) to deliver the pheromone. Results from pheromone trapping identified problem blocks that required additional chemical treatments and showed that areawide MD lowered overall mealybug density. Also tested were novel dispensers to more effectively and economically deliver the synthetic sex pheromone. In California's northern interior winegrape region and San Joaquin Valley vineyards, results showed that meso-dispensers (36 per acre) provided the same levels of control as plastic dispensers (250 per acre). Trials with puffer technology suggested that this method of pheromone deployment would not be effective because of the flight response of the adult male mealybug. In field studies, a key natural enemy, *Anagyrus pseudococci*, was shown to be attracted to the mealybug sex pheromone (lavandulyl senecioate) and use of the pheromone resulted in increased parasitism rates.

Project Goals:
(1) Establish vineyard regions employing areawide MD in concert with more effective insecticides as a control tactic for VMB and the resulting GLRaV infections.
(2) Study the effectiveness of different delivery systems for the synthetic sex pheromone in order to improve program efficiency and reduce costs.
(3) Study the VMB mating biology in order to improve control programs.

Objective 1: *Areawide MD and GLRaV.*
The VMB female does not have wings and is relatively immobile as she progresses to the adult stage. In contrast, the adult male mealybug is the only stage with wings. It is fragile, often living for only a

few days. The mature female mealybug emits a sex pheromone to attract the male. The synthetic version of this sex pheromone (Lavandulyl Senecioate) can be loaded into rubber septa to monitor male flight or be loaded into plastic dispensers to control the pest through a practice termed "mating disruption." The goal of MD is to place so much synthetic sex pheromone in the vineyard that the male mealybug has difficulty finding the female to mate; this delays and/or reduces mating, which leads to decreased egg production, and therefore, pest densities in subsequent generations. Earlier studies have shown that MD might be best utilized over large areas. This practice was tested in Napa County, with a coalition of 29 different vineyards. Plastic pheromone dispensers (Checkmate® Suterra Inc., Bend, OR; 150 mg a.i. per dispenser) were deployed in 2011 and 2012 and the mealybug pest density was monitored and compared with control fields. Overall, the trial showed that areawide control can be successful with reduced or eliminated spread of the VMB and lowered overall damage in most locations. The results suggested that an important aspect of an areawide control program might be the trapping that helped identify hot spots where the pest population density is high and additional treatments were necessary.

Objective 2: *Study the effectiveness of different delivery systems for the synthetic sex pheromone in order to improve program efficiency and reduce costs.*
One of the greatest hurdles for the widespread adoption of MD for the VMB is the cost of the program in comparison with available effective insecticides. To reduce costs, methods to deliver the pheromone more effectively were investigated. These included the use of 'puffer' spray cans and 'meso' dispensers that reduce the number of dispensers per acre needed. The standard MD program used 250 dispensers per acre – or about one dispenser hand-placed on every second or third vine in the vineyard. Puffers require only 2 per acre and meso dispensers require only 36 per acre. If effective, this would be a labor cost savings. Studies looked at both the effectiveness (mealybug damage) and the science (pheromone plumes) for both of these innovations. Results suggest that puffers may not be as effective as dispensers because the male mealybugs are weak flyers and more 'point' sources of pheromone would provide better control. The meso-dispensers (at 36 per acre) actually did as well as the standard dispenser (250 per acre), but still require field crews to walk the vineyard and hand-place on vines throughout each block.

Objective 3: *Study the VMB mating biology in order to improve control programs.*
Female mealybug requirements for viable egg production showed that mating was required, but many female insects can reproduce parthenogenetically (without mating), and if this were the case for VMB, than MD would have that inherent flaw. Along with mating behavior, male flight was studied and, as before, the data suggest that the males are not strong flyers and move very little from their source or upwind to follow a plume of pheromone. The last study looked at the attraction of one of the key parasitoids (called *Anagyrus pseudococci*) to the mealybug pheromone. Parasitism levels were higher near VMB pheromone lures, suggesting that the parasitoid used the pheromone just like the adult male mealybugs – to help locate the female pest. These results suggest that the use of MD may improve other sustainable controls such as biological controls.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

All of the proposed research activities were completed. Studies were designed to test, demonstrate and improve MD for VMB in five locations, each with a different project goal. These were (1) Napa Valley areawide MD and GLRaV trials; (2) Lodi-Woodbridge trials to test MD dispensers vs. insecticides; (3) Lodi-Woodbridge trials to test MD using 'puffers" to disperse the sex pheromone; (4) Fowler (Fresno) and Napa trials to follow aerial pheromone plumes emitted from puffers; and (5) San Luis Obispo and Denair trials to test deployment rates of pheromone dispensers.

Objective 1: *Establish vineyard regions employing areawide MD in concert with more effective insecticides as a control tactic for VMB and the resulting GLRaV infections.*
(a) Napa (areawide): Trials in Napa formed the foundation of the areawide MD demonstration project. From 2011 to 2013, the vineyard regions used did vary slightly, and more studies were added in regions with more VMB and decreased the studies in regions where there was less VMB pressure – either through repeated insecticide use or – as was the case in 2013 – because the program was effective. Here, the middle section (2011-2012) of the project is highlighted, where work was conducted in cooperation with 29 growers to evaluate the effectiveness of VMB MD in three ~150 acre treatment sites within Napa County. The major participating growers had small acreage (<10 acres) but there were some larger Napa farms including 20, 25, 30, 33, 43, 67, and 76 acre vineyards. To coordinate these activities, members of the University of California (UC) team met with growers before, during, and after the project.

Each 150 acre MD block was paired with nearby and similarly sized vineyard sections (84, 93, 102, and 138 acres) that had standard insecticide controls, but no mating disruption. These trials were difficult to set up because of the large number of growers involved, each utilizing different control tactics; however, the design and inherent complications was exactly what the program sought to demonstrate (rather than scientifically study).

For these areawide trials, the 'standard' MD program was used, which is the placement of plastic pheromone dispensers (Checkmate® Suterra Inc., Bend, OR; 150 mg a.i. per dispenser) at a rate of 250 per dispensers acre (about every third vine in winegrapes planted at 750 vines per acre). (See Attachment A, Photo 1)

To evaluate the program's effectiveness, a number of sampling techniques were used, but the most important were the use of the 'red delta pheromone traps' (See Attachment A, Photo 1) that were baited with the VMB sex pheromone. If MD is effective, the trap counts should be low because the male mealybugs will not be able to find the female mealybugs – or the pheromone traps. Pheromone traps were deployed in a grid within each of the 150 acre blocks as well as in the paired control blocks, typically putting the traps out during peak flight periods in July, September and October of each year. The numbers of male mealybugs in each trap are then counted in the laboratory (the male mealybugs are very small and an accurate count cannot be made in the field).

The VMB populations were also sampled within each 150-acre area in mid to late May and again in early August 2011 (first year), while one to two 1500-vine blocks were sampled at each control site. To accomplish this sampling, 150 vines were visually inspected within each individual block (about 30 growers) using a grid pattern: 10 samples per row were sampled in 15 rows and sampled vines were 10 vines apart. On each vine, the field crew recorded the number of nymphs, adults and ovisacs, mummified mealybugs and natural enemies, as well as the presence of honeydew, sooty mold and ants.

To determine cluster damage, numbers of mealybugs were counted and mealybug damage near harvest-time was rated, typically in September and October (2010, 2011, 2012), on 5-10% of the vines within each areawide block. One cluster per vine was rated for VMB density and honeydew accumulation on a 0–3 scale, with 0 meaning no mealybug/honeydew damage, 1 meaning 1-2 mealybugs/some honeydew present, 2 meaning 3 to 10 mealybugs with honeydew accumulation, and 3 meaning >10 mealybugs and considerable honeydew damage (an unmarketable cluster).

The results were very promising, especially in light of some of the unexpected obstacles. As an example, a comparison of 2011 and 2012 damage within the same block (one of three areawide blocks), with the small white to red circles in each figure representing counts of male mealybugs caught in pheromone traps in fall collections (September or October 2011) – the larger and redder the circles the higher the captures of male mealybugs in that region of the block (Fig. 1). Results show that for this areawide section there were two mealybug 'hotspots' (inside the yellow circle) in 2011 that needed to be targeted for control .These are the mealybug populations that may result in infestation of nearby blocks. In other words, mealybug control should be considered as a regional issue rather than a vineyard-by-vineyard issue. The infested blocks will serve as pest inoculums for the other 'clean blocks'' in the region. For growers concerned with GLRaV management, attaining a 'zero' mealybug population density would be difficult to achieve and nearly impossible to maintain with a source population of mealybug in the region.

Results from samples comparing fall 2011 (See Attachment A, Figure 1A) to fall 2012 (See Attachment A, Figure 1B) showed no increase (spread) of VMB from 2011 to 2012. Male mealybug captures in 12 of 14 traps in "hotspots" with measurable mealybug populations showed decreases from 2011 to 2012.

A larger analysis of all sites and controls is currently being conducted; however, the insights from the material presented are very promising. First, the sites where the VMB population remained high are those that did not apply the UC Integrated Pest Management (IPM) suggested insecticides. The areawide trapping program showed the participating growers where the source populations for the mealybugs were located. Participating growers should then treat problem blocks to reduce future damage.

Second, one of the unexpected outcomes was that many of the participating growers in blocks with low mealybug infestation levels decided not to apply insecticides that offset the costs of the pheromone. This was not the original plan, which called for areawide MD with areawide insecticides in order to drive down the population to such low levels that the mealybugs could not be detected. Still, without insecticide applications the pest populations remained low. In fact, in 2013 the 'Napa County Winegrape Pest and Disease Control District' that helped to sponsor the program decided that populations were so low in 2012 at the studied sites that they wanted the trial moved to a new location with greater mealybug pressure (the other two areawide sections had lower population densities than shown in Figure 1). Moreover, many of the growers that participated in the 2011 to 2012 trials continued to purchase (without subsidies) pheromones for MD in 2013.

Third, for organic growers with mealybugs, the control tactic can now include MD with multiple applications of an oil based insecticide along with parasitoid (*A. pseudococci*) release to prevent pest damage; however, if a dense population of the mealybug does establish, conventional insecticides will be needed.

Because of the success of the 2011 and 2012 program, after consulting with the Napa Valley Vine Mealybug Task Force, and participating grower consult, the areawide project was moved to a different region in 2013 where there was greater mealybug pressure. The concept remains similar, but in this year the program also recorded a mixture of vine mealybug (*Planococcus ficus*) and grape mealybug (*Pseudococcus maritimus*), as well as methods to reduce costs, such as dispenser density.

(b) Napa Grapevine Leafroll-Associated Viruses (spray-all-the-time): The areawide project included GLRaV. It is actually these pathogens, which cause grape leafroll disease (GLD), that are the primary concern with the different vineyard mealybugs. GLRaV symptoms are a downward curling and red coloration (most prevalent in red varieties) of the leaves (See Attachment A, Photo 2). GLRaV pest status results primarily from a reduction in wine quality and a delay in ripening, and therefore, harvest-time.

Two of the critical questions are 1) how small does the mealybug population have to be to control the spread of GLRaV-3; and 2) can the farmer simply spray each year to kill mealybugs and thereby prevent the spread. This could not easily be studied in the areawide plots because the virus epidemiology is not clearly understood – including how long before symptoms are visible after inoculation.

A hypothesis was tested that newly planted vineyards could be sprayed repeatedly for mealybugs in order to prevent the spread of GLD in a ca. 40 ac ‘Cabernet Sauvignon vineyard in Napa Valley. The block, planted in 2008, was surrounded on three sides by older blocks with moderate levels of GLRaV infested vines; blocks to the south and west were removed in 2010 and 2011, respectively. The block was split into two sections, east and west, with each section consisting of 120 rows and 115 to 125 vines per row. Each section was divided into 3-row plots. Treatments are (i) zero tolerance for mealybugs; and (ii) a standard no insecticide treatment during block establishment.

To achieve “a zero tolerance for mealybugs” the grower cooperator applied annual foliar and systemic insecticide treatments. Foliar insecticides were applied using an overhead spray rig that targeted insecticides onto three-row sections, and systemic materials were applied through the drip irrigation system, which has line valves in each row. Insecticide treatments were maintained from 2009 to 2012, and samples were collected from 2009 to 2013. In each section treatments were assigned in a randomized block design, with each block consisting of a 30 row section. There are twenty replicates per treatment (five per block) in each of the two vineyard sections.
Each fall, mealybugs were mapped with visual counts and/or pheromone traps, and GLD incidence. Locations of GLD symptomatic vines were marked using a handheld mapping device (Garmin GPS Map 76) and plastic flagging tape, and petiole samples were collected from all vines with possible GLD symptoms, as well as five vines without leafroll symptoms (negative controls), and five known infected vines from an adjacent infected block (positive controls). Petioles were analyzed for GLRaV-3 via RT-PCR with LC1F/LC2R and 4711-130F/580R primers, and GLRaV-3 group determined via RT-PCR and fragment analysis. Treatments will be compared using both ANCOVA (treatment and location as variables) and correlation analyses.

The results were surprising and quite informative. No mealybugs were found during visual searches of either control or treatment rows (from 2009 to 2012, the 2013 data have not yet been collected). The pheromone trap used in 2011 did, however, indicate the presence of grape mealybugs (GMB), but no VMB. Data from the visual search suggested that the new planting initially had few or no mealybugs, while the pheromone traps captured male GMB from nearby or on-site, so perhaps mealybug populations are ephemeral, too low to be detected by the visual search, or moved in from adjacent vineyards. This leads to the possibility of GMB crawlers being blown in on prevailing winds from adjacent leafroll-infected blocks.

Each year, a few new GLD vines were found. Two new GLRaV-3 infected vines were detected in 2012, compared to six new infections in 2011 (Yr 3) and one new infection each in 2010 (Yr2) and 2009 (Yr1). The pattern of infected vines (See Attachment A, Figure 2) indicated that infections were not spreading out from previously-infected vines, but instead were randomly distributed within the plot.

More important, there were five vines in each treatment, insecticide (white text, red background) and control (black text, white background), infected with GLRaV-3 and the infections were not grouped (See Attachment A, Figure 2). Also multiplex Polymerase Chain Reaction (PCR) followed by fragment analysis showed that GLRaV-3 infections in the spray trial block were predominantly -3a with a few mixed infections of -3a and -3c, or -3a and -3d. GLRaV-3b was the only variant recovered from leafroll-infected vines in blocks to the north and west of the spray trial block.

These data suggest, first, that even with populations of mealybugs so low that they could not be detected with intense visual samples, GLRaV infections still occurred, although very slowly. Second, spraying every year regardless of mealybug presence will not reduce new infestations (given that the mealybug density is low). The results suggest that the insecticide used, while very effective, still allowed GLRaV transmission because these neonicotinoid, lipid biosynthesis and insect growth regulator materials all require the mealybug to feed in order to acquire the pesticide. Third, because of the different GLRaV species found in the vineyard, the mealybugs entering the field probably came from multiple sources outside of the block, perhaps in mealybug crawlers blown in by the wind.

The conclusion is the best mealybug and GLD control may be an areawide program because your neighbors' mealybug and GLD problems may eventually be yours, and vice-versa.

Objective 2. *Study the effectiveness of different delivery systems for the synthetic sex pheromone in order to improve program efficiency and reduce costs.*
Over the three year period a number of trials were conducted to improve mating disruption efficiency. This is because the greatest obstacle to widespread adoption is the cost. Mating disruption works better – for most insect species – when there is a low pest density. This should be intuitive: the lower the pest density is, the harder it will be for the males to find the female. This is especially true for mealybugs that are clumped and, for this reason, mating disruption does not work well at high mealybug densities. Therefore, mating disruption for vine mealybugs should be combined with insecticide sprays, at least until the population density is very low. Growers that pay for insecticides to control mealybugs are more adverse to the additional costs for mating disruption. To lower costs, studies focused primarily at reducing the amount of pheromone active ingredient (and standard dispensers) placed in the field, and changing the dispenser structure to reduce the labor costs in hanging the dispenser. Here, a report from one year from each research group is presented to show the progress and limitations of these alternative deployment strategies.

(a) Lodi-Woodbridge (meso dispensers): The commercial available dispenser is the Checkmate dispensers (Checkmate® Suterra Inc., Bend, OR) that has 150 mg a.i. per of pheromone per dispenser. The suggested rate is 250 dispensers per acre, typically hung in May. The costs of hanging means that a field crew must go down each row and hang a dispenser every 2-3 vines. 'Meso' dispensers hold and release a larger column of the sex pheromone (ca. 1000-2000 mg a.i. per dispenser). This means that each acre might require only 30-50 dispensers per acre, a reduction in labor costs of placing the material in the vineyard. (See Attachment A, Photo 3)

The standard vs. the meso-dispenser were tested in commercial vineyards in Lodi, California, along with a grower standard insecticide, in a large contiguous block of winegrapes. The acreage was uniformly infested with low densities of VMB, and had received prior annual pesticide treatments.

The treatments in 2011 were meso-dispensers (Suterra Inc., Bend, OR) deployed at 36 dispensers per acres, the standard CheckMate® VMB-XL dispensers (Suterra Inc., Bend, OR) at full rate at 250 per acre, and no MD (the grower standard insecticide treatment alone). In 2012 the treatments were meso-dispensers deployed at 36 per acre, standard Checkmate dispenser applied at either 250 dispensers per acre or 175 dispensers per acre, and the grower insecticide treatment.

In both years (2010 and 2011), dispensers were hung on the fruiting wire in April or May, before the first large male flight. Each plot was a minimum of 10 acres, and treatments were replicated four times in a Randomized Complete Block design. The treatments were spread throughout the ranch in order to reduce near-neighbor impact of the sex pheromone volatiles.

VMB were sampled, similar to the previous description, using a visual search of vines twice during the season (June and August 2010 and 2011), and a harvest-time rating of clusters for damage (August), and pheromone trap counts for adult males once a month (June to September 2010 and 2011).

The most important results are the cluster ratings (See Attachment A, Figure 3). In 2011, the cluster ratings showed no mealybugs or mealybug damage in the Admire (insecticide treatment), and higher levels in the standard plastic dispenser and meso dispenser treatments – but no difference between treatments (See Figure 3A). Pheromone trapping data (adult male flight) showed an increase at the end of the season in the plastic dispenser treatment, while male flight counts remained near zero in the Admire and meso dispenser treatments (suggesting that the meso-dispensers lasted slightly longer in the field).

Harvest samples in 2012 showed no difference among treatments ($\chi^2 = 5.635$, df = 9, $P = 0.776$; Figure 3A). This is a positive result that indicates MD performed as well as insecticide applications. There were actually more unmarketable clusters (category "3") in the insecticide treatment than the mating disruption treatments.

In March-April 2013, this project was redesigned, in cooperation with Suterra Inc. (the manufacturer of the MD dispensers) to test novel dispensers that will have a more even release rate (of the sex pheromone). The two years data combined did not provide any clear indication that meso-dispensers would be better, or worse. What may be implied (no statistics) is that in 2011, cluster damage was slightly higher in the meso-dispensers treatment, at the end of that season, pheromone trap counts showed the meso-dispensers were still active while the number of adult male mealybugs increased in the insecticide and standard dispenser plots; in 2012, the meso-dispenser treatment had slightly lower cluster damage.

(b) Puffer delivery system – field trail: Another method to reduce costs of mating disruption would be the use of 'puffers,' which are basically aerosol spray cans, with a computer chip, that are housed in a brown plastic container (it looks a little like a bird box). The puffer can be programmed to send out a 'puff' of pheromone every hour. Using this technology in other crops, researchers have shown that only a few puffers per acre have controlled different moth pests (See Attachment A, Photo 3).

Puffers were studied in 2011 on commercial vineyards in the San Joaquin Valley of California. Research site was located in Denair, CA. (lat. 37.4^{o}N, long 120.4^{o}W, 79 m absolute elevation). The experiment was arranged as a randomized complete block with two treatments (puffers vs. control) each with three replications. Each treatment-replicate consisted of ca. 8 acres of uniform vineyard block (96 vines long x 56 rows wide), which each were at least 1600 m away from each other. Each treatment-replicate consisted of 5376 vines, of which 536 were sampled for experimental purposes.

Treatment sites were established in blocks known to be infested with VMB, and three were treated with the VMB pheromone Lavandulyl Senecioate and three were left untreated as controls. Checkmate^{R} Puffer dispensers were applied 1.8 m above the canopy in a grid pattern at a rate of two puffers per acre using 50 mm wide PVC stakes. The dispensers were programmed to apply pheromone on a 24 h cycle and had an output of 24 g per acre over the course of the season. On the same day as the treatments were applied, a perimeter of 214 Checkmate^{R} VMB-XL pheromone dispensers were established in each treatment block, these dispensers emitted 3.1 grams each. Two vine mealybug monitoring traps were also placed in each treatment block. These traps were loaded with a Scenturion^{TM} Vine Mealybug lure. The traps were collected weekly and counted for male VMB catches.

To determine crop damage, near harvest-time, clusters were collected from 10% of the vines in each plot and rated damage using the 0-3 scale, described previously. The results show less pheromone trap catches (Figure 4A) and less cluster damage (Figure 4B) in the MD (using the puffer technology) plots that the control plots. Here, note that all plots did receive a combination of a delayed dormant application of chlorpyrifos and a post-harvest application of spirotetramat (Movento, Bayer CropScience).

(c) Puffer delivery system – plume trial: Trials were conducted in 2011 and 2012 to demonstrate the area of impact for pheromone applied from different dispenser types and the effect of pheromone concentration on VMB trap suppression.

Trials conducted in 2011 examined the following treatment variables: 1) pheromone emitter device (aerosol puffer or meso emitters); 2) aerosol puffer release timing (puffer set to 24 hr or 12 hr cycle); 3) puffer release rate (12 gm and 42 gm aerosol cans); and 4) puffer placement (above or at canopy level).

In 2012, trials attempted to further refine the impact of release rate (36 gm, 24 gm, 18 gm, 12 gm aerosol cans, and no pheromone) on the pest population. Interpolation surfaces were generated using the R statistical data analysis environment. Trap positions were geo-referenced and interpolation surfaces of VMB capture were performed using geostatistical models for each trial replicate. Data were log-transformed $ln(x+1)$ for analysis. Hourly wind data is obtained from a nearby California Irrigation Management Information System (CIMIS) station.

Here, a 2011 data set from a commercial vineyard near Fowler, California is presented as an example of the results (See Attachment A, Figure 5 and 6). It is important to note that other vineyards sites were used in 2011 and 2012, and had low mealybug populations; however, the results are not as apparent as the results shown in Figure 5 and 6. At the Fowler site, two plots placed in the site permitted contrasts of treatment (pheromone) and control (no pheromone) in the same time frame; additionally treatment assignment was switched weekly between the two plots such that location effects could be minimized. Each one-acre plot consisted of a 64-trap grid created by eight rows of eight traps set on a 24-foot spacing. Male flight activity was monitored weekly using pheromone traps baited with VMB pheromone lures. Seventeen trapping intervals were conducted. Each trial replicate was run for one week, and each trial was replicated 3-4 times.

Results shown below demonstrate the 'pheromone plume' from a single puffer unit placed below the top canopy boundary in the center of the pheromone treatment plot "puffed" every 15 minutes between 2 am to 2 pm daily. The results demonstrate the impact of emissions of 1.56 mg ai / puff and 5.123 mg ai / puff and show total weekly trap capture within a 1-acre 64-trap grid ranged from 4,000 to more than 80,000 VMB. Pheromone treatments rotated weekly between east and west plots. At both pheromone concentrations, trap captures were significantly reduced compared to the control treatments and no block (plot) effect was observed.

At 1.56 mg ai per puff, the effects of the puffer are easily observed within a single week. Average trap suppression of ca. 72% over four replicated intervals is shown in the averages ($P < 0.01$). The pattern is consistent for puffer treated areas to have lower counts compared to the untreated areas despite being moved each week, thus eliminating the potential bias of positional effects. What is also striking is that the reduction was so clearly observed despite the extreme populations levels averaging > 1200 VMB males per trap in some weeks.

Using a different setup with 5.124 mg ai per puff, a similar pattern in trap suppression was observed of ca. 65% when comparing the pheromone treated and untreated plots. In all cases, the control plots (no puffer) were always had greater trap capture than the pheromone treated areas ($P<0.01$). One important part to note is the lack of any clear rate response when the pheromone levels were increased by more than 3 fold. What is not clear at this point is if the level of pheromone can be reduced below 1.56 mg ai per acre. Surface maps of VMB trap capture and suppression patterns are shown in Figures 5 and 6.

These data can be used to look for the possible distance that the pheromone can move and still effectively suppress traps. For both pheromone concentrations, a clear local suppression is observed and appears to range from a very narrow band of 50 feet to beyond the plot boundaries of 200 feet. While the surface responses present a more intuitive way to see the shape of the plume, the effects of the pheromone program on the total trap suppression are easily seen in the weekly averages. Both types of analyses provide important, but different insights for optimizing the VMB MD program for potential implementation.

(d) Dispenser density and pheromone load: Another way to lower costs is to put out fewer numbers of dispensers per acre. The standard 'dose' (e.g., how much active ingredient per acre) is 250 dispensers per acre, each with a load of 150 mg ai per dispenser. What is actually needed was never really studied for VMB

MD, but the dose was based on other insect pests – mostly moths – and the cost of production per mg of the pheromone. For example, if half the number of dispensers per acre (125) or half the amount of active ingredient (75 mg ai per dispenser) can provide the same level of control, than costs may be substantially reduced.

The first trials were located in Central Coast winegrapes (San Luis Obispo County) with the Pacific Vineyards operation, from 2010 to 2012. The effect of different rates of Checkmate dispensers (150 mg ai per dispenser) per acre was investigated in order to determine if costs for MD can be reduced. This was a large trial. In 24 separate vineyard blocks, 10 acre plots for mating disruption were established, using four dispenser density rates: 50, 125, 188 and 250 dispensers per acre. All sites had VMB prior to treatment application. Additionally, a treatment of 50 dispensers per acre was established in blocks that reportedly had no VMB, but were surrounded by infested blocks. This experiment was designed to test the MD release rate needed to control VMB, as well as whether a low release rate would be able to keep a clean vineyard clean. There were four replicates for each treatment. The results for the 2011 trial suggest that the number of dispenser pheromone trap counts showed that at both 188 and 250 dispensers per acre there was trap shut down, until an unexpected insecticide application was made in July (See Attachment A, Figure 7).

A more complex study was conducted in the Central Valley in 2012 where both the number of dispensers and the amount of ai per dispenser were manipulated. This was done to test whether it is the amount of pheromone placed in the vineyard, or it is the number of point sources (e.g., dispensers per acre) in the vineyards. Checkmate dispensers were hung in 55 acres of Pinot noir vineyards east of Denair, California with six different treatments organized in a randomized complete block design. Treatments were 200 and 300 mg of pheromone per dispenser with 125 dispensers per acre; 143 and 214 mg of pheromone with 175 dispensers per acre; and 100 and 150 mg of pheromone per dispenser with 250 dispensers per acre. The combination of rate (number of dispensers per acre) and load (mg per dispenser) led to a dose (rate x load) of either 25 or 37.5 g ai of pheromone per acre per treatment (Table 1).

The analysis yielded surprisingly good results in that all mating disruption treatments had significantly lower damage than the control (Pearson Chi-square = 76.253, df = 18, $P < 0.0001$). The control blocks had at least 17.5% damage far more than any of the mating disruption treatments, regardless of the dispenser load or placement density (Table 1). The level of damage in the mating disruption plots would be considered clean by most growing standards.

There was really not clear pattern within the pheromone treatment blocks (e.g., rate vs load vs dose). Treatments with the highest density of pheromone card dispensers (250 per ac) had 7.22% damage and 9.44% damage at loads of 25 and 37.5 mg ai, respectively. Whereas, treatments with 175 dispensers per acre had even lower damage levels than the higher rate, which is contrary to expectations (e.g., more dispensers or point sources would be better for control). These plots were 99.44% and 98.33% clean in plots with loadings of 25 g/acre and 37.5 g/acre respectively. What is important to note is that all mating disruption plots had lower damage than the control, and in a vineyard that was highly infested in the previous years, this represents a remarkable level of insect control (grower cooperator suggests that no additional insecticides were used at the site and that all treatments received the same amounts of insecticides previous to the study and during the study).

Objective 3: *Study the VMB mating biology in order to improve control programs.* There were two main studies of VMB biology and behavior that impacted MD:

(a) Mating requirements for viable egg production: Early in the project, studies were completed that showed the VMB must mate to have viable offspring. This was in questionsbecause a preliminary study found some isolated females produced ovisacs with a small number of eggs. The later work, using better isolate techniques, clearly showed that mating is required for the production of viable eggs. There is still the possibility that environmental cues, such as crowding or plant host condition, could impact the offspring sex ratio or mating biology.

(b) Male flight towards a pheromone lure: In the second study, a very important field characteristic was investigated – how far does the adult male mealybug fly to find the females? The adult male is the only stage with wings, and is quite small and fragile. Earlier observations suggested that adult male mealybugs would not be strong fliers, but earlier trapping programs caught male mealybugs in pheromone traps up to 1 km from any know population source. The answer to male flight direction in response to female sex pheromone plumes will impact how MD should work.

Individual pheromone plumes were compared to male flight behavior in a pistachio orchard, where there were no other mealybugs to interfere with the study. The experiment explains the relationship between standard wind conditions and the distance or direction that male mealybugs are able to fly.

Experiments ran in July and August 2012 in Fresno County at the Fresno State campus. The experiments evaluate the effectiveness of the pheromone plume and the threshold wind value that the male mealybugs are capable of resisting in a field setting. The experiment consisted of 50 pheromone traps baited with vine mealybug pheromone lures (100 µg of pheromone). The traps were placed in a grid pattern in the ca. 20 acre pistachio field, each hung at 2 m above the orchard floor on the northwest quadrant of the tree. Minimum distance between traps was 36.6 m. To create a source of male VMB in the pistachio field, butternut squash were infested with VMB and placed near the center of the orchard. Cohorts of insects were left in the field for 10 days, providing one treatment replicate each.

The numbers of male trap catches were recorded three times during each trial at 2-day intervals. Prior to the experiment, lured pheromone traps were placed in the field as controls to ensure no outside mealybug source. Control traps were placed in a grid pattern with 21 m between traps in a total of 16 locations. Control and lure traps were recorded with the PN-60 GPS device and loaded into Delorme Earthmate software to extract coordinates. Coordinates were used in ARC Map to generate spatial interpolation maps as visual representations of the trap counts and male mealybug movement over time. Information on wind speed, direction and daily mean temperature was taken from CIMIS weather station data available online.

The results from trap counts and geostatistical analysis with ArcMap software shows that over the first repetition of the trial the male VMB are not moving towards a known pheromone source (See Attachment A, Figure 8).

(c) Impact of mealybug sex pheromone on parasitoid performance. Pheromone trap catches of adult parasitoids suggest that parasitoids may be attracted to the mealybug sex pheromone, as has been noted by other researchers. The results indicate that the use of MD might increase parasitism levels, in part, by changing the parasitoid's searching behavior. Two field trials were conducted to look at the impact of MD on parasitism or parasitoid behavior. Here, data are presented from the second trial that looked at trap captures.

Previously, traps baited with VMB sex pheromone were shown to catch female *A. pseudococci* and higher levels of parasitism were reported in vineyards with VMB MD. Recently, a Japanese scientist suggested that a chemical compound (2,4,4-trimethyl-2-cyclohexenyl)methyl butyrate (cyclolavandulyl butyrate), which was discovered as an artifact during the laboratory-scale synthesis of a mealybug (*Planococcus kraunhiae*) sex pheromone compound, attracted a large number of a mealybug-parasitoids (*Anagyrus sawadai*) and enhanced parasitism of the mealybug by both natural and non-natural parasitoid species.

To test, a persimmon block heavily infested with longtailed mealybug (*Pseudococcus longispinus*) was used in 2011. In a block of trees that each had enough mealybugs for repeated samples, four treatments were established in a randomized block design with six replicates: control (blank septa), one VMB septa (100 µg lavandulyl senecioate), three VMB septa (300 µg lavandulyl senecioate), or one septa containing cyclolavandulyl butyrate. Prior to parasitoid release and lure placement, a 30 cm terminal branch sample was taken from each of 20 trees, biased towards heavily infested branches. After which, parasitoids (*A. pseudococci*) were released in the middle row (not on a tree) at equal distances from each sample tree, with 850, 1000, 2500, and 1500 released at 1, 9, 18, and 25 days post treatment application. Parasitism levels were then recorded by taking a 30 cm terminal branch sample, located near the septa, taken from each tree at 15, 24, and 43 days post treatment application (See Attachment A, Figure 9).

Contributions of participants

This project represents a true collaboration from different research agencies and the public sector. The Principle Investigator from UC Berkeley coordinated the activities and was involved with all projects described herein. Researchers from several agencies such as California State University, Fresno, and UC Davis, led or conducted field and other research.

The field trials could be accomplished only with the assistance of dozens of individual farmers that allowed the crews to work on their farms. This often included a reduction or elimination of pesticides, which obviously presented a risk that these farmers took to aid the development of research and extension of results. Of particular note are Pacific Vineyards, Constellation, Vino Farms, and Bronco Wine Company.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

A survey was to be conducted of mealybug pest tactics and GLD. However, during the granting period, an extensive survey concerning grape leafroll associated virus and mealybugs was conducted in the Napa and Sonoma regions by a cooperating UC Davis researcher, who was aided by one of the team members of this project. A separate survey is currently underway by a UC Davis researcher on grower management practices. These large grower surveys are far more detailed than could have been done within this project timeframe. Participating surveys will be conducted at the end of the trials on areawide MD via pesticide use reports and an accounting by Suterra on mating disruption sales.

The short term goal was to demonstrate the effectiveness of MD and improve methodologies. The project goal was accomplished. The long term goal is now to create greater adoption of MD for VMB. There is some suggested evidence of this in Napa in 2013, as growers in areawide treatment regions continued to use MD after the program was discontinued. Additionally, team members facilitated the formation of a 19-grower member "neighborhood group" in March 2012, to address mealybug and leafroll disease management. The group continues to meet monthly and uses an areawide approach to management, as suggested by this research. The major hurdle here is the costs of MD as compared with some very effective insecticides. The future goals will be to follow adoption of the practice and to determine how to improve adoption.

For researchers, one of the best measurements of activities is the outreach through presentations and publications. In this aspect, this project has excelled, with this research team now the recognized world leaders in management of vine mealybug and grapevine leafroll disease.

A) The benchmark for presentations was far exceeded by this project with at least 39 presentations made (averaging >10 per year) (see list below).

B) The benchmark for academic publications (2-3 per year) was met with 9 peer-reviewed publications (averaging 3 per year). Moreover, there are 8 publications planned as well as extension bulletins (See Attachment A, Presentation and Publication lists).

C) In 2010, MD was used in 13,000 acres, all using plastic dispensers. In 2013, an estimated 20,000 acres employed MD. Wide spread adoption is still limited to costs in comparison with insecticide treatments. The research helped to identify better deployment methods, and these results are currently being extended to the clientele.

D) Use of commercially released *Anagyrus pseudococci*, a parasitoid of the VMB, was considered, in 2010, to be a benchmark goal. In fact, commercial acreage receiving *Anagyrus pseudococci* has probably decreased. This may actually be a result of improved insecticide use, the use of MD without the release of natural enemies, and the spread of *Anagyrus pseudococci* material imported and released by UC Berkeley and California Department of Food and Agriculture.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

California wine grapes represent one of the larger and more valuable specialty crop with an estimated annual crop value over $2 billion with additional revenue through associated employment and tourism. California vineyard farmers are the primary beneficiaries; however, a reduction in the use of pesticides will have compounding benefits across many groups.

There is no quantitative data at this time on the effects of this project in terms of the exact change in the use of MD (such data are difficult to collect immediately after the project ended and Suterra Inc. has not released their proprietary information on pheromone sales).

The long term goals are to reduce the need to apply annual insecticides for VMB. This outcome would be quantifiable through pesticide reductions and sales of mealybug pheromone products. Research results are being presented here in California, as well as by collaborators in Oregon and Washington.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

Mating disruption can help suppress mealybug damage and population densities. A major obstacle is that the price may not be competitive with new pesticide chemistries. Still, because of the importance of leafroll diseases, farmers may need to apply both pesticides and other forms of control to maintain low mealybug population densities.

An unexpected outcome of this project was the formation of a neighborhood group in March 2012 consisting of 19 growers. As suggested by this research, the group is applying an areawide approach to mealybug and leafroll disease management in an area of roughly 1,900 acres in Napa County. In April 2013, building on the successes of this neighbor group, a second group formed in a different region of Napa County, with similar objectives. Growers in both groups are sharing information on mealybug and leafroll disease, and are working on coordinated approaches to management.

After investigating a number of deployment tactics, it is clear that puffers are not currently feasible because the mealybugs are not strong flyers and a greater number of 'point sources' may be required for best coverage of the pheromone. Future studies many investigate the use of a sprayable pheromone and other Suterra products.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

See Attachment A for a list of presentations and publications.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

<table>
<tr><td>USDA Project No.:
4</td><td colspan="2">Project Title:
Multi-Commodity Sustainability Programs: Assessment and Implementation</td></tr>
<tr><td>Grant Recipient:
SureHarvest</td><td>Grant Agreement No.:
SCB10004</td><td>Date Submitted:
December 2013</td></tr>
<tr><td>Recipient Contact:
Clifford P. Ohmart</td><td>Telephone:
530-601-0740</td><td>Email:
cohmart@sureharvest.com</td></tr>
</table>

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Today's consumer and food distribution network is demanding increased knowledge and assurance about food quality, safety, and best management production practices. Growers and packers are struggling to address buyer and regulatory mandates as well as being able to demonstrate their commitment to practicing sustainable farming. Properly designed and executed, sustainability programs address grower sustainability information needs by identifying and promoting ecological, economic, and social best management practices and providing tools for tracking farm improvement over time. Collecting data confidentially from many growers gives commodity groups tools for targeting education, funding, regulatory support efforts, as well as providing messaging for important target audiences such as buyers and consumers. Commodity groups working together are far more efficient than individually. The California wine industry has demonstrated self-assessment tools can be used to benchmark and track sustainability improvements over time. The Multi-Commodity Sustainability Programs project was proposed to help at least eight specialty crop groups use the sustainability program template developed in the first phase of the project, funded by 2009 Project 10, to develop self-assessment workbooks for each of the crops, have individual growers self-assess their farming operation, benchmark and report on important best management practices related to climate change, energy use, air quality and water quality and quantity.

The project was considered timely because more than ever the essential resources required for healthy California communities, such as energy, water, air quality, soil quality and plant and animal habitat must be managed and used wisely.

The Multi-Commodity Sustainability Programs project was built on the deliverables of 2009 Project 10, which carried out the initial steps for development of a sustainability program for more than eight specialty crop commodities, including the development of a sustainable strategic plan, selection of an education/outreach model, and an agreed upon sustainability practice and performance metrics framework. The Multi-Commodity Sustainability Programs project carried out the final steps of program development, which was to create self-assessment workbooks using the selected education/outreach model and sustainability practice and performance metrics framework from 2009 Project 10, and convene grower self-assessment workshops.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Project Activities and Tasks: The first major task of the project was to draft and finalize the self-assessment template that would be the foundation for the development of self-assessment workbooks for each specialty crop. This was accomplished through two face to face meetings of the project leadership team and project stakeholder committee and five two-hour webinars to review and edit drafts of the self-assessment template. Once the self-assessment template was finalized the project team began lengthy interactions with grower groups, trade associations and private companies. The goal was to secure growers from each specialty crop to review, edit, and pilot test the self-assessment workbook drafts the project team would create for each specialty crop based on the self-assessment template. The interactions took the form of 37 face to face meetings with grower groups around California, four presentations to grower group conferences, two presentations at trade conferences, and email and phone calls. The remainder of the grant period was spent drafting, reviewing and finalizing self-assessment workbooks for individual specialty crops.

Project Accomplishments: The project team completed self-assessment workbooks for the following 9 specialty crops: carrots (Attachment 1), cherries (Attachment 2), fresh market tomatoes (Attachment 3), pistachios (Attachment 4), peppers (Attachment 5), onions (Attachment 6), processing tomatoes (Attachment 7), strawberries (Attachment 8), and raisins (Attachment 9). Project work with the Pear Industry, through the California Pear Advisory Board, took the form of adding practice questions from the self-assessment template to an existing grower practice survey that had been implemented with all California pear growers in 2009 and 2011. The 42 practice questions added to the existing survey (Attachment 10) were in management areas that had not been covered in previous iterations of the survey, including: Financial Management, Waste Management, Food Safety Management Planning, and Neighbors & Community. The new survey was then sent out to all California pear growers, which currently are 65 in number, in March of 2013 and will be closed at the end of June 2013. Project work with the California almond industry took the form of taking practices from the Multi-Commodity self-assessment template and creating a new self-assessment module, Financial Management (Attachment 11), to add to the existing 5 self-assessment modules of the California Sustainable Almond Program (CASP). The CASP self-assessment is not only in printed form but exists as an on-line self-assessment available to all 6,000 California almond growers. Once the Almond Board stakeholder committee reviews the Financial Management module, it will be incorporated into the on-line CASP self-assessment system. The module will be downloadable by anyone at the following web address approximately the beginning of January 2014:
http://www.almondboard.com/Growers/Sustainability/SustainabilityModules/Pages/Default.aspx.

Contributions and Roles of the Project Partners: The project partners include an almond farmer who is also a member of the Almond Board's Environmental Committee, and Sustainable Conservation. The project partners have extensive contacts with growers and grower groups, which played a critical role in successfully engaging grower groups and growers. Their extensive background in agriculture was invaluable in helping develop the self-assessment workbooks as well as providing excellent reviews and edits of the self-assessment workbooks.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The original project goal was to develop self-assessment workbooks for eight specialty crops. The project team completed self-assessment workbooks for nine crops. Moreover, the project contributed additional content to the Pear Industry's sustainability grower survey as well as a new self-assessment module, Financial Management, to the California Sustainable Almond Program. United Fresh Produce Association (United Fresh) used the Multi-Commodity Self-Assessment template as a model for a sustainability self-assessment for its members. The self-assessment was published and distributed to United Fresh members during this reporting period. Therefore the original project goal of eight self-assessment workbooks was exceeded by a significant amount. One round of pilot testing was carried out for the self-assessment workbooks for peppers and fresh market tomatoes. However, the growers did not share their self-assessment data with the project team. The trade associations for two crops, cherries and pears, chose to not pilot the workbook for those crops but instead sent the self-assessment out to all their members in an effort to get an assessment of the practices being used by their entire membership. As mentioned earlier in the report, the Pear self-assessment was in the form of a grower practices survey. The Financial Management module developed from this project for the California Sustainable Almond Program will be incorporated into its on-line self-assessment system and used by the entire membership of the California Almond Board. Currently more than 600 almond growers are using the on-line self-assessment and the goal of the Almond Board is to increase the number of growers using the system.

The amount of time, communication and meetings it would take to finalize the self-assessment workbooks for each specialty crop was misjudged and resulted in two project objectives not being completely accomplished during the grant period: assessment of practices in grower workshops and then reassessment by the same growers the following growing season. It was intended to have small grower groups from each crop pilot test the workbook in a workshop setting, capture their assessment scores anonymously, then have the growers repeat the assessment in the following growing season in a follow-up workshop so they could appreciate the fact that one of the values of the workbook is evaluating one's practices, developing an action plan to improve in some areas, and then reassessing practices in the future to achieve continuous improvement on the farm. The development of the final drafts of the workbooks of all but two crops took the entire grant period. As noted above, grower workshops were held for peppers and fresh market tomatoes.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

A large number of grower groups and individual growers benefited from the successful completion of the self-assessment workbooks for nine crops plus the new module for the CASP program and new content for the pear grower survey. Members from all of these groups and companies played a significant role in developing the self-assessment workbooks for their crops. The beneficiaries are the grower members of the following organizations: Almond Board of California, American Pistachio Growers Association, Bolthouse Farms, California Cherry Board, California Garlic and Onion Research Advisory Board, California Pear Advisory Board, California Pepper Commission, California Pistachio Board, California Raisin Marketing Board, California Specialty Crop Council, California Tomato Farmers, Campbell's Soup Company, Sun-Maid Growers, United Fresh Produce Association.

The self-assessment workbooks can be used as a foundation for sustainability programs for the participating grower groups and trade associations. The California wine community has benefited greatly from their sustainability program which is based on their self-assessment workbook and the California almond industry is just beginning to realize the benefits of CASP. It will be up to the groups that participated in the Multi-Commodity Sustainability Program project to follow their example and used their self-assessments to their economic, social, and environmental benefits.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The lessons learned from trying to engage growers in the Multi-Commodity Sustainability Programs project are the reluctance of growers to participate in such a project. Often they initially only see the downsides of participation, not the benefits. There is a dearth of economic data showing the use of a self-assessment workbook increasing revenue or decreasing farming costs. Secondly, the growers of some crops, like processing tomatoes, are experiencing 'audit' fatigue because they sell to multiple buyers and each one has its own practice checklist. Some growers viewed the Multi-Commodity self-assessment template as just another survey they had to fill out and therefore said they were too busy to become involved. Another challenge encountered with some growers was concern that the self-assessment would be turned into a regulatory requirement. Finally, growers are busy people and a common comment was 'I would do an assessment if it only took 5 minutes'. This experience has shown that the best way to get a grower to realize the value of a self-assessment workbook is to somehow get the grower to complete the assessment. By doing so, the grower begins to see the many ways it adds value to a farming operation. Some of these are: 1) Discovering practices they were not aware of that could save time and money; 2) Increasing efficiencies on the farm; 3) Learning where they stand in relation to peers that grow the same crops; 4) Collectively telling their good story based on the aggregated practice data from the self-assessments. There are many ways to convince a grower to fill out the workbook and all should be tried because different approaches work with different growers. The following are suggestions: 1) have a respected grower ask colleagues to fill out a workbook; 2) couple a workbook workshop with another event like a lunch, 3) have a grower processor/packer/shipper encourage grower clients to fill out the workbook, 4) provide continuing education credits for filling out the workbook that counts towards a grower's private applicators license; 5) provide educational content to a workbook workshop by inviting expert speakers to address an important topic in the self-assessment. Advice to any project working to engage growers in sustainability programs is that it always takes longer than one thinks it will. However, an engaged grower will become a proponent of the program and encourage peers to join.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

United Fresh Produce Association (United Fresh) was granted permission to use the Multi-Commodity Self-Assessment template as a model for a sustainability self-assessment for their members. The self-assessment was published and distributed to United Fresh members. (Attachment 12)

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 5	**Project Title:** Development of high throughput assay for rapid and accurate detection of regulated citrus pathogens	
Grant Recipient: USDA - Agricultural Research Service	**Grant Agreement No.:** SCB10005	**Date Submitted:** December 2013
Recipient Contact: Raymond Yokomi	**Telephone:** 559-596-2990	**Email:** Ray.yokomi@ars.usda.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Sensitive amplification of specific gene sequences by polymerase chain reaction (PCR) has revolutionized pathogen detection. New technology has also been developed to enable pathogen detection by multiplex hybridization assays. Moreover, robotic methods and magnetic-bead based kits, developed to support genomic identification, allows rapid and standardized extraction and purification of nucleic acids containing host and pathogen genes. These methods can be developed into a cost-effective and sensitive disease surveillance system for citrus pathogens. This is needed by the citrus industry because the Asian citrus psyllid (ACP) (*Diaphornia citri* (Hemipetera: Psyllidae) became established in California in 2008. The psyllid now is confirmed to be in San Diego, Imperial, Riverside, San Bernardino, Orange, Los Angeles, Ventura and Tulare Counties and has resulted in quarantines and restricted areas. In March 2012, huanglongbing (HLB), or citrus greening, was confirmed detected in an ACP sample and a lemon/pummelo tree in a residential neighborhood in the Hacienda Heights area of Los Angeles County. This is the first and only confirmed detection of HLB in California. The disease kills infected citrus trees and is the most devastating disease of citrus. The pathogen associated with HLB is vectored in nature by the ACP in a persistent manner. HLB control is achieved by a multi-faceted management system based on ACP (vector) control, early disease detection and rapid inoculum removal. The purpose of this research project is to support this disease management strategy and expand the pathogen detection system to include all major citrus disease agents by developing a contemporary method in a simple standardized format. The new detection system would be at an economic scale since one sample and its preparation can be used for multiple pathogens to be tested simultaneously. On June 25-26, 2013, the ACP was found on six different glassy-winged sharpshooter traps in Porterville. Disease surveillance for HLB has now intensified in the San Joaquin Valley where 76.7% of California's 266,090 acres of commercial citrus is grown (2012 California Citrus Acreage Report). California is the top citrus-producing state in the U.S. worth an estimated value of over $2.2 billion in 2011. California produces ~80% of the nation's fresh fruit citrus and is the country's main source (80%) of fresh-market oranges. HLB and ACP are now present in all major citrus-producing states in the U.S. and the disease is a serious threat for all of the nation's citrus production. In addition to the HLB-ACP threat, Central California is facing the spread of severe strains of the aphid-transmitted *Citrus tristeza virus*.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

- Parlier and UCR group. Assembled list of all major citrus pathogens and queried/downloaded associated sequences for these citrus pathogens from the National Center for Biotechnology Information (NCBI). Project list included 20 pathogens and strains. 100% complete.
- All groups. Selected primers/probes for best singleplex detection for these pathogens by real-time quantitative polymerase chain reaction (qPCR) assays. Ordered reagents and validated primers and probes. In addition, Parlier is selecting and using unique bacteriophage (phage and prophage) sequences to provide increased sensitivity as pathogen-associated targets because of its multiple gene copy numbers in relation to the pathogen genome. Research 100% complete but validation from *in planta* exotic pathogen sources is 95% complete because samples were not available.
- Los Alamos and UCR group. Difficulties were encountered with Multiplexed Oligonucleotide Ligation-PCR (MOL-PCR) in transferring *in silico* applications to detect real pathogen targets with sensitivity. Methods continue to be modified to improve ligation. An additional problem occurred when the manufacturer of Lumenix made upgrades to the instrument which made the original magnetic beads fabricated for the project obsolete. A different bead and bead manufacturer was selected and adaptions were made. In June, 2012, the MOL-PCR research was ~60% complete due to lack of sensitivity attributed to incomplete ligation with *in planta* pathogen oligonucleotides. Thus, the UCR and Parlier groups abandoned MOL-PCR to develop alternative methods to accomplish project goals. This made the MOL-PCR research 100% complete with the caveat that LANL is continuing to make improvements for citrus pathogen detection from other financial sources.
- Parlier, Bari and UCR groups. Utilized robotic bead-based nucleic acid extraction and purification equipment; tested commercial kits for efficacy to extract and purify citrus pathogens from infected citrus tissue. Automated extraction now being used by various citrus disease diagnostic laboratories. 100% complete. At least five other citrus disease laboratories now use automated extraction (US Sugar; Florida Dept. Agric. & Consumer Services, DPI, Florida Citrus Budwood Certification Program; UC Citrus Clonal Protection Program; USDA, ARS National Clonal Repository for Citrus and Dates; Citrus Research Board's Jerry Dimitman Laboratory).
- UCR group. The QuantiGene Luminex-based assay was developed as an alternative to MOL-PCR. The Quantigene method uses specific oligonucleotide hybridization to beads similar to that of MOL-PCR. Instead of PCR, the QuantiGene method indirectly increases test sensitive by repeated decoration of a standardized DNA branch attached to hybridized target. Method has good applicability and was effective using non-purified nucleic acid extracts from diseased citrus. Project research is 80% complete due to project expiration. UCR, however, is completing this project funded by a new grant.
- ARS Parlier and Riverside group. Developing custom TaqMan Low Density Array (TLDA) micro-fluidic card system for simultaneous pathogen detection. Samples are loaded uniformly in individual wells in a 96- or 384-well format by centrifugation and each sample tested in a singleplex real-time PCR assay that results in a simultaneous pathogen array test. Method has excellent precision and is user

friendly. Although this project is only 75% complete due to project expiration, ARS will continue the project activities with another funding source.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
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- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

- Vidalakis, Wang and Rucker. 2012. CDFA-Citrus Nursery Stock Pest Cleanliness Program, Permit No. QC 1354. Real Time SYBR Green Reverse Transcription Quantitative Polymerase Chain Reaction (SYBR RT-qPCR) for Universal Detection of Citrus Viroids. Certifies testing registered citrus mother trees with the use of robotic high throughput extraction and RT-qPCR for infection by citrus viroids. Project benchmarks addressed: i) optimized sample collection and preparation; ii) determined limitations of seasonal titer and distribution for sample collection; iii) selected sequences and developed primers; iv) evaluated reverse transcription PCR protocols; v) developed uniform high throughput extraction. Scientific validation was achieved for SYBR Green RT-PCR for all known citrus viroids in two reactions. The pathogens included seven viroids from four genera (Pospiviroid, Hostyviroid, Cocadviroid, Apscaviroid) of Pospiviroidae. Previously, testing was by bioindexing and subsequently conducting oligonucleotide hybridization tests and/or sequential polyacrylamide gel electrophoresis (sPAGE). These procedures are complex and laborious and take from 6 to 9 mo. to complete. The new procedure is significantly more economical and timely than biological indexing and allows testing of all ~7000 registered scion nursery trees in California annually rather than every 5 year cycles. The new detection procedure allows citrus nurseries to increase the number of certified varieties for propagation.
- Saponari, Loconsole, Liao, Jiang, Savino, and Yokomi. 2013. Validation of high-throughput real time polymerase chain reaction assays for simultaneous detection of invasive citrus pathogens. Journal of Virological Methods http://dx.doi.org/10.1016/j.jviromet.2013.07.002. Project benchmarks addressed: i) optimized sample collection and preparation; ii) determined limitations of seasonal titer and distribution sample collection; iii) selected sequences and developed primers; iv) evaluated reverse transcription PCR protocols; v) developed multiplex qPCR assays; vi) developed uniform high throughput extraction. Scientific validation achieved for TaqMan-based RT-qPCR for universal CTV, VT3- genotype CTV, CLas (HLB), hop stunt viroid and citrus exocortis viroid in two reactions. Data documented accuracy and sensitivity of robotic high throughput high extraction for citrus infected with CLas (HLB caused by "*Candidatus* Liberibacter asiaticus" (CLas) *Citrus tristeza virus* (CTV), *Citrus exocortis viroid* (CEVd) and *Hop stunt viroid* (HSVd) and detection in two separate triplex RT-qPCR tests.
  - Loconsole, Onelge, Yokomi, Abou Kubaa, Savino, and Saponari. 2013. Rapid differentiation of citrus Hop stunt viroid variants by real-time RT-PCR and high resolution melting analysis. Molecular and Cellular Probes http://dx.doi.org/10.1016/j.mcp.2013.07.003 . Project benchmarks addressed: i) optimized sample collection and preparation; ii) selected sequences and developed primers and probes; iii) evaluated reverse transcription PCR protocols using high resolution melt analysis; iv) developed

multiplex qPCR assays; v) used high throughput extraction. Data provided validation of rapid diagnosis of cachexia and non-cachexia variants, important for the management of HSVd in citrus and eliminated the need for bioindexing and sequencing.

- Yokomi. 2013. Developed a citrus pathogen detection PCR kit for rapid and sensitive diagnosis of 24 different citrus pathogens and strains. The format is flexible and can adapt to custom standardized detection of different arrays of citrus pathogens. Project benchmarks addressed: i) optimized sample collection and preparation; ii) determined limitations of seasonal titer and distribution for sample collection; iii) selected sequences and developed primers and Taqman probes; iv) evaluated reverse transcription PCR protocols; v) used uniform high throughput extraction. The procedure using Taqman probes in a RT-qPCR for CTV detection is being used by the Citrus Pest Detection Agency (CPDA) (aka Central California Tristeza Eradication Agency (CCTEA), Tulare, CA) to detect citrus trees infected with virulent isolates of CTV in just a few days. Previous CPDA methods created a laboratory backlog which delayed confirming ELISA tests with MCA13 from 6 to 12 months. The new method developed expands CTV sample period 3 months and shortens evaluation test time to less than one month with current manpower and facilities. Formerly, confirmed MCA13 reaction took up to one year or more after initial sample collection.
- J. Wang, Vidalakis et al. High-throughput QuantiGene Plex-based assay for rapid and accurate multiplex detection of citrus pathogens. Project benchmarks addressed: i) selected sequences and developed specific oligonucleotide primers; ii) evaluated hybridization assay and analysis by Luminex; iii) compared high throughput extraction as well crude sap with no further extraction. Pathogens validated for simultaneous detection were: Tristeza-Pan, Tristeza-T30, Tristeza-VT, Cachexia, Exocortis, Psorosis, Tatter Leaf, Leaf Blotch, Leprosis, Huanglongbing (HLB), Citrus Canker, Citrus variegated chlorosis (CVC), Stubborn, and Witches' Broom. The procedure is user friendly and robust: reverse transcription, PCR and purification of nucleic acid are not needed; samples are pooled and multiplexed. The procedure is also compatible with automation.
- All objectives were met except MOL-PCR for detection of citrus pathogens. For this reason, the alternate methods of the QuanitiGene and TLDA assays were undertaken and completed. Therefore, all project results and outcomes were considered meeting required performance measures. Although each system needs some refinement, project goals were considered complete, MOL-PCR notwithstanding.

Project results were made available directly to stakeholders (farmers, nurserymen, citrus hobbyists and gardeners) through presentations, meetings, and board reports. The following is a list of presentations made:

1. April 30, 2010. Yokomi RK. Screening for virulent strains of tristeza. UCCE Spring Citrus Meeting, Tulare, CA
2. February 1-3, 2011. Yokomi, Vidalakis and Lee. Workshop on Citrus Pathogen Detection. California Citrus Nursery Board. Parlier, CA.
3. June 8, 2011. Yokomi, RK. Report on the CCNB-Sponsored Workshop on Citrus Pathogen Detection. Citrus Variety Committee, California Citrus Nursery Society, Exeter, CA
4. September 22, 2011. Yokomi RK. Molecular diagnosis of citrus pathogens: advantages and limitations. UCCE Fall Citrus Meeting, Tulare, CA.

5. June 11, 2012. Yokomi RK. Update on Citrus Pathology Research in CDPG, Parlier. Tristeza, and stubborn: innovative detection tools. Crop Diseases, Pest and Genetics (CDPG) Research Unit, Citrus Stakeholder Meeting, Parlier, CA.
6. December 12, 2012. Yokomi, RK. Recent lessons learned studying citrus stubborn disease in central California. Friends of Citrus, UC Riverside.
7. April 16, 2013. Yokomi RK. Improved diagnosis of citrus stubborn disease by PCR detection of phage/prophage of *Spiroplasma citri*. UCCE Spring Citrus Meeting, Tulare, CA
8. May 20, 2013. Yokomi, RK. Citrus disease diagnosis in a PCR kit. Citrus Variety Committee, California Citrus Nursery Society, Exeter, CA
9. August 1, 2013. Yokomi, RK. Citrus disease diagnosis in a PCR Kit. Tulare County Pest Control District Board Meeting, Exeter, CA.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Citrus growers are impacted by new USDA, APHIS, PPQ and/or CDFA regulations and quarantines imposed on the California citrus industry due to the establishment of the ACP. As such, citrus growers benefit directly from the more efficient and cost-efficient detection of citrus pathogens developed in this project.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

Nearly all goals of the grant were achieved. However, given the slow nature of dealing with developing citrus pathogen detection assays, the USDA/ARS may have been a bit over zealous in a few goals.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Chen, J., X. Deng, X. Wang and R. Yokomi. 2013. Prophages in "*Candidatus* Liberibacter asiaticus" and *Spiroplasma citri*. 19th Conf. IOCV, Kruger National Park, South Africa.

Rucker, T., T. Dang, S-H Tan, J. Wang, and G. Vidalakis. 2013. A semi-automated nucleic acid extraction and purification protocol for citrus tissue. 19th Conf. IOCV, Kruger National Park, South Africa.

Vidalakis G., and J. Wang. 2013. A SYBR Green RT-qPCR method for universal detection of citrus viroids. 19th Conf. IOCV, Kruger National Park, South Africa.

Wang, J., I.N. Boubourakas, A. E. Voloudakis, T. Agorastou, G. Magripis, T. Rucker, P. E. Kyriakopoulou, and G. Vidalakis. In Press. Identification and characterization of known and novel viroid variants in the Greek National Citrus Germplasm Collection and threats to the industry. European Journal of Plant Pathology.

Wang, J., O. Bozan, S. J. Kwon, T. Rucker, C. Thomas, R. Yokomi, R. Lee, S. Folimonova, G. Vidalakis. 2012. Molecular diversity of *Citrus tristeza virus* (CTV) strains collected over the past 50 years and maintained in CTV collections in California. Proc. Intern. Citrus Congress, Valencia, Spain, Nov. 18-23, 2012. p 240.

Wang, J., and G. Vidalakis. 2013. A molecular non-PCR based high throughput multiplex detection method for citrus pathogens. 2013. American Society for Virology, University Park, PA, USA.

Wang, J., G. Vidalakis, R. F. Lee, and R. K. Yokomi. 2012. Development of a high throughput assay for rapid and accurate 10-plex detection of citrus pathogens. Phytopathology 102: S4.131

Wang, J., R. Yokomi, R. Lee, S.Y. Folimonova, and G. Vidalakis. 2013. Molecular diversity of *Citrus tristeza virus* in California. Phytopathology 103(Suppl. 2):S2.156

Wang, X., H. Doddapaneni, J. Chen, and R. Yokomi. 2012. Genetic variation of *Spiroplasma citri* populations in California revealed by two genomic loci . Proc. Intern. Citrus Congress, Valencia, Spain, Nov. 18-23, 2012. p 213.

Wang, X., R. Yokomi, and J. Chen. 2013. Sensitive detection of *Spiroplasma citri* by targeting prophage sequences. Phytopathology 103(Suppl. 2):S2.157.

Yokomi, R.,and M. Sisterson. 2012. Estimation of incidence and spatial temporal distribution of citrus stubborn disease. Phytopathology 102:S4.141.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 6	Project Title: Paso Robles Distinct & Different Direct-to-Consumer Marketing Campaign	
Grant Recipient: Paso Robles Wine Country Alliance (PRWCA)	**Grant Agreement No.:** SCB10006	**Date Submitted:** December 2013
Recipient Contact: Jennifer Porter	**Telephone:** (805) 239-8463	**Email:** jporter@pasowine.com

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complemented and enhanced previously completed work.

The goal of the Paso Robles direct-to-consumer marketing campaign was to grow market for more than 200 vintners and 100 independent grape growers representing 26,000 vineyard acres in the Paso Robles American Viticultural Area (AVA) by generating awareness about the area's diversity among consumers, trade and media, by:

- Strengthening marketing data and building practical tools, focusing on small emerging brands with education and marketing tools.
- Improving awareness among consumers and the Millennial Generation by adopting new interactive technologies to be used by vintners and growers, and marketing events geared specifically for them.
- Differentiating Paso Robles wines from the competition and building awareness of the region's wine, culinary and tourism diversity by inviting media with national reach to visit the area.
- Leveraging regional marketing programs and work with tourism partners to grow traffic to local businesses, which will increase direct-to-consumer sales for the Paso Robles wineries.

The timing of this project was optimal to help Paso Robles' wine industry due to the challenging economy and distributor consolidation; the traditional three-tier system (wholesaler-retailer-consumer) is no longer a viable model for many of the new and smaller brands. More than 90% of Paso Robles wineries rely on direct-to-consumer sales as part of their business plans.

To support these entrepreneurial businesses, while enhancing the overall competitiveness of California's wine industry, it was critical for the region to:

- Better understand the driving forces of its wine buyers and wine tourists
- Develop new consumer demographic groups via targeted marketing strategies and innovative technologies
- Garner national acclaim through media tours
- Expand consumer awareness and help Paso Robles wines differentiate from the competition via marketing events

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Research

Two benchmark surveys were conducted by Stonebridge Research via SurveyMonkey.com, the first in November - December 2010 with 107 respondents and a follow-up survey in April - May 2013 with 117 respondents. In addition to the surveys, visitor data was collected from member wineries to measure visitor demographic information and market development. Two tourist visitor research studies were conducted (June - October 2010/11, February - May 2013) using 10,000+ visitor names, cross-referenced with a third party database to provide, income, education, employment, geography, "over" and "under" representation of regions, MDI (the index comparing metropolitan area representation among the visitors with the norm for those regions), etc. The information from the 2010/11 survey and study were shared in November 2011 via a Winery and Grower Education Workshop. The 2013 report will be shared post-harvest, at Paso Robles Wine Country Alliance (PRWCA) expense, to maximize potential impact.

Interactive Trip Planner (ITP)

Once the Scope of Work (SOW) was finalized and action items for technology vendors identified, Kraftwerk Design initiated the design of the overall layout to be consistent with other marketing. Clever Concepts, in tandem with Moosepoint Technologies developed the online tool. Clever Concepts and Mike Bobbitt & Associates collected and entered data. Testing prior to launch was conducted in December 2011 - January 2012. Winery and Grower Workshops were held demonstrating the new web-based technology on December 12, 2011 and January 19, 2012, attended by 220 members. The ITP had a soft launch, from January 1, 2012 - March 31, 2012. A press release was issued on June 19, 2012 announcing the official launch.

Media Familiarization (FAM) Tours

Cordial Communications and PRWCA staff worked together to research journalists, send invitations, book travel, conduct the FAM trip from September 28, 2011 – October 2, 2011 and March 20-23, 2012, follow-up post-trip and continually track coverage for impressions and ad equivalency.

Grand Tasting Tours

Fast Forward Ventures worked with PRWCA staff to execute the Orange County tasting on February 29, 2012. Invitations were sent to a qualified list of trade and media, Sante Magazine, Dining Out Magazine and Fiji Water were identified as sponsors and press releases were issued. PRWCA conducted all invite, sponsor and press related activities for San Diego (February 26, 2013), Los Angeles (February 28, 2013) and San Francisco (April 11, 2013), in addition to venue selection and all other event logistics.

CRAVE

CRAVE, the Millennial Generation event, was officially cancelled because only 20% of the PRWCA members rated the event as important. This is significant because PRWCA is a membership based organization and the PRWCA seeks to provide its members with programs they value. Furthermore, it was determined based on research that Millennials are not brand loyal and typically purchase lower priced wine, thus this event was no longer necessary for the project. However, the project still effectively reached Millennial through Facebook, Twitter, Blogs, online videos, and the ITP. Those funds originally dedicated to CRAVE were used instead to fund a Northern and Southern California Tasting tour in 2013. Instead of reaching 200-400 Millennials in 2012 and 2013 combined, the second tour location in 2013 allowed PRWCA to reach an additional 175-250 trade and 250-500 consumers, equating to a 53% increase in reach.

Project savings allowed the PRWCA to expand the scope of the project to include development of a mobile version of its website, www.pasowine.com, and an iPhone/iPad/Android app. Making the website available to the large number of people who use their smartphones "on-the-go" provided PRWCA with another avenue to build awareness of the region's 200+ wineries.

Mobile Website

Clever Concepts designed the mobile site to complement pasowine.com's main website design, as well as build a Content Management System to allow management of the mobile site content. The site was launched via e-blast to 16,000 on September 20, 2012.

iOS App

David & Goliath designed the user experience, wireframe development, application design, development, testing and deployment of the iOS app, which has been presented and vetted through the PRWCA Board and membership during the July 15, 2013 membership meeting.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The Paso Robles Distinct & Different direct-to-consumer marketing campaign has grown sales for Paso Robles wine. The goals as outlined in the grant were met, and in many cases exceeded as detailed below:

Research

The 2010/11 and 2013 research reports tracked direct-to-consumer business and visitor demographics The 2011 benchmark study was intended to measure the potential impact of the campaign by tracking winery visits and direct sales through various direct channels. The goal of the 2013 study was to evaluate and measure the effectiveness of the campaign. The 2013 study showed positive results, proving marketing efforts worked in generating awareness of and visitation to Paso Robles among a prime target audience, leading to increased direct-to-consumer sales for wineries. Traffic to tasting rooms and wine club membership has increased since 2011. Forty four percent of wineries now have over 1,000 wine club members compared to 26% in 2010. A PRWCA survey from May 2013 indicated 68.6% of wineries were experiencing increased traffic as compared to 2012. Overall, pasowine.com is seeing 20%+ increases month-to-month versus year ago, with a record high 52,000+ visits in May 2012. Also, the PRWCA succeeded in attracting more women and younger visitors (25 - 44 years of age) to Paso Robles wine and have made progress in attracting visitors from outside of California (Texas, Idaho, Wyoming, Colorado and the Southeast).

Interactive Trip Planner

The ITP officially launched on pasowine.com in June 2012 allowing users to customize an itinerary based on winery, varietal, and amenities, complete with driving directions. The online tool also incorporates area restaurants, accommodations and transportation companies. The goal was for this tool to allow the user easy access to create customized wine tasting itineraries that highlight the region's distinct offerings through web-based technology. This new marketing tool was targeted to increase the number of website hits (15 - 25%), extend visit duration (3 - 5 minutes) and strengthen consumer relationships (increase database by 10 - 15%). Since launch, the Trip Planner had succeeded in allowing visitors to customize itineraries. Both visits and unique visitors are up since launch, as well as attracting new visitors. Page views for AVA Map are up 15.6%, meeting goal. Time spent on the AVA Map is up 12% and it is the fifth most visited page on pasowine.com. Press on the Trip Planner, including an article in the LA Times, has garnered 20.6 million impressions.

Media Familiarization Tours

Media tours were conducted in Paso Robles from September 28, 2011 – October 2, 2011 and March 20-23, 2012. The goal was to host 16 - 24 journalists in order to create consumer awareness through national media coverage that would result in important third-party endorsements and 48 - 72 million readers who would learn about Paso Robles Wine Country. The PRWCA hosted 13 journalists, slightly below goal, who contributed editorial pieces garnering 118.9 million impressions. Total media impressions, including Grand Tasting Tours and the ITP, totaled 224.1 million impressions, 199% over goal. Articles about Paso Robles and partner wineries, restaurants, hotels and other local activities were featured in Fodors.com, seriouseats.com, KCET.com, Everett Potter's Travel Report, About.com, JustLuxe.com, Daily Candy San Francisco, iSantemagazine.com and The Daily Meal. Due to the success of the project, the program will be continued in 2014 through alternate funding sources.

Grand Tasting Tours

Media/trade and consumer tastings were conducted in Orange County (February 29, 2012), San Diego (February 26, 2013), Los Angeles (February 28, 2013) and San Francisco (April 11, 2013). The goal was to host Grand Tastings in 2012 and 2013 that would generate trade (350 - 500) and consumer (400 - 600) attendance in two California markets. Exceeding the goal, the PRWCA hosted four market visits, two more than scheduled, for a total of 639 trade media/trade attendees (28% over top goal), 898 consumers (50% over top goal) and 84.6 million media impressions. This program helped introduce new industry members and consumers to Paso Robles wines, further extending the consumer base. Pending PRWCA budget, this program may continue in 2014, with market selection determined using the above mentioned research.

CRAVE

As noted above, CRAVE events were cancelled. The goal was to target the Millennial Generation with an interactive event, CRAVE, a wine and food tasting organized by variety in a lounge atmosphere (200-400 attendees). The program was cancelled due to lack of interest from participating wineries and poor outcomes at previous CRAVE events. In addition, the PRWCA was confident that Millennials were adequately reached through website and social media programs, not funded by the grant. The PRWCA has over 10,000 'Likes' on Facebook, with 34.8% from those under 34 years of age and 7,782 Twitter followers. Twenty six percent of views to YouTube's Paso Wine channel are under 34 years of age with over 200,000 total views.

Mobile Website

The mobile site launched in September 2012. Although not part of the original scope, this program was funded through project savings. The goal was to develop a mobile-friendly site allowing 159+ million smartphone users to access the site. Since September 2012 launch, the pasowine.com mobile site has received 38,604 visitors, 72.96% of whom are new to the site, for a total of 52,914 visits and 143,880 page views. The mobile site currently represents over 15% of total traffic to pasowine.com.

iOS App

The iOS App was originally scheduled to launch in late August 2013, pending Apple approval. The goal was to develop an iOS app, since 88% of pasowine.com traffic comes from Apple devices, allowing robust content for 159+ million smartphone users. The app was added to the App Store on October 25, 2013 (https://itunes.apple.com/us/app/pasowineapp/id728975709?mt=8).

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The Paso Robles Distinct & Different direct-to-consumer marketing campaign benefitted more than 500 local businesses that are primarily family owned and operated. More than 200 wineries and 100 independent grape growers represent an economic impact of $1.467 billion and 7,000 jobs in the Paso Robles AVA. The economic impact figures are garnered from a 2007 study and have grown since based on the increase in Tourism Occupancy Tax and other measures. (In 2014, the PRWCA is considering updating the economic impact study.) Furthermore, this project has had an immediate benefit to the Paso Robles wine region by increasing consumer traffic to winery websites and tasting rooms, resulting in increase sales.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

Research

It was challenging to get member wineries to share data, due to their database privacy policies making it difficult to adhere to the work plan schedule without compliance. Based on member response trends, it was decided to conduct the 2013 survey results educational seminar post summer holidays and harvest season to maximize impact, at PRWCA expense. Also, the third party database company no longer offered the same profile report as 2011, which required increased expenditure on research; however, it offered a wider variety of data.

Interactive Trip Planner

When creating and building technological tools, it would be beneficial to account for the extra time for unexpected delays and plan for how the tool will be updated as wineries and other partners open, close, change location, etc. It is important to consider the functionality of tool from consumer perspective, as well as technological functionality. The PRWCA has future programs aimed at increasing usage of the tool, including a soon to launch customer challenge via pasowine.com and social media encouraging users to submit their best itineraries to be housed on pasowine.com as a visitor resource.

Grand Tasting Tours

Overall the program ran well and exceeded expectations; however, San Francisco was a challenging market given fierce competition and frequency of wine related events. Therefore, the PRWCA in the future will use updated research data to consider markets where the Paso Robles wine region can make more of an impact. Southern California proved to be a strong territory for Paso Robles, but it is important to consider opportunities elsewhere that can build awareness and garner winery interest.

Mobile Site

Due to success of the mobile site described above, it was clear there was a critical need for a mobile compatible site.

iOS App

There were unexpected delays to find an appropriate vendor and craft appropriate user experience/SOW within a limited budget. Apple's developer site was hacked; therefore, delays in registering as a developer further delayed submission of the app for approval, and thus, the launch date. An additional unexpected delay occurred when submitting the app to Apple for approval. The App was submitted to Apple for approval in late August 2013, and was added to the App Store October 25, 2013.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

California Department of Food & Agriculture
Specialty Crop Block Grant Program
FINAL PERFORMANCE REPORT

USDA Project No.: 7	Project Title: Management of Asian Citrus Psyllid in Organic Citrus	
Grant Recipient: The Regents of the University of California	**Grant Agreement No:** SCB10007	**Date Submitted:** December 2013
Recipient Contacts: Robert Chan (Sr. Contract & Grant Officer) Dr. Mark Hoddle (PI)	**Telephone:** (951) 827-7986 (951) 827-4714	**Email:** rchan@ucr.edu mark.hoddle@ucr.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Asian citrus psyllid (ACP), *Diaphorina citri*, was first detected in California (CA) in 2008. This exotic pest is a serious threat to CA citrus production because it spreads a bacterium that causes a lethal disease in citrus called huanglongbing (HLB). Organic citrus growers have limited chemical control options for ACP and another citrus pest the glassy-winged sharpshooter (GWSS). Organic citrus is grown on ~10,000 acres across 30 CA counties and is worth ~$69 million. San Diego County, an area with ACP infestations, has the largest concentration of organic citrus growers with 345 farms growing organic citrus on ~2,500 acres (~25% of organic acreage). It is estimated that organically-certified citrus acreage is growing at a rate of 10-15% per year in CA. To address these serious threats for the organic citrus, certified organic pesticides were screened in laboratory trials, and the most promising were evaluated against ACP and GWSS in field trials. Additionally, because nothing was known about the population phenology of ACP or its primary natural enemy, the parasitoid *Tamarixia radiata* in CA, studies were undertaken in urban areas to better understand population cycles of ACP and its natural enemy over the course of this 3 year project. The ACP part of this project builds on a previous Specialty Crop Block Grant (SCBGP 09056 grant), "Host Specificity Testing of Exotic Parasitoids for Biocontrol of Asian Citrus Psyllid" which helped establish *Tamarixia* sourced from Pakistan in CA for ACP biocontrol.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

<u>1) Lab screening of organic pesticides for efficacy against ACP & GWSS:</u> Ten different organic pesticides (including a water control) were tested in the lab against nymphs of ACP. Pesticides were aged for varying time intervals outdoors before exposure to ACP adults and nymphs as follows: (1) no weathering (exposure to ACP 3 hours post-treatment once residues had dried); (2) weathering for 1 day; (3) 3 days; (4) 5 days; or (5) 7 days. ACP adults and 5^{th} instar nymphs reared in the University of California, Riverside (UCR) quarantine facility were used to inoculate test plants for testing pesticide efficacy. The best organic pesticides tested were Neemix + Pyganic + oil mixture, IAP organic oil 440, and Trilogy + oil mixture which initially resulted in >98% ACP nymph mortality. However this effectiveness deteriorated quickly, with less than 3-5 days (depending on the product) of moderate control resulting. Similar results were observed for GWSS; 7 selected organic pesticides applied to potted citrus trees gave initial good to moderate levels of control, but effectiveness was short-lived (Table 1). The ACP part of this project was overseen by PI's Morse and Hoddle; the GWSS work was overseen by co-PI Bethke.

Table 1. Percentage mortality of adult GWSS on potted citrus trees at different time intervals when exposed to residues of 7 different organic pesticides. Survivorship was monitored until pesticide efficacy broke and no longer provided > 50% of GWSS.

Treatment	48 hours	7 Days	14 Days	21 Days	28 Days	35 Days
Untreated control	12%	4%	6%	4%	6%	6%
Tritek @ 1gal/100 gal	30%	20%	24%	16%		
Tritek @ 2gal/100 gal	26%	30%	28%	20%		
Suffoil X @ 2gal/100 gal	28%	20%	20%	14%		
Exirel @ 13.5 floz/100gal	76%	66%	58%	44%	26%	16%
Exirel @ 20.25 floz/100gal	84%	64%	50%	46%	30%	18%
Verimark @ 30 floz/100/gal	46%	76%	64%	58%	40%	18%
BreakThru	18%		20%			
Grandevo @ 48oz/100gal	34%		12%			
MB 206 @ 3gal/100gal	34%		34%			

2) Field evaluations of organic pesticides against ACP: Forty-five Valencia orange trees in a Yorba Linda (Orange County, CA) organic orchard were divided into five treatment groups of nine single-tree replicates, consisting of control (no spray), Grandevo with Silwet adjuvant, 1.4% horticultural oil, 0.5% horticultural oil, and a Neemix/Pyganic mixture. Trees were sprayed on October 4, 2012 using manual-pump SP Systems Professional Backpack Sprayers. The only treatment which caused a statistically significant reduction in psyllid counts in comparison with the untreated control was the Neemix/Pyganic combination in week 1 and week 2 of sampling (Table 2). This aspect of the project was supervised by PI Morse.

Table 2: Mean adult ACP counts (± SE) on experimental organic citrus in Yorba Linda in Oct. 2012.

	Control (n=9)		Grandevo/Silwet (n=9)		1.4% oil (n=9)		0.5% oil (n=9)		Neemix/Pyganic (n=9)	
	mean	SE‡	mean	SE	mean	SE	mean	SE	mean	SE
Pre-count 10/4/12	19.8	4.6	17.9	2.9	17.9	3.2	20.2	5.0	18.0	3.3
Week 1 10/11/12	36.0	5.5	13.6	2.3	20.6	4.1	17.0	2.8	8.9*	1.6
Week 2 10/18/12	19.9	3.1	11.8	2.5	14.0	2.1	15.6	2.2	10.1*	1.4
Week 3 10/25/12	25.4	3.2	15.8	2.7	22.9	5.1	27.1	5.4	15.2	1.5

‡ SE = STDEV(data range)/SQRT(n) calculated within Microsoft Excel. * Results significantly different from mean psyllid counts from control trees.

Conclusions from organic pesticide evaluations: Of the tested organic pesticides, products containing Neemix and Pyganic combined with a highly refined petroleum oil were the most efficacious against ACP.

However, in the lab and in the field, the residual strength of these products was not long, and in comparison to conventional pesticides their killing power was relatively weak. It is likely that organic pesticides, at least those that are currently available, will not be able to provide effective or prolonged control of either ACP or GWSS. This could be extremely problematic for organic citrus growers as they will face the choice of either not spraying, or having to spray every 1-2 weeks with organic pesticides. This latter option will likely not be cost effective and could result in resistance development.

<u>3) Population Phenology of ACP in LA and Parasitoid Survey Results:</u> Every two weeks, lemon and lime trees in residential properties in LA County are surveyed for ACP eggs, nymphs, and adults. The numbers of each life stage are recorded during timed searches in each quadrant of experimental trees. Data indicated that ACP adults are present in detectable numbers almost year round (Fig 1). Additionally, the growth stage, in particular the flush, of the citrus plant is assessed and recorded and compared to ACP population phenology (Fig. 2). Parasitoid surveys are conducted by collecting large ACP nymphs (4th and 5th instars) that are returned under permit to the UCR Quarantine Facility. Nymphs are dissected under a microscope and examined for parasitoid eggs or larvae. Parasitism has been detected at about 20% of sites where *Tamarixia* has been released. Additionally, *Tamarixia* has been detected at sites up to 7.5 miles from the nearest release site. DNA analyses have confirmed that the parasitoids found in the field are *Tamarixia* and their unique genetic signature indicates that they originated from Pakistan. The conclusions from the DNA work are that the Pakistani parasitoids recovered from the field were released by teams from UCR and CDFA and that these parasitoids were not accidentally introduced with ACP. So far >75,000 parasitoids have been released at >270 different sites in CA which encompass ~250 zip codes and ~ 55 cities.

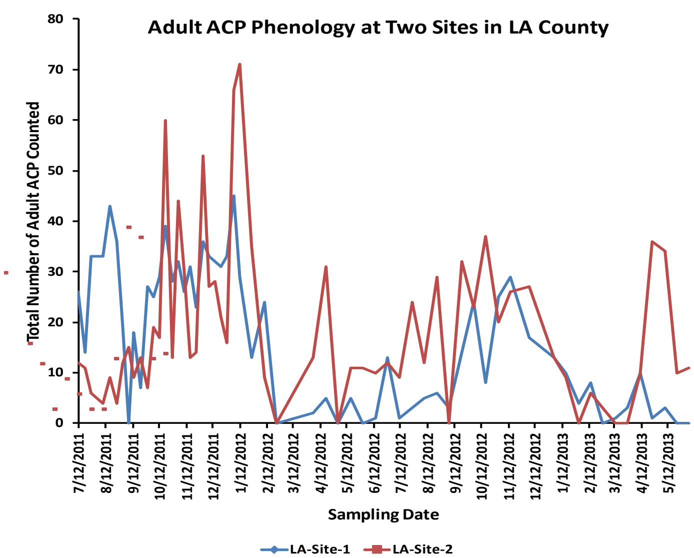

Fig. 1. Adult ACP population phenology on lemons at two residential sites in LA County.

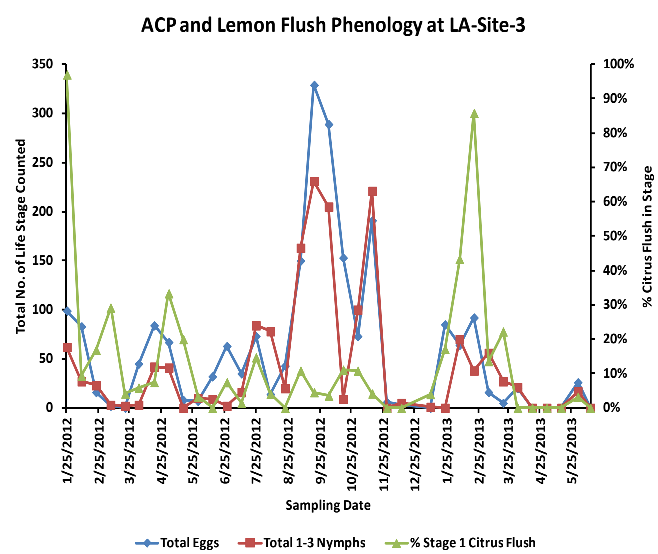

Fig. 2. Population phenology of ACP eggs, nymphs, and citrus flush growth on a lemon tree growing in a residential property in Los Angeles County.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Organic pesticides were evaluated in the lab for control ACP and GWSS. For the laboratory trials against ACP, nine organic pesticides and a water control were evaluated. Laboratory assays for GWSS evaluated seven organic pesticides.

The best four performing organic pesticides from laboratory screening assays were selected for field trials against ACP in a commercial organic citrus orchard in Yorba Linda. Results from field trials confirmed similar findings from small scale laboratory assays that the Neemix/Pyganic combination is most effective against ACP. This product combination can be recommended to organic citrus growers in CA, but the caveat is that this pesticide combination is not likely to be highly efficacious. Lab and field assays against either ACP or GWSS have demonstrated that organic pesticides are not particularly effective.

Our understanding of ACP population phenology and citrus flush patterns in urban areas has improved significantly during the course of this project. We now have excellent data on the patterns of ACP population growth and how this is synchronized with the flush of young citrus leaves, the stage that ACP most prefers to lay its eggs on. Following the revision of the Scope of Work, this project has met all of its intended goals, and it managed to accomplish field trials (executed Oct. 2012), despite the very late detection of ACP in organic citrus orchards following the invasion of this pest into CA in 2008.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

This project has provided very valuable information to organic citrus growers who farm > 10,000 acres across 30 CA counties and produce $69 million worth of fruit each year. In San Diego County, part of the ACP infestation zone, there are 345 organic citrus farms covering > 2,500 acres. Additionally, these data are very useful to homeowners interested in "soft" options for controlling ACP or GWSS on backyard plants, and Integrated Pest Management workers for large botanical gardens like the Huntington and LA Arboretum which have extensive citrus plantings. Finally, these data will assist professional pest control advisors who help manage organic citrus to assess the costs/benefits of recommending ACP and GWSS control with organic pesticides to farm owners.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

This work has clearly demonstrated that there are currently no effective organic pesticides (either commercially-available or under development) for the control of ACP and GWSS for organic citrus growers. This will make pesticide-management decisions very difficult for organic producers, and if applications are chosen, they are going to be expensive because of the need for multiple applications that are closely spaced.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Two appendices are provided to support the outcomes of this project. The first is a PDF of a powerpoint presentation on the field trials assessing organic pestcides against ACP in an organic citrus orchard in Yorba Linda, CA (prepared by Dr. Joseph Morse). The second is an overview of ACP biological control in California that has been given at numerous meetings, including California Association of Pest Control Advisors, Professional Assoication of Pesticide Applicators, Master Gardeners, Friends of Citrus Society, California Rare Fruit Growers Association, Citrus Research Board Meetings, and professional entomology meetings (prepared by Mark Hoddle).

USDA Project No.: 8	Project Title: Accelerated development of pest resistant baby leaf lettuce cultivars.	
Grant Recipient: USDA, Agriculture Research Service	**Grant Agreement No.:** SCB10008	**Date Submitted:** December 2013
Recipient Contact: Ryan Hayes	**Telephone:** (831) 755-2834	**Email:** Ryan.Hayes@ars.usda.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Baby leaf lettuce is a rapidly expanding crop in California, but the fungal disease downy mildew (caused by *Bremia lactucae*), as well as the insect pest leafminers can reduce profits and may slow expansion of this industry. Bacterial leaf spot (BLS) caused by *Xanthomonas campestris* pv. *vitians* (*Xcv*) has been increasingly damaging during recent seasons. The high density plantings of baby-leaf exacerbate these pest problems, and because culling individually affected plants is impossible, entire crops are plowed down when these pests occur. Pest resistant varieties could reduce losses, but breeding pest resistant baby leaf types receives little attention. This project developed baby leaf breeding lines with genetic resistance to leafminers, BLS, and downy mildew. There are about fifteen different types of lettuce used in baby leaf production. Staff targeted breeding toward the types where resistance was most needed. In addition, baby leaf cultivars (cvs) require good salad shelf-life for industry acceptance. The shelf-life of each resistant breeding line or population was determined and only lines with acceptable shelf-life were considered for release. Little is known regarding the lettuce – Xcv pathosystem, and staff worked to define the relationship between pathogen diversity and virulence to target breeding and effectively deploy BLS resistant cvs. This project worked to develop new Xcv detection and quantification tools. These can be used by growers and seed producers to identify important inoculum sources for control. An improved understanding of the mechanism and inheritance of BLS resistance can accelerate the development of new resistant cvs.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Leafminer resistance breeding: Staff tested green leaf, red leaf, and green romaine inbred lettuce breeding lines for leafminer-resistance, downy mildew resistance, corky root resistance, yield, and horticultural traits and salad shelf-life in five field experiments. Leafminer resistance data were collected at baby leaf and mature plant stages to determine the correlation of leafminer resistance at different growth stages. These breeding lines were also tested for BLS resistance in inoculated greenhouse tests (attachment A, figure 1). The results are summarized.

Downy Mildew resistance breeding: Staff evaluated over 1,800 accessions for their resistance to downy mildew, and more than 300 accessions for their deterioration after minimally processing for salad using the method of Hayes and Liu (2008). Data from multiple trials of downy mildew and post-harvest deterioration were combined into two overall ratings in order to select desirable lines. Data were also used in genetic analysis of downy mildew resistance. Seven selected lines were further tested for resistance to lettuce drop, leaf miner and dieback (with molecular markers). Combined results from multiple experiments are summarized in attachment B. Phenotyping tests for bacterial leaf spot resistance were completed and will be statistically analyzed in September 2013.

BLS resistance breeding: Five greenhouse experiments were conducted to select early generation (S2 or S3) populations of lettuce that were genetically fixed for resistance to BLS but genetically variable for leaf morphology. Two field experiments were subsequently conducted to select BLS resistant populations that had good salad shelf-life. From these experiments, two S3 green and red romaine populations were developed and publically released (attachment C). S1 populations have been developed from crossing a BLS susceptible red oak leaf cv to a breeding line possessing a high level of BLS resistance. Project staff anticipates releasing red leaf and red oak leaf BLS resistant populations in 2015.

Pathogen classification: One hundred and thirty *Xcv* strains were classified into two different bacterial species. Four genes were sequenced from 150 *Xcv* and control strains. These gene sequences were compared to type and pathotype strains from *Xanthomonas* and classified into multilocus sequence types (MLST). An MLST scheme was developed to identify the pathogen and describe diversity within *Xcv.* Seven strains of *Xcv* belong to the non-pathogenic species *X. axonopodis* pv. *vitians*, and were not evaluated further. The remaining strains of *Xcv* were classified as *X. hortorum* (attachment A: Figure 2). *X. hortorum* (*Xcv*) strains were further divided into five MLST, labeled MLST A through MLST E.

BLS resistance host-pathogen interaction: Twenty-six greenhouse experiments were conducted to develop scientific information on the mechanism and inheritance of BLS resistance. Infiltration of lettuce leaves with *Xcv* isolate BS347 were conducted on lettuce cvs and populations derived from intercrossing BLS resistant and susceptible cvs. A hypersensitive response (HR) was discovered as a mechanism of resistance in lettuce cvs La Brillante, Little Gem, and Pavane. The HR is due to a single dominant gene in La Brillante located on chromosome 2 of lettuce, and the same or closely linked gene in Little Gem and Pavane. Two greenhouse and one field experiment determined that the HR gene confers high level resistance to BLS. Cultivars with BLS resistance other than La Brillante, Little Gem, and Pavane are known, but not widely used in breeding because their resistance is poorly understood. To study the resistance in these cvs, populations of lettuce were genotyped with SNP markers using the Golden Gate Bead Xpress system at the University of California, Davis, DNA core facilities. Staff will use this data in genetics studies after the end date of the SCBG project. This work extends the objectives of the project beyond what was originally proposed.

Ten experiments evaluated the role of pathogen diversity in disease and HR. Strain BS3127 was significantly more virulent on Little Gem then other strains tested. BS3127 was a member of MLST A while all the other strains evaluated were members of MLST B. Strains from each MLST were evaluated for the HR on Little Gem. Strains from MLST A and C did not induce the HR in Little Gem whereas strains from all other MLST did. Thus, strains from MLST A and C are overcoming the resistance conferred by Little Gem. It was further determined that strain BS3127 overcomes resistance in Little Gem, La Brillante, and Pavane.

Detection and Quantification of *X. hortorum* (*Xcv*) strains: An identification protocol was developed from the MLST typing scheme. The B132 primer PCR protocol (Barak et al., 2001) was not specific for *X. hortorum* (*Xcv*) and amplified DNA from *X. hortorum* pv. *taraxaci* and a new pathovar of *X. hortorum* from radicchio. Additional genes (16S rDNA, 16S-23S ITS region, *hrpB*, *fliC*) were sequenced from a subset of strains (~30), however, none of the sequences provided enough variability for the development of differential primers. All *X. hortorum* pathotypes and representatives from each of the *X. hortorum* (*Xcv*) MLST are currently being sequenced.

Student Training. Seven student interns were trained in aspects of phytobacteriology and plant breeding. Five of the six undergraduate students are moving into STEM intensive agriculture professions. The high school student intern now works part time for the USDA, ARS.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
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Release of leafminer resistant germplasm: About 20 breeding lines of green leaf, red leaf, and romaine lettuce had significantly lower leafminer sting density than check cvs and had acceptable plant weight and core length. Some lines showed resistance to corky root, downy mildew, BLS, and possessed excellent shelf life. Leafminer sting density at the young (baby leaf or spring mix) stage was correlated with sting density at the mature stage. This suggests that the leafminer-resistant lettuce germplasm developed can be used for both baby leaf and whole plant production. These breeding lines are ready to be released. A manuscript for the journal HortScience describing these breeding lines is in preparation (attachment D, #3). This work surpasses the project goals of breeding leafminer-resistant green leaf and romaine lettuce.

Release of Downy Mildew resistant germplasm: Seven breeding lines with high to very high quantitative resistance to downy mildew were selected for release. Five of the breeding lines (SM13A, SM13B, SM13C, SM13D, and SM13E) originate from a cross between cvs. Grand Rapids and Iceberg; one line (SM13F) originates from a cross between cv. Merlot and plant introduction PI 491224; one line (RH08-0464) originates from a cross between cvs. Darkland and Balady Banha. All breeding lines with high and intermediate level of resistance to downy mildew will be distributed to the seed industry in Fall 2013. A manuscript for the journal HortScience describing these breeding lines is in preparation (attachment D, #4). Location of genes for polygenic resistance to downy mildew in the Grand Rapids x Iceberg population will be described in the manuscript that is being prepared for the journal of Scientific Reports (attachment D, #5). This work fulfills the expected measurable outcome of developing red and green leaf with downy mildew resistance.

Release of BLS resistant red and green romaine populations: Two BLS resistant S3 populations have been approved for public release by the USDA and 15 seed companies have requested and received seed. It is anticipated that private seed companies will select and commercialize BLS resistant red or green romaine cvs for use in baby leaf production. No red romaine cvs with BLS resistance were known prior to this research. The populations are therefore the first-of-their-kind. This outcome fulfills the expected measurable outcome of developing red romaine with BLS resistance. Long-term, development of these populations will reduce losses of baby leaf lettuce from BLS. A manuscript describing the breeding scheme used in this research is in preparation (attachment D, #6).

Clarified the taxonomy of *Xcv* strains: This work represents the broadest genotyping of *Xcv* strains and an important clarification of the taxonomy of these pathogens. Appropriate identification of these pathogens was necessary in order to deploy appropriate germplasm and identify appropriate targets for detection and quantification. Because of this work, MLST can now be used to identify and genotype *X. hortorum* (*Xcv*) strains isolated from environmental sources. These findings were reported at a scientific conference (attachment D, #1) and a manuscript from this work is in preparation (attachment D, #7). This work surpasses the expected measurable outcome of genotypic analysis of strains.

BLS resistance host-pathogen interaction: Nothing was known about the lettuce – *Xcv* pathosystem prior to this project. This project identified a single dominant gene for BLS resistance and determined the mechanism of resistance conferred by this gene. The gene can be easily bred into diverse lettuce cvs suitable for baby leaf or whole head production using a simple leaf infiltration test for HR. This is the first bacterial resistance gene found in lettuce and deployment of this gene in new lettuce cvs is expected to reduce crop losses from BLS. These findings were communicated at a scientific meeting and three seed companies have visited the USDA in Salinas to obtain more information on this research (attachment D, #2), and a manuscript describing this research is in preparation (attachment D, #8). These activities fulfill the expected measurable outcome of developing and communicating scientific information on the lettuce – *Xcv* pathosystem.

This project identified pathogens able to overcome resistance conferred by the HR in Little Gem, Pavane, and La Brillante. These pathogens are associated with two of the five MLST. Two seed companies have already requested strains to broaden their screening programs. This project developed a rigorous typing scheme to monitor the movement of MLST overcoming resistance as they enter and/or spread the California production system. This will help to devise additional strategies for prolonging the usefulness of resistance deployed. Peer reviewed manuscripts are being developed from this work (attachment D, #9). These findings surpass the expected outcomes of the research.

Release PCR based methods to industry: The MLST identification and genotyping methods were provided to the industry in October. This method surpassed expectations in that any *X. hortorum* (*Xcv*) strain can now be typed to one of the five MLST. Because there is a correlation between MLST and ability to overcome resistance, this information will be vital to deployment of resistant cvs. Consequently, seed companies have requested to have their *Xcv* strains genotyped by MLST by USDA/ARS laboratories. Additionally, the classification results allowed staff to use the appropriate control in testing the B162 primer PCR protocol (Barak et al., 2001) and in searching 16S rDNA, 16S-23S ITS region, *hrpB*, and *fliC* for sequences useful in developing single-step detection and quantification protocols. Unfortunately none of these genes yielded useful sequences. Therefore, the complete genomes of relevant *X. hortorum* (*Xcv*) strains and controls strains were sequenced. Thus, although the goal was not met using the strategies outlined in the proposal, more robust information and a greater quantity of data has been obtained.

Of the seven student interns trained in aspects of phytobacteriology and plant breeding, five are moving into STEM intensive ag professions. The research experiences of interns (partially funded by this program) led to the following outcomes: Three of the students are currently pursuing graduate degrees in plant pathology at Tier 1 Universities (one as an NSF graduate research fellow) and another student is committed to do the same. The remaining students are in STEM and agricultural fields.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
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The popularity of baby leaf lettuce has increased, and California is the top producer. Baby leaf lettuce is the primary component of spring mix, which is approximately 90% more valuable per ton than bulk iceberg or leaf lettuce and was worth more than $140 Million to Monterey Co. alone in 2010. Significant amounts are also grown in four other California counties, although the value of this production is not known. The research conducted in this project will promote the continued expansion of this industry and continue California's commanding market share. This project developed breeding lines and scientific information that will reduce crop losses on more than 13,000 acres supplying over 20 packing companies in California. New pathogen detection methods and scientific information on the *Xcv*-lettuce pathosystem will benefit all lettuce production, a $1.7 billion industry. The breeding lines and populations were released into the public domain, allowing seed companies to conduct further selection for new and novel cvs to commercialize and sell to producers. A larger selection of seed will benefit baby leaf lettuce growers.

Students trained during this research are better prepared for careers in agriculture and graduate research in agricultural science. Research programs of four Tier I universities and the NSF directly benefited in that highly trained students are now part of their programs.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
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Staff conducted downy mildew resistance testing in both greenhouse and field conditions. The greenhouse experiments produced inconsistent results that did not correlate well with previous field observations. Therefore, an alternative approach was developed to select breeding lines for field evaluation based on rank-aggregating approach (Simko and Piepho, 2011).

Staff did not develop BLS resistant red leaf populations before the end of the grant. The initial S1 seed lot selected for these experiments was incorrectly labeled. Consequently, plants grown from this seed lot were not BLS resistant. As an alternative, we developed 2 new S1 populations from crossing a BLS susceptible red oak leaf and red leaf cv to a USDA breeding line possessing an HR response to *Xcv*. We anticipate releasing BLS resistant populations in 2015.

We did not anticipate that *Xcv* strains overcoming resistance would be identified. These strains can now be used to identify different types of resistance that is not based on the HR which will increase options for management of this disease.

The taxonomy of most *Xcv* strains was unclear. This project provided information needed to develop detection and identification methods. Although the genes originally proposed did not yield adequate sequence variability and flexibility, broader collaborations have allowed staff to initiate whole genome sequencing of pathotypes of *X. hortorum* and representative strains of *Xcv*. This will allow for the search of specific sequences throughout the entire genomes and the development of additional hypotheses not anticipated.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

List of attachments

Attachment A: summary of downy mildew resistant breeding lines
Attachment B: USDA, ARS release statement for BLS resistant populations
Attachment C: figure and tables
Attachment D: presentations given and anticipated publications
Attachment E: citations

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 9	**Project Title:** California Granny Smith Maturity Standardization	
Grant Recipient: California Apple Commission	**Grant Agreement No.:** SCB10009	**Date Submitted:** December 2013
Recipient Contact: Alexander Ott	**Telephone:** 559-225-3000	**Email:** aott@calapple.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

In 1992, the Granny Smith Association, the precursor to the California Apple Commission (CAC), adopted a 2.5 starch-iodine (SI) standard on Granny Smith apples. This 2.5 numerical value has been determined by use of an iodine-potassium iodide solution which is then reviewed by a local County agricultural inspector. Each County inspector was responsible for determining the starch levels in the Granny Smith apple and therefore when the apples could be released. Subsequently, this led to the possibility of human error and subjectivity during the Granny Smith harvest. Historically, Granny Smith apples from the southernmost counties reach a maturity date first with the harvest moving north as time passes. The current subjective testing had led to some northern counties releasing prior to southern counties which increased pressure on the market.

This research was necessary to discern how the 2.5 standard can be used universally and objectively. Historical data on release dates, consumer taste tests, and scientific research on a new objective testing procedure were conducted under this grant. Unexpectedly, the industry voted to repeal the Granny Smith Standard before the grant was completed. The repeal of the standard actually strengthened the necessity for the grants' results because the industry was divided on the need for the standard. The taste test demonstrated that the consumer wanted a tart apple therefore indicating that the Granny Smith needed to be released earlier. The historical data gathering on the release dates demonstrated that there were discrepancies and extreme fluctuations in County releases of the Granny Smith crop. So much so, that a grower, who had an orchard split in half by a County line, was able to release half the orchard but not the other due to the subjectivity of the testing/county officials.

Finally, Fruit Dynamics, Inc. (FDI) designed a new testing procedure that would eliminate the subjectivity of the old standard test. Once the report was finalized, it demonstrated there is a linear correlation between the traditional subjective visual Starch Iodine (S/I) index methodology and the L*, A*, and B* color values, as measured on a spectrophotometer, of Granny Smith apple puree treated with an iodine solution. This finding allowed the CAC to give the industry an objective testing method should the Starch-Iodine Standard be re-implemented. In June 2013, the CAC Board of Directors met and decided unanimously to continue without the Starch-Iodine Standard but to provide the industry with the technology should they want to maintain the Standard on an individual basis.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Year 1: FDI and the CAC began their activities in October 2010 which was 9 months before these activities were scheduled to begin. FDI was originally going to begin testing in July 2011 but decided that they wanted more data so taste testing began in October 2010. This was done at no extra cost to the grant and was intended to get a head start on the research. By July 2011, the CAC had formed a stakeholder group in order to create an assessment of tools and methods that are currently being implemented. During the first year of the grant, the CAC compiled historical release date data of Granny Smith apples during the first year of the grant, utilizing records and resources from all California Agricultural Commissioner Offices, CDFA and USDA. To achieve this, the CAC utilized its own historical data as well as data from all California County Agricultural Commissioner Offices, the California Department of Food and Agriculture, and the U.S. Department of Agriculture.

Once all the information was gathered, the CAC cross referenced the historical release data from all sources and got the most accurate and reliable data. This covered every year that the Granny Smith Standard had been in place. FDI preformed a demographic breakdown and sampling of counties. From that data, two commercially producing orchards per county and two locations per orchard were designated for continued and consistent sampling throughout the grant. The apple sampling comprised of harvesting Granny Smith apples from the same specific trees within each orchard, at the same time of day and relative same temperature, and from the same section/area on the tree. It was important to conduct the sampling process in this manner to maintain consistency and validity of the Granny Smith apples throughout the grant. The CAC and FDI wanted all apples that were being tested to be as similar as possible when the L*A*B* value was applied. This was done in the beginning of 2011 season and continued throughout the 2012 season. Each sample lot concluded with a visual starch-iodine value and a correlative L*A*B* value. A visual starch-iodine test consists of cutting an apple and applying iodine to the flesh of the apple. Depending on how dark or how light the apple flesh is after the iodine application, the researcher would then make a subjective decision on the maturity of the apple. With an L*A*B* value test, the apple is reduced into a slurry mixture. Iodine is then introduced into the apple slurry mixture and the amount of light refracted is measured and applied to a pre-established maturity scale. FDI was responsible for sample collection and calculating the maturity value on a weekly basis beginning October 2010 to September 2012. All values were entered into a database for subsequent analysis/filtering, and all sample lots were photographed for presentation in a final report done collaboratively with FDI, CAC staff, and the stakeholder group.

Year 2: The timeframe of October 2012 to the final report of the grant had relatively low activity for this project. During this timeframe, the major research activities began cycling down and preparation for disseminating the findings began. The grant accomplished the objectives that were required within the workplan and performance monitoring plan. FDI provided the CAC with a final report on the starch-iodine testing procedures. The report demonstrated there is a linear correlation between the traditional subjective visual S/I index methodology and the objective L*, A*, and B* color values, as measured on a spectrophotometer, of Granny Smith apple puree treated with an iodine solution. This report was included in the CAC's annual report to the industry. The CAC Board of Directors reviewed the data and made the determination to continue the repeal of the Granny Smith Standardization. As of August 2013, the Granny Smith Standard is still inactive and the industry is showing no signs of reinstating the requirement.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
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The main goals of the project were to develop an accurate/objective testing method that would correspond with a consumer taste preference and allow the California grower the ability to capture the market in a timely and profitable manner. All activities of the grant were completed and achieved on schedule. The grant began in October 2010 with FDI performing taste testing research. This was 8 months ahead of schedule and allowed for a more valid numerical set of data to be included. The taste testing allowed FDI and the CAC to get a baseline on what the consumer wants. The baseline was determined by reviewing all of the taste test participants score totals and determining what Granny Smith apple was preferred the most by all participants. Once the preferred apple taste was established, the preferred apple was correlated with accepted Granny Smith maturity standards. Over many tests, a common preferred Granny Smith apple maturity was established and could be considered the standard/baseline. Once that baseline was established, the comparing and contrasting with L*A*B* ratings began. In July 2011, the sampling of the Granny Smiths began and the gathering of historical release dates was initiated. The gathering of historical release records became a critical component early on because it clearly demonstrated that there was a distinct and clear subjectivity to the old testing method. Once all of the sampling, compiling, and comparing of L*A*B* ratings of the Granny Smith data had been accomplished, the 2 year data was analyzed and put into a final report for the industry. A new objective test was developed and had the documentation and supporting confirmation to demonstrate that it was reliable and accurate.

In October 2012 the CAC received Specialty Crop Block Grant Project 17 to determine the economic impact of the removal of the Granny Smith Standard. Project 17 concluded that California apple growers forfeited millions of dollars by enforcing the Granny Smith Standard. Using the analyses and information from this project and the 2012 project, the CAC's Board of Directors made a decision to maintain the repeal and let the market dictate the harvest of the Granny Smith apple. Although the industry elected not to reinstate the Standard, the new objective testing method, using the L*A*B* ratings, was provided to the industry allowing them to use the technology to regulate individually if wanted. As a result, a more consistent and tastier Granny Smith apple is now being released to the consumers.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The CAC is made up 72 growers and 11 packers who are mandated by state law to pay an assessment to the CAC. These 72 apple growers and 11 packers all benefited directly from this project. The information obtained was distributed throughout the industry. The project provided crucial market data that detailed why or why not the CAC should be implementing a very subjective Granny Smith Standardization.

During the duration of the project, all of the beneficiaries of the grant benefited from the completion of the project. Initially, there was some industry concern due to the belief that a change in the standard would cause an earlier release date of Granny Smith apples which would devalue the market because consumers would not desire the lower than 2.5 starch-iodine apple. These concerns were quickly alleviated. The grant confirmed that not only is the 2.5 standard too high but that consumers preferred the lower starch apple and that the market value would increase because of it. For example, one grower stated that due to the removal of the standard he was able to generate an additional $300,000 dollars from his Granny Smith crop. It was the first time in several years that his Granny Smith crop was profitable and prompted him to not remove the orchard. Armed with many similar accounts, the CAC Board of Directors reviewed the grant research and decided that the best decision was to remove the standard permanently, but provide the industry with the testing method developed by this project so objective testing can be performed if desired.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

This project demonstrated to be enormously beneficial and useful to the California apple industry. Once the grant began, it was obvious that there was a need for more information. The original standard testing procedure was very outdated and extremely subjective. Prior to the repeal of the standard, the CAC fielded many phone calls from growers asking why their Granny Smith's orchard was not being released for harvest. Growers were upset the market was dictating a high price for Granny Smith apples and a subjective testing procedure was preventing them from capturing it.

After the initial findings of the grant, the CAC Board of Directors voted to repeal the standard until the grant was complete and more information was available. Since the standard was repealed, the complaints about the test were eliminated and the compliments regarding the Granny Smith harvest increased dramatically. In the past, growers used the Granny Smith apple as a bridge between the other apple harvests. The repeal and subsequent proof that the customer wants an earlier Granny Smith changed that outlook. Now growers are looking at the Granny Smith apple as a profitable variety with room to grow. When the results of 2012 Project 17 supported the initial repeal decision, the CAC decided to permanently remove the standard and let the market dictate the harvest timing.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Attachment: Report from the 2012 Specialty Crop Block Grant Project 17: Economic Impact of Removing the Maturity Standard for California Granny Smith Apples

Project 10 - Western Growers (WG)

Final Performance Report

Project Title
California Agricultural Communications Coalition (CACC) Promotional Campaign

Project Summary
According to a recent study by the Center for Food Integrity (CFI), the public does not understand the way their food is grown or raised, and this lack of understanding creates opportunities for activists and detractors to generate negative publicity toward the industry. Research from the CFI also indicates that to counter this type of misinformation, the industry must engage consumers in communication that is based on shared values and ethics. Through comprehensive research, the CACC has identified specific messaging points that communicate the shared values and ethics of farmers and consumers, and has developed the www.KnowACaliforniaFarmer.com (KACF.com) website as a platform for farmers to communicate these shared values and ethics using the latest social media tools.

The CACC Promotional Campaign worked in conjunction with two other ongoing block grant awards. One grant award focused on developing the CACC, including common messaging and the development of the KACF.com website that allows farmers to utilize the latest social media tools to connect directly with consumers, and the other grant award aimed at social media training for farmers to drive traffic to the KACF.com website and jumpstart the dialogue between California farmers and consumers. The CACC Promotional Campaign leveraged a Facebook "win groceries for a year" campaign to raise consumer awareness of the KACF effort and website, as well as engage consumers in a meaningful community on the KACF Facebook and Twitter pages. To do this, multiple digital ads (including banner ads on more than 300 of the top digital publication outlets in California) and targeted blogger outreach were employed to drive consumer traffic to the KACF Facebook page. In order to enter, consumers had to "like" the KACF Facebook page. Once they entered, they were redirected to the KACF.com website.

Project Approach
Facebook Page and Twitter Account
Prior to execution of the two-month Facebook "win groceries for a year" sweepstakes campaign; the CACC laid the groundwork by developing the KACF Facebook page and Twitter account. Both platforms serve as a medium to push out content from the KACF.com website, are kept fresh and engaging with new content posted daily, and enhance the searchable content from the KACF.com website.

The KACF Facebook page gives consumers the opportunity to talk about the food that California farmers provide. WG uses the page to share videos, blog posts, and photos uploaded on the KACF website, and also to stimulate conversation about food, flowers, fiber and farming. As of September 30, 2011, the KACF Facebook page had 2,542 fans and had logged 19,562 total visits. More importantly, there were a total of 1,873 likes and comments on the page, which resulted in a total of 382,236 total impressions (views of status updates in news feed).

The KACF Twitter account has proven an effective way to join consumers in existing conversations about California agriculture. By searching for relevant conversations about food production and agriculture, conversations are monitored and join them when appropriate. As of September 30, 2011, the KACF Twitter account has 1,093 followers and has received a total of 760 mentions.

Facebook "Win Groceries for a Year" Sweepstakes

The two-month sweepstakes was held from July 15, 2011 to September 15, 2011 to promote awareness of the KACF effort, and to bring consumers to the KACF Facebook page and website. In order to enter, consumers had to "like" the KACF Facebook page. Once they entered, consumers were redirected to the KACF.com website. The Facebook content, blogs, videos and photos enabled consumers to engage in on-line conversations directly with farmers. The grand prize was a gift card for groceries for a year for one winner. The retail value of the prize was $10,000. Secondary prizes included a year of monthly fresh flowers for one winner and eight weekly giveaways of a $100 gift card for groceries. All prizes were provided by members of the CACC, including Western Growers, California Farm Bureau Federation, California Agricultural Council, California Pear Advisory Board and the California Cut Flower Commission. The sweepstakes was promoted through multiple digital ads over the course of eight weeks, including banner ads on more than 300 of the top digital publication outlets (food, women, special interest, national media, local/regional) in California, including: Food Network, Food and Wine, Allrecipes.com, BabyCenter.com, Disney Online, Family Education Network, iVillage, Oprah.com, Oxygen, Parenthood.com, RealSimple.com, A&E Television Networks, Discovery.com, Meredith Interactive, A&E Television Networks, Discovery.com, ABC Digital, CBS Digital, NBC, Fox Interactive Media, Sign On San Diego, L.A. Daily News, LA Times and LA.com.

As a result of the banner ads, there were a total of 6,603,546 impressions with 2,271 total clicks. This digital campaign delivered in full and performed at industry standards. Having the brand in front of so many Californians will help future efforts because the foundation has been laid of awareness. In addition to the banner ads, Facebook ads were customized on a daily basis to target key food decision makers in California (college-educated women, 35 to 54 years of age in the $75,000 plus income bracket). As a result of the Facebook ads, there were a total of 80,423,479 impressions with a total of 6,248 clicks. Combined, over 87 million ad impressions were delivered, increasing awareness of the KACF brand and effort. The people who made up the more than 8,500 clicks were taken to the sweepstakes tab on the Facebook page where they learned more about the giveaway and the effort.

Over the course of the sweepstakes, the KACF.com Facebook received 1,823 new "likes," which represents a 244 percent increase from prior to the campaign. More importantly, the increase in "likes" came from California consumers, not people that are part of the KACF effort. At industry averages, about 300,000 people saw that their friends Like KACF, and as interactions increase on Facebook, WG has greatly increased the reach outside agriculture and into California homes. Additionally, during the course of the sweepstakes, the KACF Twitter account added 451 new followers, an increase of 75 percent from prior to the campaign. Heavily made up of California consumers, as opposed to people that are part of the KACF effort, these 451 followers extend the potential reach by over 15,000 California consumers.

Blogger Outreach
Prior to the Facebook sweepstakes campaign, research was conducted to find key parent bloggers, food bloggers and farmer bloggers who would be interested in learning about the KACF program. The candidates needed to have an active, up-to-date, online presence with a following of people that would be effective in promoting the efforts of the KACF initiative. Equally important was the ability for these bloggers to be an objective tour audience, willing to engage in a dialogue about farming practices without pre-determined agendas and/or ideas.

The outreach culminated in the top 12 bloggers being invited to a live event hosted by two California farm families one representing leafy greens and the other berries. World-renowned blogger and social media expert Jay Baer attended the event and tour, to encourage attendance and to help foster greater understanding between these groups of key influencers. Six pre-selected food and parenting bloggers from the San Francisco and Sacramento regions attended the event. The secondary audience for this initiative was the more than one million Californians who actively read and interact with the selected food and parenting bloggers. The hash tag "#FarmFreshTour" was created, to encourage engagement and dialogue among the bloggers' followers. Social media monitoring from the event's hash tag #FarmFreshTour indicate that 212,908 people were reached via 491 tweets with an exposure of 1,249,640 impressions. More than 100 Twitter users tweeted with the #FarmFreshTour hash tag.

Post-event blogs have been written by several of the authors, discussing various agricultural topics including:
- Differences and similarities between conventional and organic farming practices.
- Farm labor conditions and treatment,
- Family farming history and stories.
- Differences and similarities between large, incorporated farming practices and small farming operations.
- Logistics of harvesting and delivering food to grocery stores and restaurants across the country.
- Farm management practices, such as tilling organic matter back into soil.

Blog posts written by attendees have received an estimated 25,000 plus views and over 35 comments. YouTube videos from the Tanimura & Antle tour were also posted by a blogger attendee and have garnered over 40,000 views and over 100 comments. The blogger outreach resulted in new advocates for the KACF effort in the food and parenting sectors of blogging. The largest food video blogger, Chef John, has more than 130,000 subscribers to his Food Wishes site, with weekly audiences of 500,000 plus. Food Wishes was recently purchased by allrecipes.com. Chef John is just one example of non-ag bloggers now supporting the KACF message.

Earned Media
Through traditional public relations tactics, a statewide outreach to promote the KACF.com sweepstakes was implemented. To begin, a press release announcing the sweepstakes and KACF.com was distributed to 185 media contacts throughout California, representing both urban and rural media outlets. The information within the release allowed journalists from print, television and radio mediums to understand what KACF is about. It also gave the media the opportunity to connect directly with California farmers to hear their stories and learn about the

social media tactics farmers are using to talk about their farming operations. Throughout the sweepstakes duration, various winners of the sweepstakes' secondary prizes were utilized to draw more attention to the KACF initiative and to ultimately create a better engaged and aware consumer audience about the efforts of KACF.com and the sweepstakes.

A resident from Temecula, California was chosen as the winner of the sweepstakes and was awarded the prize in-person by two local area farmers. The grand prize winner was able to share her story via the KACF.com website with a personal video message thanking California's farmers for their hard work and efforts. The winner gained media attention and was featured in two major newspapers, in articles about her winning and the KACF efforts. Throughout the media attention, the winner praised California farmers for growing the freshest and best food supply in the world. A traditional media monitoring service provided consistent tracking throughout the campaign. The final report indicated that the discussion around the sweepstakes and subsequent winner garnered 2,242 mentions through a variety of print, television, radio, with social media accounting for a large majority of the mentions. So far, total traditional media coverage has resulted in an estimated 422,300 impressions.

Weekly E-newsletter
A weekly E-newsletter was issued to motivate and inspire farmers and members of the agricultural community to continually engage and interact with the general public and promote KACF's key messages. The email also included tips on connecting with California consumers via social media. The subscription list has grown to nearly 700 contacts since the start of the campaign. As of September 30, 2011, the weekly E-newsletter has seen 5,462 unique impressions with 1,206 unique clicks. The average open rate is 28.3 percent, which means that 28.3 percent of the people who see the email open it. And the average click rate of opened in is 20.5 percent, which means that 20.5 percent of the people who see the email and open it click on one of the lines contained in the email.

<u>Goals and Outcomes Achieved</u>
The primary goal for this reporting period was to drive consumer participation to the KACF.com website and related social media pages (i.e. Facebook and Twitter) as measured by the following metrics:

- 250,000 sweepstakes registrations.
- 2,500 Facebook fans.
- 1,000 Twitter followers.

With 2,542 Facebook fans and 1,093 Twitter followers as of September 30, 2011, WG was successful in achieving the 2,500 Facebook fans and 1,000 Twitter followers' marks. More importantly, with 19,562 total visits and a total of 1,873 likes and comments comes with most of the activity in the final weeks of the sweepstakes campaign. The WG was successful in establishing the KACF Facebook page as a credible destination for conversations about California agriculture. However, as discussed in further detail under the "Lessons Learned" section, the Facebook sweepstakes did not take off "virally" as was anticipated. Consequently, WG only had 2,049 registrations for the contest, well short of the 250,000 target.

Beneficiaries

In conjunction with the other two block grants being managed by the CACC, this project will benefit the entire California specialty crop (SC) industry through increased awareness of the KACF brand and the SC farmers behind the effort. As more and more California consumers engage with the various KACF social media platforms (i.e. KACF.com, Facebook, Twitter), the conversations surrounding California agriculture will begin to shift toward more positive perceptions of the industry. Furthermore, as consumers reconnect to the source of their food supply, they will become more trusting, confident and supportive of California SC farmers. Admittedly, it is difficult to quantify the potential economic impact of the Facebook sweepstakes campaign and related promotional efforts funded with this block grant. The CACC is still in its infant stages and will continue to build on the momentum established through this project. Ultimately, the long-term improvement in consumer attitudes toward California SC farmers will help preserve the $24 plus billion SC industry in the state and buoy the state economy through direct and indirect farm-related jobs.

Lessons Learned

Over the course of the sweepstakes, the KACF.com Facebook received 1,823 new "likes." While this represents a 244 percent increase, the Facebook "likes" were definitely lower than anticipated. This is mostly due to a lack of consumers passing an invitation to their friends, which would have spread the contest virally. In developing the sweepstakes with certified Facebook content developer Wildfire, WG anticipated that news of a contest with as high a value prize as was given away would be pushed out much past the media spend that supported it. Looking at the results of the sweepstakes, the opposite was true; the media spend actually drove the vast majority of entries to the contest. This demonstrates that while the contest did not go viral (you can never guarantee it will happen), the paid media performed very well. Looking back, the assumption is that the contest did not take off virally for one of two reasons. First, with such a high value prize, consumers may have felt there was a hidden agenda and did not want to participate. Second, KACF is not a well known brand with a track record as of yet, so trust in the brand may not have been high enough for consumers to submit their information.

In summary, WG needs to remember that the goal was not really to collect contest entries; it was to greatly increase the reach to the consumer base of California and spread the word about KACF. Between the paid media, social media and earned media of the sweepstakes effort, WG delivered over 87 million impressions to Californians, and almost seven million of those impressions were either high awareness drivers (banners), or sent socially by friends and family, which are trusted sources of information.

Contact Person

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Additional Information

Website:	www.KnowACaliforniaFarmer.com
Facebook:	http://www.facebook.com/knowacaliforniafarmer
Twitter:	@KnowACAFarmer

USDA Project No.: 11	Project Title: Engaging Social Media – The Voice of California's Specialty Crops	
Grant Recipient: California Department of Food & Agriculture	**Grant Agreement No:** SCB10011	**Date Submitted:** December 2013
Recipient Contact: Steve Lyle	**Telephone:** 916-654-0462	**Email:** Steve.Lyle@cdfa.ca.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

This project resulted in the "Growing California Video Series" which consists of 29 web-based videos highlighting various aspects of California's specialty crop industry. This video series was designed to raise consumer awareness on the diversity of the state's specialty crop industry to address the growing interest among consumers about their food supply. The overall objective of this project was to increase the favorable disposition of consumers to California specialty crop farmers and their products, enhancing the overall competitiveness of the industry.

The motivation for this project was prompted by the increase in consumer advocacy concerning the food system and the opportunity to provide further information to consumers about the diversity and innovations within the specialty crop sector.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

The project focused on a tiered approach to implementation. Videos were filmed from April 2012 to September 2013 and a social media program was launched in February 2013. By developing a number of videos prior to a social media release, the video series was able to be rolled out on a weekly basis beginning in February 2013. This weekly release of videos provided opportunities to leverage consumer social media engagement and interest to help achieve the overall objective of the program which was to increase the favorable disposition of consumers to California specialty crops.

Video production was facilitated by California State University, Sacramento – Academic Technology and Creative Services along with CDFA staff. The social media program was coordinated by CDFA staff and the Buy California Marketing Agreement.

Project team meetings were held on a consistent basis and covered pre/post production of videos along with the social media program.

CDFA's Planting Seeds Blog (http://plantingseedsblog.cdfa.ca.gov/wordpress/) served as the primary social media outlet for the developed videos. The blog was also promoted on Facebook (https://www.facebook.com/pages/California-Department-of-Food-and-Agriculture/83888787230) and Twitter (https://twitter.com/CDFANews).

The Buy California Marketing Agreement also hosted a video page on their main website (http://www.californiagrown.org/growing-california/).

In addition, videos were posted to CDFA's (http://www.youtube.com/user/CDFAtoday/videos) and Buy California Marketing Agreement's (http://www.youtube.com/user/growninca/videos) YouTube pages.

As a result of this project more than 9,864 views were generated on CDFA's Planting Seeds Blog, representing 16 percent of total viewership between February – September 2013. Video postings on the Planting Seeds Blog generated an additional 437 Facebook likes; 112 Tweets; and 31 LinkedIn shares.

Total viewership on the CDFA's Planting Seeds Blog from February – September 2013 increased 61 percent compared to the same period during the previous year. Daily average viewership also increased 56 percent during the same period February – September 2013.

Total viewership on CDFA's Planting Seeds Blog for the tracked period was 59,071—a 22,384 viewer increase from the previous year. Of the increased viewership, the video series is representative of approximately 44 percent of this total. Average viewership per video, as of September 2013, is estimated at 346 views.

This project resulted in a social media based educational resource that documents the diversity of California's specialty crop industry and its farm innovations, environmental contributions and stewardship.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The identified project goal was to increase consumer awareness on California specialty crop farmers and their products in the social media sector. The target was a 25 percent increase in the number of followers, viewership and other social media metrics. CDFA's Planting Seeds Blog served as the primary social media distributor of the Growing California video series. The blog experienced a 61 percent growth over the baseline period. The Growing California video series was representative of 16 percent (9,864 views) of the increased viewership over the baseline period.

Facebook and Twitter served as secondary platforms to promote the video series. Facebook viewership decreased by an estimated 51 percent when compared to the 2012 baseline level; however, the viral reach and impressions created through Facebook increased in the 2013 performance period by more than 175 percent in each category. Viral reach and viral impression denotes the external fan base viewership of posts. The Growing California video series in 2013 represented 24 percent of total viewership, 14 percent of generated viral reach, and 14 percent of viral impressions. Twitter increased overall followers by 34 percent, but experienced a 47 percent decrease in the growth rate of new followers.

YouTube viewership compared to the baseline year represented an increase of 17 percent, below the targeted goal. The Growing California video series represented 48 percent of total video viewership and 41 percent of total minutes watched during the performance period.

The project resulted in an increase in consumer awareness concerning California specialty crops; however not all target metrics in the social media categories were achieved. As a first year SCBG project more definitive baseline data has been achieved for potentially future activities.

	Videos	**Activity Completed:**	**Social Media Publication:**
1.	Free Spirit Farmer	November 2012	February 2013
2.	Lemon Appeal	January 2013	February 2013
3.	Farm to Family	December 2012	February 2013
4.	First Line of Defense	May 2012	February 2013
5.	Chef's Guide	July 2012	February 2013
6.	Third-Generation Farmer	August 2012	February 2013
7.	Exotic Greens	February 2013	February 2013
8.	Citrus Scourge	February 2013	March 2013
9.	Love on the Vine	March 2013	March 2013
10.	Salad Bar Superstar	March 2013	March 2013
11.	Green Broker	May 2012	March 2013
12.	Urban Farmer	October 2012	April 2013
13.	Farmer's Market	July 2012	April 2013
14.	Farm Academy	October 2012	April 2013
15.	Teen Harvesters	August 2012	April 2013
16.	Cherries Galore	June 2012	April 2013
17.	Onion Power	April 2013	May 2013
18.	Delta Delicacy	May 2013	May 2013
19.	Apple Hill	November 2012	May 2013
20.	Wheel Food	May 2013	May 2013
21.	Blossom Buddies	May 2013	June 2013

22.	For the Love of Olives	May 2013	June 2013
23.	Blooming Business	May 2013	June 2013
24.	Fun, Food, Festivals	May 2013	July 2013
25.	The Mysterious Artichoke	May 2013	July 2013
26.	Casa De Memories	September 2013	Fall/Winter 2013*
27.	Why Beans?	September 2013	Fall/Winter 2013*
28.	Almond Futures	September 2013	Fall/Winter 2013*
29.	Watermelon Masters	September 2013	Fall/Winter 2013*

* *Grant activity completed September 2013, social media publication reflective of long-term outcome measures*

Social Media Metrics:

	2012 Baseline	Performance Measure	2013 Result
Planting Seeds Blog:	36,687 views	+ 25 percent	59,071 views (+ 61%)
CDFA YouTube Page:	10,639 views	+ 25 percent	12,520 views (+ 17%)
Twitter:	3,950 followers	+ 25 percent	5,307 followers (+ 34%)
Growth rate (Feb.-Sept.)	32 percent	+ 25 percent	17 percent (- 46 %)
Facebook*:	55,177 views	+ 25 percent	26,533 views (- 51%)
Viral Reach	759 users	+ 25 percent	2,226 users (+ 193%)
Viral Impressions	2,032 users	+ 25 percent	5,375 users (+ 164%)

* *The Growing California video series in 2013 represented 24 percent of total viewership, 14 percent of generated viral reach, and 14 percent of viral impressions.*

Growing California Viewership: (February – September 2013)

Planting Seeds Blog:	9,864 views
Buy California YouTube:	5,903 views
CDFA YouTube:	6,119 views
Facebook:	6,469 views
Total views:	28,355 views

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Consumers with a favorable disposition to a product are more likely to purchase that product. This project increased the favorable disposition of consumers through education in the social media sector. California's 45,626 specialty crop farmers are the direct beneficiaries of this project. More than 28,000 views were recorded for the Growing California video series, exposure that contributed to an increase in overall social media viewership.

Consumer research from the Buy California Marketing Agreement, a project partner, indicates that sales of the California grown products have increased 7.1 percent in the state since the inception of the California Grown campaign. The Growing California video series is a complement to the California Grown Campaign, raising awareness of specialty crops and continuing the positive economic and societal trends that the campaign promotes.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The Growing California video series provided an opportunity to highlight the diversity of specialty crops within the state. The start of the program had contractual barriers that delayed project implementation and revised elements of the program scope. Contractual planning for a three-year project at the state governmental level should consider a two-phase, five-year minimum implementation time span.

Positive Results of Program:

- An increase in consumer awareness concerning California specialty crops. This awareness will further improve the competitiveness of the specialty crop sector.
- More than 111,000 social media impressions; 28,000 direct views; and 1,000 non-follower reach.
- Unanticipated matching/in-kind support for production of three additional videos (information/data is not included in reporting). Videos include: *Where's the Beef*; *Reedley's Gold*; and *From Service to Harvest.* (SCBGP funds were not used to produce these videos.)

Observations/Recommendations:

- Social media marketing is an effective means to increase consumer awareness. Improved social media performance (metrics, tracking and promotion) can be achieved through contractual activity and should be considered for future projects to maximum the visibility and consumer reach.

- Metrics for a consumer awareness campaign are difficult to achieve without significant investment in pre/post-research. This further validates the need for professional social media marketing services.
- The variety, scope and level of video production increased video cost above initial estimates. A baseline has now been established for future video projects and staffing.
- Project implementation delays limited video production of certain specialty crops. Original project timeline for video production was reduced to a one-year time frame which precluded video production in some peak season areas. Although the project time frame was extended by three months, a longer project timeline (2 years) will provide opportunity to capture more diverse aspects of specialty crop production.
- Cooperation with agricultural organizations was highly successful in determining video subjects and focus. Future project would continue this joint cooperation with agricultural stakeholders.
- Complete outsourcing of video production is not recommended because of the complexity, diversity and uniqueness of the agricultural sector.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 12	Project Title: Developing Internet Resources for California Specialty Crops	
Grant Recipient: University of California, Davis	Grant Agreement No.: SCB10012	Date Submitted: December 2013
Recipient Contact: Carlos Crisosto	Telephone: (530) 752-7579	Email: chcrisosto@ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

California tree fruit and nut agriculture is an important component of the state's total economy. In 2012 California tree fruit and nut production totaled almost $17 billion (NASS 2012). California is the primary producer of some of the largest specialty crops grown in the United States. For example, almost all domestic almond, olive, pistachio, plum, prune, nectarine, processing peach, apricot and English walnut are produced there (NASS 2012). Additionally, more than one half of domestic sweet cherry and fresh market peach are grown in California (NASS 2012). Despite the importance of California fruit and nut tree crops to the state and national economies, the health of this industry is vulnerable as a result of changes in the availability and scope of university extension programs.

Historically the University of California Cooperative Extension (UCCE) system has employed a wide range of extension specialists and farm advisors who conduct research and outreach for tree fruit and nut growers. In 1990 the UCCE system employed 325 farm advisors. Today, only 207 advisors remain with 60% expected to retire in the next decade. As a result of the declining numbers of farm advisors statewide, traditional outreach and extension tools (hard copy newsletters, brochures, posters, meetings, field days, and farm calls) are not able to meet grower demands for timely, accessible information and education. Instead, the internet is now the most efficient communication and extension medium. This project focused on two primary goals: 1) developing a wide array of new extension, outreach and educational materials online in response to surveys of fruit and nut industry representatives and farm advisors, and 2) developing a new Fruit and Nut Crop Management Certificate Program.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

A broad scientific and stakeholder advisory committee was assembled, which spanned multiple research institutions and industry members. Specifically, the committee included representatives from University of

California (UC) Davis, UCCE, the U.S Department of Agriculture (USDA) clonal germplasm repository, Fresno State University, Reedley Junior College, Burchell Nursery (one of the top four fruit and nut nurseries in California), USDA, Agricultural Research Service (ARS) and industry (fruit and nut growers).

Surveys were distributed to UCCE personnel, UC faculty, growers, shippers, processors, and produce support industry to collect information about electronic resource needs. The results of these surveys clearly indicated that members of the California fruit and nut industry use the internet as a resource for information and prefer short sections of text and videos with links to full reports. The FNRIC website was redesigned based upon recommendations from survey responses. In total, over 300 surveys were distributed with greater than 50% response rate.

After analyzing survey responses, new multimedia online educational and outreach materials were developed. All new material posted online was peer reviewed by a minimum of two UCCE or faculty experts to ensure that the information was accurate and relevant. In many cases, members of the industry (farmers, nurseries, and commodity boards) served as additional expert reviewers. The remaining efforts to develop new educational material for the California fruit and nut industries were focused on multimedia websites and courses for the certificate program. Initial surveys of growers, industry members and extension personnel clearly indicated a preference for shorter sections of multimedia educational material online with links to full peer reviewed reports or papers.

The project team focused on the following five categories of online educational materials:

<u>Information on common crops grown in California</u>:
Crops included apricot, sweet cherry, fig, kiwifruit, peach, nectarine, European pear, pecan, persimmon, plum, pomegranate and walnut. Four to eight pages were developed per crop, depending on the amount of research and information available. A total of 55 image galleries were embedded within each webpage that display historic image collections not previously displayed online and new image collections were created by project personnel.

<u>Interactive websites displaying results of UC research</u>:
Four interactive educational websites were developed and refined. An existing site, which enables almond growers to extrapolate leaf nutrient measurements to tree fertilizer demands later in the season, was updated and improved substantially. A similar site for pistachio growers was created and posted online. A third interactive site was created to help growers calculate reference water potential and improve irrigation scheduling. All three sites included 4-5 pages of reference material in addition to the interactive model section. Finally, an existing interactive weather model website was updated for improved access on tablet devices as surveys indicated that growers access the internet using phones and tablets.

<u>Information on basic tree biology and orchard management</u>:
Three new collections of educational pages focused on general orchard management and basic tree biology were developed. Topics included harvest, postharvest, pollination, flower anatomy and tree growth. This section of the website includes 32 new pages with over fifty figures, two summary tables, two glossaries and links to educational videos and animations.

A new research report database:

All available hard copies of historic research reports submitted to the California Tree Fruit Agreement were collected and digitized. The available collection included complete sets of reports through the 1980's and some older reports dating back to the 1950's. Combined, this collection includes 220 reports from 1959 to 2011. This collection of reports represents a significant asset to the California peach, nectarine and plum industries which currently lack a marketing order and funding for future research.

Educational videos and animations:

A total of 13 new educational videos and animations were posted online. Video topics included soil sampling techniques for orchards, pistachio pruning for young and established trees, flower and fruit development and tree growth and development.

In summary, the new educational websites developed included 10 videos and animations, 55 image galleries with many pictures within each gallery, 50 new educational figures, 4 interactive websites, 220 research reports, 4 glossaries and summary tables, comprehensive information on 13 fruit and nut tree crops and 32 pages on basic tree biology and orchard management.

New online content was demonstrated at the annual statewide Pomology Education Continuing Conference, and at the statewide meeting for tree fruit and nut commodity board representatives held at UC Davis in each year of the grant. Each presentation included demonstrations of multimedia websites, descriptions of plans for the certificate program and an outline for future work. Following each presentation there were 20-30 minutes of group discussion to provide critical feedback on current projects and future plans. The Project Investigator (PI) and Project Manager (PM) found the feedback provided during interactive group discussion was more valuable, dynamic and in depth than feedback that could be gleaned from multiple choice surveys.

The first ever Pomology Certificate Extension course was launched in February 2013. Forty California growers, students and educators participated in the two week long course. The first week of the course was taught by UC faculty, Extension Specialists and Farm Advisors at UC Davis. The second week included a field tour throughout fruit and nut growing regions in Northern, and Central California. Currently there are over 100 growers on a waitlist for future course offerings.

The certificate program was evaluated in three ways. First, the PI and PM solicited feedback on the scope and content of the certificate program from a wide range of experts in industry and universities. Plans for development of the certification program were thoroughly evaluated and revised in response to this feedback. Second, the course was evaluated by all participants using surveys and in person discussions. Course participants included new and experienced growers, students, and educators. All participants provided candid, critical feedback in response to written surveys and in an in person group discussion at the end of the course. Third, the certification course was critically evaluated by all instructors after completion to determine what parts of the instruction and material should be revised in future offerings.

Throughout the project the PI, PM and project personnel consulted with UC faculty, UCCE experts, and growers to ensure that the products and activities were relevant and useful to the California tree fruit and nut industry. Bi-annual oversight committee meetings were held to guide project development and provide critical feedback. Additionally, a minimum of two expert reviewers were consulted before any new online material was posted. The Fruit and Nut Research Information Center (FNRIC) website, fruitsandnuts.ucdavis.edu, contains a current list of oversight board members and expert reviewers for each new educational page.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

During the tenure of the grant, website tracking software available to the FNRIC was changed. Until January 2011 all FNRIC websites were tracked using the mandatory "smarter stats" program developed by UCCE. Beginning in January 2012 all FNRIC websites were transitioned to "google stats" tracking software. As a result, it is not possible to directly compare website visitation between the beginning and end of the project. Despite this limitation, performance can be compared within the first and second phases of the project. Both website tracking metrics indicate the project surpassed goals for visitation and use of online educational resources.

Data available from the "smarter stats" software indicate the first project objective was surpassed within the first two years of the grant. In 2010 the core FNRIC website received 380,000 hits. The number of hits more than doubled to 840,000 in 2011. Beginning in 2012 the tracking software switched to "google stats" enabling improved tracking of the number of pages viewed per visit, time of each visit and the total number of visits per year. Because "google stats" tracks *visits*, not *hits*, these numbers are not comparable to "smarter stats" estimates. During 2012 the FNRIC core site received 65,251 visits. From January 1 – June 30, 2013, the website received 49,000 visits, a 59% increase from the same time the year before.

Over 85% of website visits came from users within the United States. On average, visitors to the site viewed 3.3 pages per visit and stayed for 3 minutes. Site visits from users within California were distributed broadly throughout fruit and nut tree growing regions in Northern, Central and Southern California. Combined, these metrics demonstrate the success of the new educational materials in reaching a wide range of users in California.
The PI and PM relied heavily on Farm Advisors, Extension Specialists, and other experts from academia, the USDA and industry to provide detailed feedback on online information improvement. The PI and PM established a policy requiring all new online educational content to be reviewed by a minimum of two experts prior to publication online. All expert collaborators provided multiple reviews of material and ultimately provided their professional approval before it was published to ensure that the information provided was accurate and relevant.

Utilizing Farm Advisors as expert reviewers of new website content ensured that extension experts were familiar with all additions to the website. After reviewing new content, Farm Advisors helped inform growers and the public about the new resources available on the site. The results of this direct outreach to growers are clearly demonstrated in website visitation statistics available for the new educational pages as a part of this project.

The project goal for participation in the Pomology Certificate Program course was surpassed. Forty students, new growers and experienced growers participated in the first Course in February and March 2013. Participants in the course represented the full range of California tree crops including nuts, stone fruit, and pome fruit.

The certificate course included daily evaluation of all participants using quizzes to assess comprehension of course principles and remaining gaps in knowledge. Following evaluation of all quizzes, instructors used a group discussion to review correct answers and ensure that all certificate course participants understood the material. Follow up surveys were consistently very positive and included a few suggestions for improvement. For example, participants suggested splitting the class between new and experienced growers during the pruning demonstration to provide more focused lessons by two instructors. Participants also requested expansion of existing hands-on exercises intermixed during lecture in the first week.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The primary beneficiaries of the project are the 15,000 tree fruit and nut growing operations in California (NASS 2013). Combined, this industry is valued at $17 billion (NASS 2012). Additional beneficiaries include rural businesses and communities throughout the state where community members are employed in the fruit and nut industries. Rural communities also benefit from a healthy and sustainable fruit and nut industry through agro-tourism based farmer's markets and festivals centered on the flowering and harvest of tree crops. Finally, consumers of fruit and nut products in California benefit from the availability of high quality, low cost, healthy food products.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The PI and PM learned several lessons throughout the project about the best approaches to provide helpful educational resources to the California tree fruit and nut industry. First, California fruit and nut tree growers rely heavily on the internet to search for and obtain information on production and management. The quality and organization of available information on California tree fruit and nut agriculture is not sufficient. Information by university experts is not centralized and not sufficient to meet the demands on the industry. Websites developed by private companies or individuals are not reviewed by independent experts and, as a result, unreliable.

Growers and industry members prefer short segments of text or videos with links to detailed reports. The most popular sections of the FNRIC website include information organized by crop name and interactive models designed to improve orchard management practices.

There is substantial demand for a Pomology Certificate course by tree fruit and nut growers in California. The project easily exceeded expected enrollment of 25, with 40 participants in the first year and over 100 on a waitlist for subsequent years.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

All educational materials produced as a part of this project can be viewed online at the following sites:
- FNRIC core website fruitsandnuts.ucdavis.edu
- Page collections developed for individual crops: http://fruitsandnuts.ucdavis.edu/datastore/
- Orchard management and tree biology pages: http://fruitandnuteducation.ucdavis.edu/generaltopics/
- Educational videos and animations: http://fruitsandnuts.ucdavis.edu/photogallery/
- Interactive model websites: http://fruitsandnuts.ucdavis.edu/Weather_Services/
- Pomology Certificate Course website: http://fruitandnuteducation.ucdavis.edu/education/Course/
- California tree fruit research report database: http://ucanr.org/sites/ctfa/

USDA Project No.: 13	Project Title: Promoting Specialty Crops to Federal Nutrition Benefit Clients	
Grant Recipient: Trust for Conservation Innovation on behalf of Roots of Change	**Grant Agreement No.:** SCB10013	**Date Submitted:** December 2012
Recipient Contact: Bobby Peyton, Program Manager	**Telephone:** (415) 391-0545 x14	**Email:** bobbie@rootsofchange.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

California produces nearly half of U.S. grown fruits, nuts and vegetables (specialty crops). Despite this growth, many California specialty crop farmers struggle and often rely on farmers markets for most of their direct marketing. At the same time, the state is one of the highest for families in need of food assistance. This project connects these families with these producers to increase farmer revenue and healthy food access in low-income communities.

There are about 700 farmers' markets in California and only 145 of them accepted CalFresh benefits in 2011, according to the California Department of Food and Agriculture (CDFA). This project focuses on marketing CA grown specialty crops and encouraging low-income families to purchase them at farmers' markets by offering an incentive called Market Match to customers using their federal benefits at farmers markets. Due to the increased revenue and consumer base, it also encourages more farmers markets to accept federal benefits, including CalFresh, Supplemental Security Income (SSI), and Supplemental Nutrition Assistance Program for Women, Infants and Children (WIC).

The US Department of Agriculture, Supplemental Nutrition Assistance Program (SNAP) is the largest national food assistance program, spending $68 billion on benefits in 2010. California distributed almost $5 billion of these benefits to over 2 million recipients of CalFresh in 2009. Historically, farmers markets struggled to redeem CalFresh benefits due to the change in technology—moving from redeeming actual food stamps to only accepting electronic benefit transfer cards (EBT). The numbers of farmers markets that accept these benefits and the amount of benefit redemptions at these markets have steadily increased over the last few years with help from projects like this, drawing federal dollars into CA's local economies by using them to purchase locally grown specialty crops at farmers markets.

This project is called the California Farmers Market Consortium (CFMC) and is a statewide partnership managed by Roots of Change (ROC). The CFMC partners with nine community-based organizations working with farmers markets across the state. These partnerships are the basis for a learning community that shares best practices on how to operate an EBT project and administer Market Match, conducts outreach to hard-to-reach populations, and connects farmers markets with community health, economic and social development. In 2009, ROC piloted the CFMC (Project No. 36) to connect federal benefit customers to farmers selling specialty crops, introducing an incentive program for the first time to numerous farmers markets across the state. ROC scaled this project up from one farmers market in San Diego County to 124 farmers' markets in 16 CA counties within two years.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

ROC convened all partners for monthly conference calls and three in-person meetings to collaborate on best practices and share resources. ROC provided project oversight and assistance with activities like project creation and development. Collectively, the CFMC redeemed $394,723 in CalFresh benefits, $98,643 in Women, Infant, and Children Program (WIC) benefits and $123,071 in Market Match tokens or vouchers. This was an increased income of $616,437 in federal benefits dollars for 754 individual small farmers selling specialty crops at 124 participating farmers' markets in 16 counties. Additionally, the partners prescreened more than 17,000 families for CalFresh and WIC eligibility. This activity is particularly important because only 50% of those eligible in CA have applied for these benefits. The more families that are certified to receive the benefits they need, more families will potentially be eligible to spend their federal benefits dollars on fruits and vegetables at the farmers markets, while increasing the state's food security. Almost 600 customer surveys were administered to gather information about the customers' willingness to continue to shop at the market with or without Market Match (see Attachment A for survey template). About 20% of those surveyed were identified as first time customers to the market, and 66% stated that they would continue to purchase specialty crops without Market Match.

Total farmers markets participating accepting CalFresh 81 (Target 57), with 31 new markets added (Target 30)
Total clients receiving incentives, 16,275 (Target 765)
Total promotional materials distributed over a million (Target 965,850)

<u>Agriculture and Land-Based Training Association (ALBA), Monterey County</u>
Worked with the Department of Social Services through Monterey County's Food Bank, to distribute postcards listing markets that provide Market Match.

Promoted the importance of farmers markets and the role of Market Match in helping people get more locally grown produce for Fresh Family Farm Day for Monterey and Santa Cruz Counties; materials were in English and Spanish.

<u>Pacific Coast Farmers' Market Association (PCFMA), Alameda & San Clara Counties</u>
Distributed 5,000 copies of a farmers' market access guide on urban agriculture projects for CalFresh/WIC customers.

Hunger Action Los Angeles (HALA), Los Angeles County
Organized field trips to farmers markets for childcare centers in the LA County.
Hosted LA's CalFresh Month in May, promoting farmers markets as an integral part to increasing food security.

Worked with the Department of Social Services in LA to organize a mass mailing to all LA county CalFresh recipients about using benefits to purchase fresh fruits and veggies at farmers' markets.

Soil Born Farms, Sacramento County
Worked with Alchemist Community Development Corporation to bring on board farmers markets initially resistant to accepting CalFresh.

Produced a direct mailing with Sacramento County Department of Human Services to promote their farm stand solely selling specialty crops in Rancho Cordova.

Sustainable Economic Enterprises of Los Angeles (SEE-LA), Los Angeles County
Designed outreach materials saying, "We Welcome EBT" with the CalFresh logo, resulting in more EBT customers coming to Hollywood's market.

International Rescue Committee (IRC), San Diego County
Worked with San Diego County on a bus stop marketing campaign about using federal benefits at farmers markets.
Distributed 2,000 fliers on using federal benefits at farmers' markets to WIC offices.
Participated in steering committees to advise on best practices for community-based outreach.

Fresno Economic Opportunities Commission (Fresno EOC), Fresno County
Participated in a consumer awareness campaign to promote farmers markets.
Received a grant for Market Match vouchers from the Cal Endowment.

Food for People, Humboldt County
Distributed a monthly flyer to federal benefit customers that provided helpful tips for how to cost effectively shop at farmers' markets and recipes using specialty crops.
Worked with Congressional Representative to promote using CalFresh benefits at farmers' markets.

ROC connected with State and County CalFresh offices, as well as USDA agencies. The Program Manager (PM) participated in the USDA's AMS Farmers' Market Consortium, where political officials, organizational leaders and farmers' market professionals convene on a biannual basis to discuss pertinent projects and policies concerning farmers' markets. The PM only sat in on these discussions and contributed to the discussions pertaining to farmers' market projects. No specialty crop block grant funds were used for lobbying because these were not lobbying activities. ROC also collaborated with Ecology Center on a statewide outreach project promoting the use of federal benefits at farmers' markets.

Several partners also administered a producer/vendor survey to gain valuable feedback from the specialty crop farmers on the program. Results will be used to address any challenges the specialty crop farmers are having with the administration of Market Match.

ROC understands that farmers markets benefit more commodities than specialty crops (SC). Specific guidelines have been developed that guarantee this project solely benefits specialty crops. CFMC is committed to increasing access to and consumption of specialty crops only. The project guidelines are listed below:

1. ROC has signed formal contracts with each of its lead partners that state that their projects will "solely enhance the competitiveness of specialty crops"
2. The tokens that CalFresh/WIC clients are given to spend in farmers markets have "produce only" printed on them and cannot be used at non-specialty crop vendors
3. ROC has provided each of the CFMC members with resources and information on eligible specialty crops
4. ROC staff conducts site visits to our lead partners' farmers markets to monitor procedures and ensure standardization
5. ROC has developed tools that track the amount of top up money & federal benefits spent at each market for each SC farmer.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The following goals were achieved according to the Work Plan:

Organized 9 community-based partners.
Provided partners with reporting tools that tracked CalFresh, WIC, SSI and Market Match redemptions and the number of clients that received Market Match. All partners were trained on how to fill out these forms, including creating budgets, reports and invoices.
Brought on board 23 farmers markets to accept CalFresh for the first time.
Offered Market Match to an average of 765 clients per market day at 70 farmers' markets.
Designed a customer survey that better understands whether this project is drawing in more lifelong customers to the market and whether they purchased more specialty crops, the role farmers markets play in community development, and the role Market Match plays in encouraging purchases of specialty crops by CalFresh, WIC and SSI recipients.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Nine partner community-based organizations statewide benefited from increased funding for projects; 754 individual small farmers selling specialty crops at 124 participating farmers' markets; and more than 17,000 families eligible for CalFresh and WIC in 16 counties. A total of 754 eligible SC producers who sell eligible SC in 16 counties benefitted from this project through increased sales, both through redemption of federal nutrition benefits and incentive funds. In addition, this project brought EBT to newly opened farmers markets; trained specialty crop farmers on the new technology of handheld EBT devices; and promoted specialty crops throughout the state through new and traditional media and outreach to community based organizations (CBOs) and agencies.

In the majority of the target regions, EBT redemption increased more than 100 percent. Redeemed EBT dollars from all partner CBOs totaled nearly $700,000, which total an increase of revenue for the SC farmers selling at participating farmers markets.

Other beneficiaries include federal nutrition benefit program clients (including SNAP, WIC FMN), Seniors' FMNP, WIC FVC and SSI) who were proximal to the 124 participating farmers markets in the 16 target counties. The partners reached approximately 17,000 families through pre-enrollment screenings at four farmers markets; direct mailings; radio public service announcements in Spanish and multiple Asian languages; and events held at the markets. This increased outreach to CalFresh, WIC and seniors brought new patronage to participating farmers markets, and partners distributed more than 45,000 in outreach materials.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

Administering customer surveys proved challenging. Some organizations curtailed the survey questions to best fit their organizational and farmers' market needs. This resulted in disparate results. To account for these differences, yet still retain the valuable data collected, results were aggregated and summarized according to common questions only. Moving forward, ROC will provide a uniform customer survey designed to specifically address program goals.

Communication of Market Match was inconsistent. Many partners called the farmers' market incentive program by different names, which caused confusion when talking about it across the state. Many partners also designed individual outreach materials. This resulted in duplication of efforts. Moving forward, Market Match will be branded as a statewide effort across all CFMC partners. Partners will be provided templates for outreach materials, logo, tagline and brief communications about the program and Market Match in English and Spanish with hope for other translations as well. This will help us communicate the program as a statewide effort, conserve resources and reduce duplicated of efforts.

During this year, there were two major staff changes for partner organizations. These changes required some additional training at each organization to complete the project.
ROC encouraged partners to reach out to new farmers' markets to help them accept federal benefits. It proved difficult to reach the full goal. Many partners found some farmer's market managers unresponsive. However, moving forward, ROC is supporting organizations that will act as third party vendors for those unwilling to accept these benefits at their farmers markets.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Please see Attachments for customer survey template.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 14	**Project Title:** Development of a steam injection system for control of replant disease in fruit and nut orchards without fumigants	
Grant Recipient: The Regents of the University of California, Davis	**Grant Agreement No.:** SCB10014	**Date Submitted:** December 2013
Recipient Contact: Bradley D. Hanson	**Telephone:** (530) 752-8115	**Email:** bhanson@ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The United States is the world's largest almond producer with 99% of the production coming from about 825,000 orchard acres in the Central Valley of California. In 2012, California almond production exceeded two billion pounds and had a value of about $3.9 billion. In terms of crop value, this was second among over 400 commodities produced in the state (USDA-NASS, 2012).

Almond orchards typically are productive for 20 to 25 years before profitability begins to decline. As orchards are removed and replanted, the young trees may experience one or several of the "replant problems" common to second and later generation orchards. Replant problems can result from interacting physical, chemical, and biological factors, but the biological aspects usually dominate. Growers can minimize physical and chemical contributions to replant problems by pre-plant deep tillage and other site remediation practices and amendments. The biological component of replant problems can include aggressive pathogens (e.g. *Armillaria*, *Phytophthora,* and *Verticillium* spp.), plant parasitic nematodes (ring, lesion, and, on some rootstocks, root knot nematodes) and Prunus replant disease. When sampling or previous cropping history indicates that these pests may be present, the pest complex usually is managed with a pre-plant soil fumigation treatment in order to reduce transplant mortality and increase tree vigor and productivity during the orchard establishment years.

Methyl bromide, the fumigant that has been historically used for control of these disorders, has been phased out of most uses in developed countries, although Critical Use Exemptions exist for some cropping systems. Research over the past ten years has identified fumigant alternatives to methyl bromide that provide similar, if not better, control of some of the biological replant problems, including chloropicrin and 1,3-dichloropropene.

Increasing regulations have restricted the use of fumigants within varying distances from sensitive areas depending upon the type and amount of fumigant used. For example, current regulations require a "buffer zone" of up to 300 feet for orchards that border domestic wells, homes, schools, nursing homes, and daycares centers when using 1,3-dichloropropene (Telone II and others), but pending regulations may extend this buffer zone beyond 1,600 feet or further for fumigants containing chloropicrin. These buffer zones, which are designed to minimize public exposure to these products, also can prevent growers from treating areas along the agricultural-urban interface. Although alternative fumigants and reduced rate or reduced emission application techniques may provide options for managing orchard replant problems in a large portion of the orchard acres, buffer zones will be very difficult to manage and may suffer from reduced tree vigor and yield. True fumigant alternatives are needed for these untreatable areas.

This Specialty Crop Block Grant (SCBG) project tested thermal soil disinfestation using steam as a non-chemical alternative for replant disease management. A tree site auger was designed, two injection augers built, and the equipment was evaluated in several commercial almond orchards in the Central Valley between 2010 and 2013.

The overall goal of this project was to evaluate non-fumigant approaches for control of orchard replant disease in California. Specific objectives were to:

1. Optimize spot auger steam application equipment and techniques for treating orchard soils of varying texture, moisture, temperature and soil borne pest pressure.
2. Monitor effects of spot steam treatments on early growth of stone fruit and almond trees, compared to conventional fumigant treatments for preventing replant disease.
3. Evaluate the economic viability and technical feasibility of spot steam treatments using large, commercially relevant field plots.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Materials and Methods

Experiments were initiated in 2010, 2011, and 2012 to optimize and evaluate a steam injection auger system for control of Prunus replant disease. These experiments were established at four sites in the Central Valley of California. All experiments were conducted in commercial orchards being replanted to almond and were at least the third sequential Prunus orchard at the site. At the beginning of the project, two steam injection augers (24" diameter and 36" diameter) were designed and built by contractors in Salinas and Woodland, California (CA). This equipment was tested during the performance period using three experimental protocols to address the objectives of the project including optimizing the injection system, testing it under real-world field conditions, and comparing steam to traditional fumigant Prunus replant disease management.

The target temperature for thermal disinfestion was at least 158°F throughout the treated zone. After initial tests, the augers were slightly modified to increase vertical mixing of soil and increase temperature uniformity and heating efficiency (See Attachment, Figures). Two experiments were conducted to determine the appropriate length of time for steam injection, one near Delhi, CA with a sandy soil and the other near Arbuckle, CA with a fine loamy sand soil. To provide both wet and dry conditions, half of the plots at each site were irrigated 48 hours prior to steam injection. Soil moisture at Delhi for wet and dry plots was 3% and 2.5% respectively and 4.5% and 13% at Arbuckle. Steam was injected through the rotating, hollow-shaft auger for 1-, 2-, and 4-minutes and 1-, 2-, 4-, and 6-minutes with the 24- and 36-inch augers respectively. Each treatment combination was replicated three times at each site. Soil temperature was recorded at 5-

minute intervals for 1-hour following injection using Hobo data loggers to record soil temperature at depths of 12 and 24 inches and at the soil surface.

Four non-fumigant trials were established near Delhi, Atwater, Livingston and Wasco, CA to directly compare two soil steam treatments to increasing levels of soil disturbance with no steam (See Attachment, Table 1). Treatments in these trials were applied to individual tree sites with one or two trees per plot and included an untreated control, 24-inch steam injection, 36-inch steam injection, 24-inch auger disturbance, 36-inch auger disturbance, and a 4x4x2-ft backhoe pit. The untreated control received no pre-plant treatment. Steam treatments were applied through the rotating auger and steam was injected for 2.5 and 4.5 minutes for the 24- and 36-inch augers respectively. The 24- and 36-inch disturbance treatments were using the steam auger to mix the soil in the future tree site for approximately 1 minute, but not injecting steam. The largest disturbance treatment was applied by using a tractor-mounted backhoe to excavate and immediately replace the soil from a 4x4-ft area approximately 2-ft deep at a tree site. After steam injection, soil temperature was monitored in each plot using an analog thermometer inserted in the center of the auger hole. Additionally, soil temperature was recorded for 1-1.5 hours after treatment in some representative tree sites using Hobo data loggers as previously described. Steam auger treatments were applied at the Delhi site between November 20 and 22, 2012 and the orchard was replanted with bare-root trees by the cooperating grower in January 2011 (See Attachment, Table 2). Treatments were applied at the Wasco site on May 20 and 21, 2011; however, this trial did not include a backhoe treatment. The Wasco orchard was planted with non-dormant potted trees by the cooperating grower in June 2011 and experienced some failures in irrigation during early establishment. Treatments at the Atwater experiment were applied from December 20 and 23, 2011 and January 10 and 12, 2012. This extended application period was due to a serious equipment malfunction, which was later repaired. The Atwater orchard was replanted with bare-root trees by the cooperating grower in February 2012. Treatments were applied at the Livingston site on February 16 and 17, 2012 and the site was replanted with bare-root trees by the cooperating grower in March 2012.

Two large-plot fumigation trials were conducted with primary support from the U.S. Department of Agriculture, Agricultural Research Service (USDA-ARS), Pacific Areawide Program for Integrated Methyl Bromide Alternatives. In these experiments, a large plot (24-tree, replicated five times) steam auger treatment was compared to replicated conventional fumigation treatments including methyl bromide, 1,3-dichloropropene, and 1,3-dichchlorpropene plus chloropicrin at the Delhi site in 2010 and the Atwater site in 2011 (See Attachment, Tables 5 and 6). Steam treatments were applied with only the 36-inch auger in this trial as the relatively larger treated volume of soil was assumed to have the greatest likelihood for success. Untreated control plots received no treatment, steam treatments were applied as described previously, and fumigant treatments were applied by commercial applicators using conventional shank-injection application methods. Bare-root almond trees were transplanted by the cooperating grower approximately two months after treatment in both trials.

In all experiments, trunk diameter of each almond tree was recorded shortly after planting and annually during the dormant season. Disease severity ratings were made annually during the growing season based on vigor and general appearance of above ground growth using a scale from 0 to 5 (0 = healthy vigorous; 5 = dead). None of the orchards reached bearing age during the grant performance period, so no yield data were collected as a part of the project.

Results
Mechanistic studies suggested optimum injection times was of 2.5- and 4.5- minutes for the 24- and 36-inch augers respectively (See Attachment, Table 2). Performance was similar between the two soil types, but the drier soil usually reached target temperature more quickly and uniformly than wet soil.

Non-fumigant trials. At the Delhi site, first year increases in trunk diameter for trees planted in steam treated plots were greater than trees in the untreated control plots; however, there were few differences among steam plots and non-steam disturbance plots (See Attachment, Table 3). After two years of growth there were no differences among the auger treatments (steam or no-steam), but trees in the backhoe excavated plots were significantly larger than trees in the untreated control plots. No differences were observed among treatments in visual disease ratings in the first or the second growing season after planting. After two growing seasons in the Wasco trial, almond trunk diameter and visual disease ratings were similar among all treatments (See Attachment, Table 4). Trees planted in the Atwater and Livingston trials also had no differences among treatment in trunk diameter or disease severity ratings in the first growing season after pre-plant steam treatments (See Attachment, Table 4).

Fumigant trials. In the Delhi large-plot fumigant trial, almond trunk diameter was greater for trees in all fumigant plots compared to the steam injection and untreated control plots (See Attachment, Table 5), but there were no differences among the fumigation treatments. However, by the end of the second growing season differences among fumigant treatments started to become apparent with the 1,3-dichloropropene treatments numerically outperforming the methyl bromide standard while trees in the steam treated plots were not different than the untreated control. In the Atwater fumigation trial, after one season of growth the differences among treatments in almond tree growth were more subtle than in the Delhi trial (See Attachment, Table 6). When differences among fumigant treatments were noted, treatments containing chloropicrin usually resulted in greater increases in trunk diameter than the untreated control. Only the 11-ft-wide strip application of 1,3-dichchloropropene plus chloropicrin (Telone C35) resulted in greater increases in trunk diameter than the steam treatment after one season. All other fumigant treated plots showed similar increases in trunk diameter to the steam treatment and to each other. Similar to the Delhi trial, greater differences may become apparent in the second and subsequent growing seasons at the Atwater site.

Discussion
Although tree growth parameters were statistically different among non-fumigant treatments in only one of the four small plot experiments, trees in steam treated plots often were numerically larger than their corresponding no-steam auger treatment; this suggests a slight benefit to steam treatments in the first growing season. However, at the Delhi site, this difference was no longer noticeable in the second growing season, which suggests that the tree roots quickly outgrew the relatively small treated zone and/or the treated soil was recolonized by the pathogen complex. This hypothesis is supported by the fact that the largest level of soil disturbance, the backhoe treatment, also resulted in the similar or greater tree growth response as the steam auger treatments. The lack of differences in first-year tree growth among untreated, and the steam and non-steam auger treatments at three of the four experimental sites suggest that thermal or disturbance based replant disease management tactics may have greater performance variability, and thus economic risk to growers, compared to fumigants.

At the Delhi large-plot fumigation trial, the least effective fumigation treatment, methyl bromide, resulted in approximately 25% more growth then the steam treatment and the best fumigant treatment resulted in 33%

more growth than the 36-inch steam treatments. Because trunk diameter of young trees is closely correlated to expected yields, the poor early almond scion growth in steam-treated plots at the Delhi site suggests that steam may not be a viable alternative to chemical fumigation for almond replant disease management. This is in contrast to Moyls and Hocking (1994) who concluded that steam could be an effective alternative to replace methyl bromide and other soil fumigants for apple replant disease management. However, almonds and apples have different growth habits and horticultural practices associated with their cropping systems which likely accounts for these contradictory results. Apples are generally grown on dwarfing rootstocks as close as 3-ft apart and have much smaller root systems when compared to those of almond trees which are commonly planted on spacing of 18- 20-ft. In a related project, tree excavation at a different replanted orchard revealed that trees have already moved outside of a 3-ft diameter circle within the first six months after planting meaning the roots quickly leave the disinfested area of soil (unpublished data). The limited volume of soil that can be efficiently and economically treated is a major limitation to this system. While early growth indices indicate that steam cannot serve as an effective control of almond replant disease, tree growth, disease, and yield data collection will continue for these trials over the life of the orchard.

Outreach

Aspects of these experiments have been presented at several grower and scientific meetings. These include: the Almond Board of California Annual Meeting and Trade Show, the American Phytopathological Society meeting, the International Methyl Bromide Alternatives Outreach Conference and the American Society of Horticultural Sciences meeting. Interim and final results will be published in appropriate peer-reviewed and cooperative extension venues. The Delhi steam and fumigation experiments have also been presented to an audience of U.S. Environmental Protection Agency and California Department of Pesticide Regulation scientists during a March 27, 2013 field tour.

Economic Analysis

No almond yield data were collected as of the end of the project period, which made economic assessments difficult. After discussion, the PDs agreed that the relatively poor biological performance of the steam auger treatments did not warrant detailed economic analyses at this time. However, the PDs plan to include yield and economic assessment of the large-plot steam auger treatments as a part of their related soil fumigation project once the orchards reach bearing age. Thus, this goal is anticipated to be met outside the performance period of this grant.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Over the course of this project all partners contributed to various aspects of planning, implementation and evaluations, and presentation of the project results. Although most of these orchard trials are only in the second or third year after replanting, the project team expects to support the continuation of these trials using non-SCBG funding for additional growing seasons to allow a more complete assessment of the relative merits of the steam treatments.

The goal of the research was to develop, optimize and evaluate a steam injection system that might serve as an effective non-fumigant alternative for management of Prunus replant disease. While early tree growth data indicates that steam treatment does not provide adequate control of replant disease, orchards do not produce a harvestable crop until at least the third season. Thus, long-term productivity, as well as yield and economic data will need to be monitored beyond the performance period of this project. The four small plot experiments and two large plot fumigant experiments will continue yield relevant information to growers and orchard managers for several years.

The Expected Measurable Outcomes identified at the outset of this project included: 1) increasing the number of cooperating growers interested in testing the steam auger in their orchards; 2) implementation of low risk pest management techniques in some high-risk areas at the rural / urban interface; and 3) building of partnerships between the agricultural industry to commercialize and implement this reduced risk pest control program. Unfortunately, the performance of the steam auger for mitigating almond replant disease was inadequate to continue larger-scale testing in additional sandy orchard sites. This particular low risk pest management strategy has worked reasonably well in apple (Moyls and Hocking), strawberry (Fennimore et al.) and cut flower (Rainbolt et al.) work, but does not appear to be a viable solution for the deep rooted Prunus cropping system tested here and commercialization is unlikely. However, the project team will continue to monitor and evaluate a subset of the steam treatments through early yield and contribute relevant information to growers and orchard managers for several years.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Growers of nuts and stone fruits are the beneficiaries of this project. Approximately 5-8% of California's almond and stone fruit acreage is replanted each year due to normal orchard productivity cycles. This project was conducted to evaluate a nonfumigant method of orchard replant disease management and to support the methyl bromide phase-out timeline. Those orchard areas that successfully adopt non-chemical techniques for soil disinfestation prior to orchard replanting will achieve a 100% reduction in use of highly volatile and toxic soil fumigants. The project team anticipates that, even if steam disinfestion was effective, the early adopters would be orchards in fumigant buffer zones near sensitive sites including schools, hospitals, and residential areas where chemical fumigants cannot be used. Growers in these areas are currently faced with the decision to convert to non-fumigant pest management techniques or not replant the orchard. The next most likely adopters of steam disinfestation of orchard tree sites would be organic or sustainable production systems. Many stone fruit and almond growers have considered organic certification due to the price premiums in the market place; however, these plans often are abandoned due to concerns about replant disease problems.

The thermal disinfestion technique tested in six replicated experiments in commercial almond orchards did not provide satisfactory early almond tree growth benefits. Although slight benefits were noted in some site-years in the first growing season, it appears that the almond roots quickly grew beyond the treated zone and long-term benefits were minimal. Because performance was inadequate, economic assessments were not made on the small plot experiments but will be made on the two large-plot fumigation experiments once those orchards reach bearing age. Explorations of novel technologies are a necessary investment needed if non-fumigant approaches are to be found for these high value commodities in California.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

This project addressed major issues of concern to California almond growers, the Prunus replant disease, and is applicable to other stone fruit producers. Although the steam injection auger tested in this project for thermal soil disinfestion did not provide acceptable performance, the information developed still provides benefit to growers and governmental agencies interested in finding true non-fumigant alternatives for California commodities. In the short term, this work helps support reduced-area fumigant treatments that will lead to reduced fumigant use and emissions. More importantly, in the long term, information and experience from this work may lead to other innovative ideas to reduce and replace chemical fumigation. The issues surrounding orchard replant disease management are complex and, so too, are potential fumigant replacement strategies. Research such as the work conducted under this project directly addresses almond industry needs and provides benefit to agricultural economics and California's commitment to environmental and human safety.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

USDA Project No.: 15	**Project Title:** Monitoring and mating disruption of mealy plum and leaf-curl plum aphids in prunes using sex pheromones	
Grant Recipient: Regents of the University of California, Davis	**Grant Agreement No.:** SCB10015	**Date Submitted:** December 2012
Recipient Contact: Frank G. Zalom	**Telephone:** 530-752-3687	**Email:** fgzalom@ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The project addressed two key arthropod pests affecting the prune cropping system in California, mealy plum aphids (*Hyalopterus pruni*) and leaf-curl plum aphids (*Brachycaudus helichrysi*). Specifically, the project sought to improve management capabilities using aphid sex pheromones to augment current monitoring practices, and investigate the possibility of mating disruption based on population reduction tactics. California prune growers contribute 99% and 70% of the prunes produced in the United States and worldwide, respectively. Aphid pests are the most perennial and destructive of the arthropod pests affecting prune crops, and are often the only arthropod pests for which chemical treatments are routinely applied to prune orchards. Currently, the most common and widely utilized method of aphid management in prunes is via the application of dormant-season insecticide applications. Dormant sprays present the risk of runoff affecting water quality in addition to the possible disruption of natural enemies. Because of these concerns, growers and industry continue to search for alternatives to conventional dormant sprays.

The biologies of the two aphid species impacting prune crops provide a unique and ideal system in which the use of synthetic aphid sex pheromone products for monitoring and mating disruption could be investigated. Briefly, mealy plum and leaf-curl plum aphids are holocyclic heteroecious species occurring in the major prune-producing regions of California. They alternate between non-agricultural host plants (summer hosts) and prune orchards (fall, winter, spring hosts) and between asexual and sexual reproduction modalities. Once every year during fall, when aphids are migrating into prune orchards from their summer hosts, they enter the sexual stage of the life cycle, during which time males respond to sex pheromones produced by egg-laying females. During this critical period, it may be possible to exploit the sexual communication in order to improve trapping and population quantification/prediction methods as well as reduce subsequent aphid populations through mating disruption techniques. It was the goal of this project to investigate the potential for these pheromone-based improvements to aphid pest management in prune orchards. In addition to the positive impacts this project may provide to the California prune industry, the methodologies and findings of this work may be more broadly applied to other aphid pest species with similar biologies impacting a number of crops worldwide.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Activities performed from October 2010 through December 2010 involved weekly pheromone-based trapping for the monitoring experiment, and deployment of mating disruption treatments and associated weekly trapping for the mating disruption experiment. In January and February 2011, aphid egg densities in the monitoring and mating disruption experimental blocks were quantified. Due to unexpected ownership change of the commercial orchards in which the experiments were being conducted, and subsequent dormant insecticide treatment, the spring 2011 aphid population was eliminated at the study sites so data were unavailable for analyses. Data examined and analyzed for the monitoring experiment involved assessing various trapping parameters of different trap types, and the effect of pheromone-baiting status as well as examining relationships between the numbers of aphids trapped during the fall and overwintering aphid egg densities. Those data are summarized in Tables 1 and 2 below.

Table 1. Predictive value of the trap design-pheromone treatment combinations, expressed by regression statistics for numbers of aphids trapped during fall 2010 in relation to overwintering egg densities in associated monitoring plots.

Trap Design-Pheromone Treatment	Mean number (± SE) aphids trapped	Mean (± SE) overwintering egg density (eggs/spur X 100)	Slope	y-intercept	R^2	*F*	df	*P*
Delta trap – lure	2.29 ± 0.47	0.61 ± 0.31	-0.1490	0.9468	0.0524	0.2764	1, 5	0.6215
Delta trap + lure	32.71 ± 12.68	0.60 ± 0.60	0.0207	-0.0776	0.1915	1.1844	1, 5	0.3261
White sticky card – lure	8.57 ± 3.37	0.37 ± 0.26	0.0457	-0.0204	0.3568	2.7732	1, 5	0.1567
White sticky card + lure	35.43 ± 10.14	0.23 ± 0.23	0.0163	-0.3465	0.5132	5.2714	1, 5	0.0701
Water trap – lure	2.71 ± 0.57	0.64 ± 0.42	0.0067	0.6207	$8.275e^{-5}$	0.0004	1, 5	0.9846
Water trap + lure	18.86 ± 2.30	0.00 ± 0.00	0	0	0	0	1, 5	1.0000
Yellow sticky card – lure	15.00 ± 4.17	0.85 ± 0.72	0.0093	0.7146	0.0029	0.0146	1, 5	0.9085
Yellow sticky card + lure	79.00 ± 15.28	0.80 ± 0.55	0.0273	-1.3623	0.5730	6.7095	1, 5	0.0488

Table 2. Summary of results assessing monitoring parameters of the trap design-pheromone treatment combinations for use in aphid management in prune orchards.

Trap Design-Pheromone Treatment	Efficiency[a]	Selectivity[b]	Predictive Value[c]	Convenience of Use[d]	Ease of Processing[e]	Economics[f]
Delta trap – lure	2.29 ± 0.47D	1.66 ± 0.25cd	0.6215	1	1	$1.99
Delta trap + lure	32.71 ± 12.68B	16.65 ± 5.62a	0.3261	2	2	$1.99 + lure
White sticky card – lure	8.57 ± 3.37CD	2.49 ± 0.85cd	0.1567	3	4	$0.92
White sticky card + lure	35.43 ± 10.14B	10.24 ± 2.80ab	0.0701	4	3	$0.92 + lure
Water trap – lure	2.71 ± 0.57D	1.80 ± 0.33cd	0.9846	7	5	$0.56
Water trap + lure	18.86 ± 2.30B	13.48 ± 1.87a	1.0000	8	6	$0.56 + lure
Yellow sticky card – lure	15.00 ± 4.17BC	1.10 ± 0.25d	0.9085	5	7	$1.36
Yellow sticky card + lure	79.00 ± 15.28A	4.61 ± 1.08bc	0.0488	6	8	$1.36 + lure

[a] Mean number (± SE) of aphids trapped. Treatments followed by the same letter are not significantly different (ANOVA, followed by Tukey's HSD test, $F = 26.09$, df = 7, 42, $P < 0.0001$). Data also represented in Figure 1.
[b] Mean percent (± SE) of aphids relative to non-target arthropods trapped. Treatments followed by the same letter are not significantly different (ANOVA, followed by Tukey's HSD test, $F = 22.29$, df = 7, 42, $P < 0.0001$). Data also represented in Figure 2.
[c] Significance (P-values) of regression analyses of numbers of aphids trapped during fall in relation to percent overwintering egg densities.
[d] Rank based on preparation time in the lab and handling time in the field (1 = least time required, 8 = most time required)
[e] Rank based on time required to process traps (count aphids) in the lab (1 = least time required, 8 = most time required)
[f] Price ($USD) per trap. Cost of lures not yet determined (experimentally available only). Water traps reusable. All other trap types single-use.

The experiment showed that pheromone baiting increased the efficiency and selectivity of the trap types examined with regard to aphid numbers. Two pheromone-baited trap types, yellow and white sticky cards, showed the most promise with respect to their predictive value (i.e., greatest significance in relationship between numbers of aphids trapped during fall and overwintering egg densities). The mating disruption experiment was less successful because of an extremely low number of target aphid species trapped during the fall (a total of zero and four mealy plum and leaf-curl plum aphid males trapped throughout the fall trapping period, respectively) and a complete lack of aphid eggs detected in either the pheromone treated or no-pheromone control blocks.

Due to the inability to complete the 2010-2011 season experiments as originally outlined in the project workplan (i.e., spring data were unavailable), monitoring and mating disruption experiments were repeated from October 2011 through April 2012. During October through December 2011, weekly pheromone-based trapping in monitoring blocks was accomplished, mating disruption experiments were deployed, and associated weekly trapping in pheromone-treated and no-pheromone control blocks was completed. In January 2012, overwintering aphid egg densities from spur samples were quantified from monitoring and mating disruption experimental blocks. In April 2012, assessment of spring aphid populations in monitoring and mating disruption experimental blocks was achieved. Analyses of data from the monitoring experiment involved examining relationships among the numbers of aphids trapped during the fall, overwintering egg densities, and spring aphid population ratings. Mating disruption analyses involved comparing numbers of male aphids trapped, overwintering egg densities and spring aphid population ratings between pheromone treated and no-pheromone control blocks. It does not appear that the experiments were able to establish significant and meaningful relationships among the parameters evaluated in the monitoring experiment (i.e., no statistically significant relationships between numbers of aphids trapped during fall in pheromone-baited traps nor spring aphid population ratings), and no significant effects of mating disruption treatment are apparent with regard to any measure examined (i.e., no statistical differences between numbers of aphids trapped, overwintering egg densities, spring aphid populations ratings in pheromone-treated versus no-pheromone control blocks). Interestingly, experiments also failed to detect significant relationships between overwintering egg densities and spring aphid population ratings, a measure that provides, in part, the current basis for chemical treatment recommendations for aphids in prune orchards according to the University of California (UC) Integrated Pest Management guidelines.

In spite of the apparent lack of positive results in terms of the initial goals of this project within the monitoring and mating disruption experiments of 2011-2012, a significant amount of data was collected and can be further examined. This could possibly provide further information as to the within and between orchard variability in aphid population distributions and impacts of mating disruption treatment, which may provide valuable information for future projects directed at aphid pests in California prune orchards.

Results of the 2010-2011 experiments were presented at the 2011 Entomological Society of America Pacific Branch meeting, the 2011 Dried Plum Research Workgroup Annual Meeting, the Tehama County Prune Days hosted by UC Cooperative Extension, and have been made available online through the Dried Plum Research Workgroup database (http://ucce.ucdavis.edu/files/repositoryfiles/2011-69-92524.pdf).

The information has been disseminated as follows (approximately):
- Presentations at extension or grower meetings: 500 people
- Presentations at professional meetings: 120 people
- Extension newsletter articles: sent to 600 people
- Research reports for Dried Plum Growers Association (posted on UC Fruit & Nut website): 300 people
- Professional journal article in Journal of Chemical Ecology: 1000 people

Results of the 2011-2012 experiments also will be presented to the Dried Plum Research Workgroup in December 2012, and made available through the online database. Publication of the results of these studies in peer-reviewed journals is being considered.

The Project Manager, in conjunction with the Project Director, performed the above activities, data analyses, and results summarization and dissemination.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Specific activities completed in order to achieve the project goals are outlined in the above section (Project

Approach, bullet one, summary of activities and tasks performed), as are the data and results associated with the project activities.

The goals of this project were to conduct experiments that would provide information aiming to fulfill the broad long-term objectives of (1) developing reliable and efficient threshold-based methods for assessing mealy plum and leaf-curl plum aphid populations to facilitate treatment decisions using pheromone-baited trapping techniques, and (2) providing alternative population reduction methods using mating disruption techniques.

The project activities proposed to address the above goals were met and exceeded as set forth in the original project workplan. The initial proposal entailed a single year of field experiments; two years of field experiments were accomplished during the reporting period. In addition to the activities originally set forth for the monitoring and mating disruption experiments, data was collected and results generated comparing various trap designs for pheromone-based aphid monitoring.

The results of the experiments conducted in accordance with the project workplan provided some insight as to the potential and limitations of achieving the long-term objectives. In particular, the results from the first year's monitoring experiments clearly illustrated that pheromone-baiting significantly improved trapping capabilities targeting aphid detection during the fall period as they migrate into prune orchards, and further demonstrated the trap designs likely to be most effective for use by end-users in terms of their reliability for population predictive value. The results of the monitoring experiments conducted during the second year and mating disruption experiments both years were less defined, indicating that additional considerations and efforts are needed to accomplish the long-term goals of providing growers and industry with well-defined monitoring and mating disruption protocols for aphid pest management in California prunes.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Beneficiaries of this project include California prune growers and producers and their pest management advisers, the UC Agricultural and Natural resources dried plum research workgroup (composed of prune industry representatives, growers, UC Cooperative Extension, and academic researchers), and UC integrated pest management guidelines producers. Results and methodologies may be extended to other cropping systems with aphid pests with similar life histories to mealy plum and leaf-curl plum aphids. This project represented the first time that aphid sex pheromones have been academically investigated as potential tools for aphid pest management in any orchard crop system, and the methodologies and results provide information useful to future projects further exploring the exploitation of aphid semiochemical communication to improve management. This project showed that aphid sex pheromone products significantly improved trapping capabilities that will detect aphids returning to prune orchards during the fall aphid migration period, a result showing promise in utilizing such products to improve upon current monitoring practices. If pheromone-based trapping methods can be perfected and can be shown to be reliable indicators of subsequent aphid populations and/or aphid-related crop damage, economic and environmental impacts may be realized due to time savings in monitoring efforts, as well as reduced or more focused pesticide applications. In effect, this project has documented proof of concept that will require additional studies to refine, quantify and implement.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The results of this study did confirm significant activity of the aphid sex pheromone dispensers and traps based on superior aphid trapping efficiency and selectivity using pheromone-baited traps compared to non-baited traps. The inability to establish significant and reliable relationships between pheromone-based fall aphid trapping numbers, and subsequent population and damage measures within the experimental time period of this project highlights difficulties faced when conducting larger-scale experiments within commercial field environments. A number of issues may be encountered by researchers, as exemplified by experiences losing the experimental blocks due to a property sale. Additionally, a great deal of both spatial and temporal variability appear to exist in aphid populations within the "natural" field environments in which the experiments were conducted, further complicating experimental design and results. The experiments conducted for this project were not able to provide proof of concept that mating disruption in aphids in an orchard environment is possible, and leads to meaningful pest or damage reduction. However, these experiments were the first of their kind and there are many outstanding questions and directions that can be explored within the realm of aphid mating disruption research. A number of possibilities exist that may explain the lack of success in the mating disruption experiments (e.g., synthetic pheromone formulation, release method, release rate, point source density, etc.) and all should be further investigated.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

USDA Project No.: 16	Project Title: Garden-Enhanced Nutrition Education Grants for Pre-Schools	
Grant Recipient: Western Growers Foundation	**Grant Agreement No.:** SCB10016	**Date Submitted:** December 2013
Recipient Contact: Paula Olson	**Telephone:** 949-885-2249	**Email:** paula.olson@wga.com

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

One quarter of children ages 2- 5yrs. are overweight and 33% of California's low-income children enter school already overweight or obese. Food choices and dietary habits begin during the early stages of life, thus, interventions to curb these epidemics should begin before children develop poor food choices that lead to health problems. Approximately half of California's 3 to 5 year old children attend child care agencies (childcare sites/pre-schools). Two recent studies of California child care agencies reveal servings of fruit and vegetables are well below recommended levels. A child's food choices, as well as the parent/guardian's choices, are influenced by Garden-Enhanced Nutrition Education (GENE) taught through experiential school garden lessons. Children who are involved with edible school gardens: planting, caring, and harvesting fruits and vegetables are more likely to eat more fresh fruits and vegetables. Studies also show children that are exposed to GENE retain more nutrition knowledge and behaviors such as choosing and eating fresh fruits and vegetables for meals and snacks. This competitive grant process awarded $1,000, a Garden for Learning book, producepedia book marks, seeds, seedlings, and child-size tools to 100 California child care/pre-school sites to create and sustain an edible school garden.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

An extensive on-line application was created using a Google survey tool that required the applicant to explain various aspects of their plan: what commodities would be grown; would there be adequate access to water and shade; would there be community support and parent involvement. From April 1, 2011 to September 30, 2011, Western Growers Foundation (WGF) collected 342 applications for 100 grants. Both Western Grower's (WG) Communication Department and the California Department of Education (CDE) publicized this grant opportunity. The CDE spent many hours reviewing all applications using a scoring Rubric mapped back to the questions asked in the survey to grade the essentials needed for a successful school garden: specific plans for nutrition education, access to water, subjects to be taught, parent involvement, and community support.

Rather than award two cycles of 50 grants each as originally planned, WGF chose to award 100 grants at once. This rather large group of winners gave WG's Communication Department a great story to pitch to KTLA5 where WGF's project was featured: http://bit.ly/wgfktla

During the course of this grant, project staff remained in contact with the awardees through emails, surveys and visits. Monitoring of the schools who were awarded grants was able to be accomplished through Western Growers' Association Management system. This database system allows project staff to enter in each school – whether a grant was awarded or not – create "contact tracking" records, add notes, photos and documents, and update contact information.

A follow-up survey was executed to see how the schools were doing. As highlighted in the Resource Guide, there were many examples of children trying new foods, loving fruits & vegetables and, even crying from the "time out" area because they couldn't have salad with the other students.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

One hundred centers created edible school gardens; the first expected outcome was achieved. Approximately one year later, those 100 schools were surveyed; 82 responded with ways in which they were using their gardens; this activity is highlighted in the Resource Guide. The Resource Guide was posted in May 2013 and, as of mid-August 2013 there have been 472 page views, 500 page views were expected. It should be noted: the 18 centers who did not respond to the survey will not be eligible for any future grants from Western Growers Foundation.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Based on the 100 child care centers' reports, 10,145 children spent time in the gardens. Project staff reported "If they grow it, they'll eat it." Attached is a photo of a student from a Long Beach, CA. center. He is but one of 20 children at this center who devoured the baby carrots brought to a site visit. Several stories like this can be found in the Resource Guide. By influencing food choices early in children's lives, life-long consumers of fruits and veggies are being created.

Personal observation from project staff indicates that these children are increasing their daily consumption of fruits and veggies. As stated in the project purpose, children that are exposed to GENE retain more nutrition knowledge and behaviors such as choosing and eating fresh fruits and vegetables for meals and snacks.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The original plan was to have two grant cycles of 50 gardens each. WGF originally planned to award $50,000 at a time. However, upon receiving 300+ applications during the first grant cycle, both CDE and WGF felt that they should honor these applicants and award 100 at one time. The CDE spent at least 30 additional hours placing follow-up calls to make sure the schools were eligible and had all the paperwork and information required. If cash flow and man-hours permit, it is better to award the entire amount during one grant cycle. It creates more excitement, news and support; it honors those first round qualified grant applicants so that they don't have to apply again.

The other lesson that was learned is to be clear with the grantees on the requirements tied to accepting the $1,000. This includes completing an online survey, providing digital photos, agreeing to potential site visits, and, completing all project activities within a certain time period.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Publications:
http://westerngrowersfoundation.org/sites/westerngrowersfoundation.org/files/documents/wgf-resource-guide-preschool-garden-grants.pdf

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 17	**Project Title:** California Grown Grower Profile Extension Campaign	
Grant Recipient: Buy California Marketing Agreement	**Grant Agreement No.:** SCB10017	**Date Submitted:** December 2012
Recipient Contact: Nick Matteis	**Telephone:** (916) 441-5302	**Email:** nmatteis@cgfa.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project was built on a previously funded SCBGP project, describe how this project complemented and enhanced previously completed work.

Despite the important role that agriculture plays in the state, the specialty crop industry tends to be undervalued and overlooked by Californians. Additionally, advances in agriculture have allowed a small percentage of the population to fulfill food production needs and have created a disconnect between the production of food products and the end consumer. To help bridge this gap, the California Grown Grower Profile Extension Campaign's goal was to extend the current marketing program featuring California growers by creating a series of online assets, specifically videos and recipes, to visually and emotionally portray the people who produce the food that feeds families and the industries that fuel the economy. Also, the program's purpose was to use these assets in tandem with an in-store point-of-sale advertising promotion and a robust statewide public relations campaign, connecting the dots between California's specialty crops from farm to fork. At a time when consumers are taking a growing interest in where the products they buy come from and while the popularity of social media and content sharing continues to rise, the Buy California Marketing Agreement (BCMA) saw this as an opportune time to create compelling grower profile videos and other digital assets that can be shared between consumers with the click of a mouse and spread the "Buy California Grown" message.

BCMA was awarded 2009 Specialty Crop Block Grant Program funds (Project 29) in October 2009. The grant allowed for an economic impact study of specialty crop industries that was publicized in spring/summer 2010 through an integrated public relations and advertising campaign. Each program tactic of the extension project profiled California specialty crop producers, putting a face and story behind the industries that contribute to the economic well-being of the state.

In 2010, the picture was painted of the economic value of the state's specialty crops and the families responsible for them, and from 2011-2012, the goal was to bring those stories to life through a series of on-line grower profile videos.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Create social media-friendly and expand the on-line presence at www.californiagrown.org

BCMA partnered with MJR Creative Group to create a robust on-line grower profile presence at, www.californiagrown.org/farmers, featuring the grower videos and photos, as well as multiple social media share functionalities for visitors to spread the word among various social media platforms. During the height of the campaign, the website received more than 14,500 unique visitors and 48,900 page views. Visitors spent an average time of about a minute and a half on the site, and almost three-quarters of viewers were new visitors to the site.

Develop a series of grower profile videos, photos and recipes

BCMA worked with MJR, as well as Fleishman-Hillard (FH), to produce a series of grower profile videos that brought to life the real people and real stories behind a variety of California's specialty crops, including asparagus, avocados, cherries, cut flowers, pears and kiwis. The teams first identified specialty crop growers who embody California agriculture and were well-suited to help create a human connection to the previously announced economic impact data. After collecting grower information, history and California agricultural heritage information, FH provided content direction while MJR produced video vignettes for each grower. In conjunction, FH developed recipes and recipe photography for each crop. The videos and recipes were housed at www.californiagrown.org/farmers, and the videos also live on the California Grown YouTube channel. To date, the videos have received nearly 3,000 views.

Conduct a statewide public relations campaign

With the help of FH, BCMA executed an integrated traditional and blogger outreach campaign. The team distributed a press release and multimedia news release via national newswires, and disseminated video and recipe assets to statewide media outlets, resulting in an array of hometown media coverage for several growers. Additionally, a targeted group of bloggers was selected to receive crops directly from the growers and share their thoughts and photos via their blogs and Pinterest pages. This resulted in dozens of blog posts boasting quality photography and positive sentiments toward California-grown products. To date, the campaign has garnered more than 220 traditional media placements and 30 blog placements, resulting in nearly 17 million total media impressions.

Develop in-store, point-of-purchase advertising

Together, BCMA and MJR developed floor graphics and shopping cart signs, and executed the point-of-purchase component of the campaign through in-store advertising. Each piece of advertising featured two different design executions, displaying photography and messaging that coincided with the microsite. The advertising efforts resulted in 164 floor graphic participants (Save Mart-Lucky's) with four placements per store and 523 shopping cart participants (Food Maxx, VONS, Safeway).

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Goal: To increase awareness among the state's consumers about the families who produce California specialty crops.

Outcomes Achieved: FH conducted an online survey among California consumers, who were asked to view blog posts from bloggers who had posted during the campaign and featured the new assets, including video, links to the website, photography and a brief overview of California Grown. Of those surveyed, a remarkable 72 percent said they agree or strongly agree that after reading a blog post about California-grown products and/or visiting www.californiagrown.org, they have a greater awareness and understanding of California-grown products and the farmers who produce them. Also, 68 percent of this same group reported they agree or strongly agree that after reading the blog and/or visiting the website, they felt more connected to California farmers.

Goal: To raise propensity to purchase California-grown products among consumers statewide.

Outcomes Achieved: In that same consumer survey, 60 percent majority of respondents reported they agree or strongly agree that the blog posts inspired them to specifically look for and purchase California-grown produce and flowers when they shop. Also, an additional survey was conducted statewide among consumers that were not directly exposed to assets from the campaign. Eighty-five percent of those surveyors said they agree or strongly agree that if they see the blue California Grown license plate logo on produce or flowers, they are more likely to purchase that product over one that is not produced in California.

Goal: To generate 3-5 million media impressions that tell the grower story while bringing awareness and understanding to the importance of the specialty crop industry overall.

Outcomes Achieved: After conducting a robust traditional and social media outreach effort, the combination of press materials appearing on national newswires, targeted trade and grower hometown media pitching, and blogger outreach resulted in more than 16.9 million total media impressions for the duration of the campaign – representing nearly 3 times the anticipated coverage amount.

Regarding outcomes, at the conclusion of the campaign, a consumer awareness and purchase intent survey was conducted via an online consumer surveying mechanism. A total of 214 survey responses were collected that reveal the California Grown campaign continues to have a favorable influence on consumer awareness and perceptions of California-grown products. Responses were collected among bloggers who participated in the campaign; consumers who were exposed to the campaign content via blog posts, the California Grown website, and related publicity; and, online consumers at large. Key survey findings are highlighted below, along with comparisons to a BCMA survey conducted during the 2009 campaign.

Awareness:

- 86% of respondents reported they strongly agree or agree that it is important to feel connected to the people and place where their food comes from

- 72% of respondents strongly agree or agree that after reading a blog post about California-grown products they had greater awareness and understanding of California-grown products and the farmers who produce them
    - *2009 Survey Result:* 58% of respondents indicated they have heard of or seen advertisements or publicity for the California Grown campaign
    - Based on this comparison, survey statistics indicate the goal of increasing awareness by 5% was achieved
- 69% of respondents indicated they were familiar with California Grown via the California Grown license plate logo
- 68% of respondents who read a blog post about California-grown products and/or visited the website reported feeling more connected to California farmers
- Exposure to the California Grown message increased dramatically between the most recent campaign (SCB10017) and the 2009 campaign. Please see the following California Grown website statistic increases during the September – November 2011 campaign timeframe compared to the same timeframe in 2009:
    - Visits increased 50.53%
    - Unique visitors increased 51.95%
    - Page views increased 43.60%

Purchase Intent/Influence:

- 91% of respondents indicated that it is important for them to purchase food from California for their families
    - *2009 Survey Result:* 90% of respondents indicated that buying agricultural products from California is an extremely or very good way to support the local economy
- 85% of respondents reported that they strongly agree or agree that when they see the California Grown license plate logo on produce or flowers, they are more likely to purchase that product over one that is not produced in California
- 60% of respondents indicated they strongly agree or agree that the current campaign content (blog coverage) inspired them to specifically look for and purchase California-grown produce and flowers when they shop
    - *2009 Survey Result:* 52% of respondents indicated the campaign content (advertisement) was likely to inspire them to seek out and purchase agricultural products
    - Based on this comparison, survey statistics indicate the 3% propensity to purchase goal was achieved
- Among the bloggers directly involved with the program, 38% responded that *BEFORE* participating in the California Grown campaign, they strongly agreed they were likely to seek out and purchase California-grown products. However, *AFTER* participating in the program, 75% of the bloggers indicated they strongly agreed that they were more likely to seek out and purchase California-grown products – further indicating an increase in purchase intent following exposure to the campaign
- 100% of the bloggers directly involved with the program reported they support the concept of the California Grown campaign, which encourages consumers to seek out and purchase California-grown agricultural products whenever possible

In conclusion, the latest BCMA California Grown Grower Profile Extension campaign accomplished the goal of raising awareness of California Grown specialty crops and growers, while promoting a greater likelihood among consumers to seek out and purchase California-grown products.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The BCMA is a joint effort of agricultural industry groups representing the products of California's farms and ranches. While these member groups are the initial stakeholders, this campaign positively benefits all specialty crops grown in California by virtue of raising awareness of the specialty crops produce and the growers behind them. This project's central objective was to reconnect Californians with the people who produce California's vast array of specialty crops and to instill a sense of pride in choosing products that are produced in the state. A study conducted by California State University, Sacramento, concluded that a 10-percent shift in annual purchases by consumers could generate $848 million in increased revenues to farms and about $728 million in spending in California by growers to meet the growth in demand. Furthermore, based on this scenario, a spending shift could create nearly 5,500 jobs due to the increased economic activity.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

While the majority of this campaign focused on creating digital assets and sharing them with consumers through traditional media outreach, a portion of the effort included social media amplification. The outcome of the social media aspect proved to be more than just a media impressions driver – the qualitative results included thoughtful and photographic blog posts, as well as overwhelmingly positive sentiments about California-grown products, as revealed in the consumer survey results outlined above.

This illustrates that additional emphasis on social media could be greatly beneficial for BCMA's future efforts particularly given that mothers are the primary household purchasers whose regular use of social media has jumped 462 percent since 2006. Simultaneously, momentum has increased behind the locally grown movement, and social networks are playing an increasing role as the forum for these conversations.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

There is no additional information.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 18	Project Title: Expanding Usage and Consumption of Prunes through Introduction of Healthy, High Fiber Prune Breakfast Bread	
Grant Recipient: Sunsweet Growers, Inc.	**Grant Agreement No.:** SCB10018	**Date Submitted:** December 2013
Recipient Contact: Stephanie Harralson	**Telephone:** 530-822-2876	**Email:** sharralson@sunsweet.com

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The objective of this project was to increase the sales value of Sunsweet Growers, Inc. (SG) grower-members' prunes by introducing the diced prune as a key ingredient in baked goods. SG planned to partner with bakeries to market “Plum Amazin” bread made with prunes, offering nutrient dense and delicious breakfast breads.

Prune processing creates byproducts with little to no value that must often be disposed. Further, the volume of undersized fruit that cannot be pitted with standard technologies exceeds the needs for juice and is also often disposed. SG has developed new technology to dice, puree, and pulverizes undersized prunes and prune byproducts with little to no pit residue. This unique technology would be difficult for low-cost foreign competitors to duplicate, giving members’ California grown fruit an advantage.

Because Plum Amazin Bread would be made from underutilized prune byproducts and undersized, largely unsalable fruit, it will allow SG grower’s additional returns from the same crop.

The successful launch of high quality prune bread in the US market will also open up markets for the use of prunes in a wide range of baked goods, such as muffins, cookies, and pastries. Success in the US will provide a template for the development of similar products in overseas markets, where SG products already have penetration, providing a very significant potential new source of sales for the California prune industry. Finally, using often-disposed byproducts and undersized fruit will lower the environmental impact per pound of food produced.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

This project was directed by Sunsweet and Crop Source, who provides sales management and brokerage for wholesale and international business. The principal at Crop Source was the primary manager of this project and reported progress to the SG Board of Directors who represent the prune growing regions in California. SG worked with the following vendors: Sunsweet's advertising agency to develop the website and online advertising campaign; News America to place insertion of an advertisement in the Sunday newspaper, shelf signage and a direct mail piece; and with Costco Warehouse to provide in-store sampling of the Plum Amazin bread.

The primary manager conducted negotiations with regional bakeries to produce the product. Originally, SG was targeting the Pacific Northwest. However, because of the strong relationship with Costco, SG was able to get distribution in the Northeast Costco Division. Therefore, SG worked with a bakery that could supply Costco in the Northeast region.

The primary manager and other CropSource personnel attended the industry trade conferences, such as the American Society of Baking, and International Deli, Dairy and Bakery Expo, Ingredient Food Technology, where they displayed the Plum Amazin bread and held discussions with various potential bakery partners, as well as generated interest for dried plums as an inclusion in baked goods.

The primary manager met with an advertising firm in April 2011 to determine a practical advertising strategy for the Costco Northeast rollout. At that point, the grant work plan was changed to target the Costco consumer. It was determined that the best way to reach the Costco consumer would be through in-store sampling, which is their primary vehicle. Instead of producing radio spots and TV sponsorship of healthy living programming, marketing efforts and grant funds were re-allocated to support in-store sampling at Costco. Sampling is also proven to generate sales of the product.

The Plum Amazin bread began shipping to Costco Northeast in May 2011. The in-store sampling demonstrations were implemented, and the primary manager worked with the advertising firm to develop an ad for the Costco Connection magazine.

While in distribution in Costco Northeast, 22,000 units of the Plum Amazin bread were sold, representing $80,000 in revenue at 28 club stores over 13 weeks. The product included a number of ingredients derived from dried plums, representing 50% of the dry ingredients.

The weekly sales per store required maintaining shelf space of 100 units; Plum Amazin bread averaged about 80 units per week. The analysis indicated two key reasons for the shortfall. One is that the look and concept of the Plum Amazin bread was too similar to raisin bread. The second was that the measurements of velocity were taken during the summer months when bread sales are traditionally slow; also, the summer weather in the region of the trial was atypically warm and humid, which further depressed bread sales.

While the sales velocity did not meet Costco's threshold, it opened an opportunity to reformulate the bread and re-launch in Costco in the San Diego, CA region.

In August 2011, the primary manager met with a marketing firm to discuss cooperation for baking and selling Plum Amazin bread in Costco.

The Plum Amazin bread was reformulated to improve the shelf life and to include a "purple" grain, which enhanced the flavor and appearance of the plums. New product concepts were discussed with Costco divisions of San Diego, Mexico, and Los Angeles, CA.

The primary manager continued working with the marketing firm, which held almost daily discussions with various Costco divisions to fine-tune the introduction of the Plum Amazin bread. It was decided that Costco San Diego would first list a 28-ounce Purple Harvest loaf in 14 San Diego Costco stores starting September 2012 and then expand to all 55 regional clubs in January 2013. Also, Costco Mexico booked the Purple Harvest Bread into all 33 clubs in Mexico starting January 2013. These introductions were supported by in-store demos once per week, in all clubs.

Meanwhile, a production and logistics program with a bakery in Chicago was put in place to supply Wal-Mart Puerto Rico. Wal-Mart began purchasing in October 2012. Interestingly, Wal-Mart's public relations committed to placing ads in their catalogues and doing store displays at its own cost. Grant funds were not used to support the Puerto Rico effort; however the activities from the grant resulted in the product being authorized.

On September 20, 2012 the first deliveries of Plum Amazin Purple Harvest Bread were made to the 14 Costco clubs in San Diego. The item has remained in distribution and has been expanded to Costco in Colorado.

Other bakery products using the diced dried plums were also introduced in Costco:

- Sunsweet Purple Harvest Rolls were distributed in Costco San Diego stores in the 2012 Thanksgiving-News Year period as a seasonal item.
- Sunsweet "Purple Swirl" Plum Walnut Loaf was introduced in all Los Angeles region Costco clubs in February 2013. The Purple Swirl Loaf distribution was extended to all Costco Clubs from Los Angeles through San Diego, Arizona, New Mexico and Colorado.

As a result of interest from other retailers and bakeries, formulation work was done for new bakery items using plum products. For example, Plum/Walnut Bites (a small pastry) were introduced into 88 Costco club stores in the San Diego, Arizona, Colorado, New Mexico, and Mexico regions. In March 2013 CropSource had a meeting on Sunsweet's behalf with Costco Corporate headquarters to discuss further use of diced plums in Costco bread products.

The primary manager worked with the marketing firm to make presentations to Ralph's in the Los Angeles and San Diego, California regions. Ralph's launched multiple Sunsweet bakery products in June 2013. Ralphs is a major chain and owned by Kroger Corporation, the #1 national grocery chain.

An online ad for Sunsweet breads was produced by the advertising firm. In addition, Sunsweet worked with the advertising firm to launch a Sunsweet Bakery website: www.sunsweetbakery.com.

The online advertisement and website were featured in public relations outreach and online bloggers. In addition, it supported the launch of the Plum Amazin Bread at Ralphs as well as Costco in Southern California and Denver area. Total impressions were 8.4 million and targeted bread purchasers who had shopped at Costco or Ralphs in the past 30 days.

A full page insert was run in the Los Angeles and San Diego area through News America to support the launch at Ralphs, with a total circulation of 5.4 million. A direct mail piece was also sent targeting 150,000 zip codes around Ralph's stores. In addition, a shelf signage program was implemented in 236 Ralph's stores that cross-promoted the Plum Amazin bread in the dried fruit and jams/jellies aisles.

As a result of the efforts in the United States, interest in bakery products made with diced prunes has expanded to other countries, notably Japan.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Goal 1 – Achieve distribution in 2-3 grocery retail chains in the US Northwest.

Outcome: The region was changed to work with the best bakery partners and to target Costco. Distribution was achieved in several Costco divisions: Northeast, San Diego, Los Angeles, Denver, and Mexico. Distribution was also achieved at Ralphs in the southern California area, and Wal-Mart in Puerto Rico.

Goal 2 – realize annual sales of $350,000 - $500,000.

Sales of diced prunes and bits related to this grant project have totaled the following:

Year 2011	$922,000
Year 2012	$1,086,030
Year 2013	$2,700,000

These results exceed the expectations of the grant goal. SG is currently evaluating whether to expand the Plum Amazin bread nationally. The location and capabilities of the partner bakeries is a significant factor. However, project staff achieved the goal of introducing diced prunes as a desirable inclusion in baked goods. Having a bread product featuring diced prunes in the market place was crucial to that initiative.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

By creating a new usage for prunes, this project directly benefited SG 300 grower-members, as well as the economies of their surrounding communities. It also benefited SG's 300 employees by retaining and creating new jobs. Because the diced prunes in the bread are made from small fruit and byproducts with little current value, it increases the overall value of the California prune crop. Due to the unique technology required, the process would be difficult for foreign competitors to duplicate, ensuring that SG members' California grown fruit would have an advantage over foreign grown fruit.

Accordingly, this project had the support of the California Dried Plum Board, the state-wide prune marketing order, which notes benefits to the entire 67,000 acre California prune industry. SG is located in Sutter County where 1 in 10 residents' lives in poverty and the unemployment rate is nearly twice the state average; this project helped retain/create jobs in the community.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The most important thing learned is that there is strong interest in the baking community for ingredients that are new, healthy, and taste good. Diced prunes fit that profile perfectly, and project staff is optimistic about being able to grow the business of selling prunes to the global baking trade for many years to come.

Also very important are the lessons learned about the technology of using diced prunes in breads and other baked goods. Many of the delays experienced in managing the project were due to formulation issues related to the technique needed to incorporate the pieces into breads. When this project started there were virtually no recipes for using diced prunes, and the bakeries therefore needed to find the right formulations that worked with their equipment. While this process was often frustrating for all involved, SG now has a good background in formulation techniques, which will make future projects run more smoothly.

Finally, a great deal was also learned about the distribution mechanics of bread from manufacturer to retailer to consumer. The lack of knowledge of bread distribution at the start of the project created unexpected delays. However, this hard earned understanding will allow SG to better select partners to cooperate with in the future.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Websites: www.sunsweetbakery.com
http://www.plumamazins.com/?page=plum-bread

Award: Progressive Grocers 2013 Best New Products Editor's Pick. Judged on Innovation, Taste/Functionality, Value.

Sample online banner ad. Video ad is available for viewing at sunsweetbakery.com

Advertisement insert in Sunday Newspaper

Sample direct mail piece

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 19	**Project Title:** Improving Forage Resources for California's Specialty Crops	
Grant Recipient: California State Beekeepers Association	**Grant Agreement No:** SCB10019	**Date Submitted:** December 2013
Recipient Contact: Christi Heintz	**Telephone:** 520-834-2832	**Email:** christih@cox.net

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Honey bees are required to pollinate one-third of our food supply, including $6 billion in California specialty crops. Bees require a diversity of food resources to maintain health. Increased herbicide use on public and private lands, including herbicides used in farming, on highways and along waterways, has resulted in reduced habitat and biodiversity. Drought, wildfires, loss of cotton acreage, changes in citrus crop management, expansion of single crop acreage and urbanization have further combined to seriously affect available food sources for pollinators. This project has served to encourage landowners and land managers to produce food resources for pollinators, specifically forage crops for honey bees pollinating CA specialty crops.

The project was instigated and completed during the course of a critical time period for honey bees. Since 2006 and the onset of Colony Collapse Disorder (CCD), beekeepers have experienced an annual over-wintering loss of 30% of their honey bees. In the Upper Midwest, the loss of 10 million acres of Conservation Research Program (CRP) lands in the past five years has seriously affected available food resources for honey bees. Most of those bees travel to California to pollinate California crops but require the normally abundant summer nectar and pollen of the Upper Midwest summers to thrive. The purpose of the project was to educate and enlist landowners and managers to produce food resources for pollinators, resulting in better bee nutrition and immune systems, and improved colony health, strength and quantities, thus improving specialty crop productivity and yields.

This project built upon the objective evaluations of bee health from the 2007 Specialty Crop Block Grant Project 6 (Scientific Evaluation Protocol for Sampling Honey Bees), and Best Management Practices (BMPs) for honey bees from the 2009 Specialty Crop Block Grant Project 25 (Best Management Practices (BMPs) for Honey Bees Pollinating California's Specialty Crops). Honey bee nutrition warranted considerable additional focus; as a result this project was developed.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

A focus of this project was the development of forage demonstration plots from Fall 2010 through Spring 2013. Grower and beekeeper cooperators were identified, as well as criteria for evaluating honey bee health and strength. Seed mixtures were identified, sourced and planted. Three fall plantings were made in 2010, 2011, and 2012 and each evaluated the following spring (2011, 2012, and 2013). Three main seed suppliers were identified: Kamprath Seeds in Manteca, CA; Allen Clark in Florence, Arizona; and S and S Seeds in Carpinteria, CA. Kamprath assisted in developing low cost seed mixtures, Clark provided nutritious mustards, and S and S provided extremely low moisture-requiring plant species. Honey bee forage seed mixes and offerings included a wildflower mix, a clover/vetch mix and rapini mustard. The main demonstration sites were Capay Ranch in Glenn County, CA; AgPollen LLC in Waterford, CA; and Paramount Farming in Lost Hills, CA. These sites represented north, central and southern growing regions for the fertile Central Valley of CA.

In addition to the three main demonstration sites, meetings were arranged with other private landowners and public land managers to present the benefits of establishing honey bee forage sites. The Bureau of Land Management (BLM), the United States Geological Survey (USGS), and three agencies of the United States Department of Agriculture (USDA)—the Farm Service Agency (FSA), Natural Resources Conservation Service (NRCS), and the Agricultural Research Service (ARS)—were among the agencies contacted and visited to discuss honey bee forage. Research was conducted to identify economical and bee-friendly plant species and mixes. Fifty presentations were given to enlist landowners and managers and to present results at regional, state and national meetings. Information updates were published in print media (45 different articles) and on the web (nearly 2,500 hits to the forage tab of the Project Apis m. website).

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The project goal was to increase CA acreage dedicated to bee forage. The primary measure of success was the number of growers and amount of acreage dedicated to bee forage. The project targeted landowners and land managers with significant acreage (>5,000 acres). At the onset of the project, it was estimated that three large growers and 2,000 acres were devoted to providing honey bee forage crops, and the target for the project was to recruit twelve to fifteen significant land owners by June 2013. The target was exceeded, as eighteen significant landowners were recruited to plant honey bee forage. These landowners included five almond growers, an additional almond/walnut grower, three almond growers who are also beekeepers, a beekeeper/mandarin producer, a rancher, a land trust with experimental orchards, an Indian reservation, two crop protection companies that own significant acreage, a food processor who irrigates considerable acreage with industrial plant effluent, and two CA research institutions that manage significant experimental acreage. Performance goals were more heavily weighted toward recruiting a number of significant landowners to plant honey bee forage rather than number of acres. Providing bee food resources requires a paradigm shift in land management and demonstration by visible early adopters. The project targeted credible early adopters, and total acreage committed doubled to 4,000 acres.

Data on bee strength with and without forage crops was collected throughout the project term. Though it was difficult to control all variables, bee brood increased with proper nutrition resources. The project found that bees in diverse sites had more vitellogenin (a protein indicative of bee health), better immunity and less mortality than bees in poor forage sites. Additionally data recorded indicated honey bee visitation on wildflower mixtures. From pre-tests to post-tests, overall measures of bee health improved somewhat. Over-wintering honey bees losses dropped from 34% to 30%, yet 30% losses are still unsustainable. Varroa, viruses, poor nutrition because of loss of CRP lands, increases in corn and soybeans (poor nutrition for bees) and drought have prevented bees across the nation from prospering. A significant outcome of this project was to engage Dr. Neal Williams from the University of California, Davis. Long-term, Dr. Williams' lab will research honey-bee friendly plants, provide web-based geographical adaptability of the plants and provide data on observations of honey bee visitation.

Development of honey bee forage species exceeded expectations. As a result of this project, the following were evaluated: California poppy, California blue bells, Baby blue eyes, Five spot, Bicolor lupine, Chinese houses, Crimson clover, Persian clover, Hykon rose clover, Balansa clover, Lana vetch, Alyssum, Rapini mustard and black mustard. These plant species were evaluated singly and in combination. Five spot and the mustards were found to be early bloomers, prior to almond bloom, with frequent honey bee visitations. Prior to the project, there was little to no information available on honey bee visitation by these plant species and/or combinations for California.

Outreach and education accomplishments included: 1) regular updates on project progress and findings to the Project Apis m. and the CA State Beekeepers Association (CSBA) board of directors and in their newsletters, 2) presentations at the American Honey Producers Association, American Beekeeping Federation, Almond Board of California and CSBA annual meetings, and at numerous regional and bee club meetings (Attachment 01), 3) numerous print media hits (*Western Farm Press, Ag Alert, The Grower, Pacific Nut Producer*, Blue Diamond *Almond Facts, The Modesto Bee, The Sacramento Bee, The Fresno Bee* and Western Apicultural Society), 4) regular updates and information on honey bee forage posted to the Project Apis m. website, and 5) other television, video and radio coverage (including CBS47 Fresno, Project Apis m. You Tube, California Department of Food and Agriculture's Planting Seeds blog, and National Public Radio). A white paper on *Brassicas* was written (Attachment 02). A brochure entitled "Growers Guide to Planting Honey Bee Forage" was developed and distributed (Attachment 03). A Forage Field Day was held in April 2013 and timed to show blooming of the various plantings at the Capay Ranch demonstration site (Attachment 04). Media from the event is also included (Attachment 05 and 06).

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The completion of this project has benefitted beekeepers pollinating CA's 45 specialty crops and particularly CA's $6 billion almond industry, plus numerous allied industries. Considering the impact of this project on the beekeeping industry, beekeepers manage approximately 1.6 million hives that pollinate CA crops and at 30% annual losses nationally, beekeepers have to regenerate conservatively, 500,000 colonies each year at a value of over $100 million to cover California's pollination needs. Proper forage and nutrition for honey bees decreases these losses in addition to decreasing input crops for beekeepers. Concerning the almond industry, bee colony rentals are 15-17% of a grower's operating costs, at about $155 per colony in rental fees. A short supply of honey bees results in higher colony rental costs to the grower, thus negatively affecting operating expenses and proper pollination necessary to produce desired crop yields. This project has led efforts in providing better honey bee forage resulting in better nutrition for bees and ultimately better pollination service to CA's specialty crops.

Efforts under this project have also served to decrease seed costs and seed mixes for honey bee forage. The original wildflower mix tested was $320 per acre and not economically feasible for widespread adoption. Fine-tuning the seed composition and seed mixture resulted in a $100 per acre decrease in seed costs from the original wildflower mix. All bee-friendly seeds and seed mixes were developed keeping cost in mind.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

Honey bee forage plantings need to occur between mid-September and early December, depending on the location, and preferably by October 1st. Planting just prior to the first fall rains is important. In order to accomplish this timing, outreach to landowners and land managers needs to occur by mid-summer. The expense of native wildflowers and native wildflower seed mixes will limit their widespread adoption as they are cost prohibitive on a large scale. Clovers, clover/vetch and mustards were found to be economically feasible, and long-term, will be important plant species for honey bees. Emergence is highly dependent upon water supply.

Seven significant benefits to landowners of planting honey bee forage were enumerated under the project: 1) potential to reduce pollination rental expense, 2) contributions to pollination and yield, 3) soil stabilization and reduced runoff, 4) nitrogen fixation, 5) addition of organic matter to soils, 6) decreased soil compaction and increased water penetration, and 7) increased habitat for not only honey bees, but other beneficiaries.

Five major hurdles to planting honey bee forage were identified. These hurdles included: 1) the lack of natural rainfall in CA to germinate seeds, 2) weed pressure, 3) the costs associated with cultivation, labor and fuel to plant seeds, 4) hesitation by landowners to introduce plants that may require additional control and management measures, and 5) the inability to recognize appreciable benefits of planting honey bee forage.

Two allied agricultural industries that have been impacted positively, that were not predicted at the onset of the project, were the crop protection industry and the seed industry. The crop protection industry realizes the positive value of promoting forage and honey bee health. Over the course of this project that industry has become much more involved in promoting and providing natural food resources for bees and benefitting from the positive press. Several companies within the seed industry realize the market potential of providing seeds for honey bee forage and/or providing soil stabilizer mixes that have pollination potential. Further, as the market develops and seed supply for bee-beneficial plants increases, seed prices become more affordable.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Please visit the Forage tab of www.ProjectApism.org. Attachments include examples of education and outreach material (Attachments 1-6) and AgScience Consulting's Project *Apis mellifera:* Field Nutrition Research Final Report (Attachment 7).

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 20	**Project Title:** *What's Growin' On?* 10th Edition – Focus on Specialty Crops	
Grant Recipient: California Foundation for Agriculture in the Classroom	**Grant Agreement No.:** SCB10020	**Date Submitted:** December 2013
Recipient Contact: Judy Culbertson	**Telephone:** (916) 561-5625	**Email:** Judy@LearnAboutAg.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The purpose of this project was to develop a 16-page standards-aligned, activity-based newspaper supplement to showcase California specialty crops and improve the public's appreciation of agriculture's value to the health and well-being of all Californians. An 8-page Spanish version of the supplement was also developed. The California Foundation for Agriculture in the Classroom (CFAITC) committed to disseminating the supplements through online availability, offering free classroom sets to California teachers, distributing at educator conferences and trainings and inserting into California newspapers. This comprehensive outreach plan was designed to provide a unified message to Californians on behalf of all specialty crop farmers.

This project was important and timely. Now, more than ever, students, parents and teachers are interested in the origin and the story behind the food they eat and the agricultural products they buy. In this era of increasing budget cuts and diminishing teacher support, educators are eager to receive free, standards-based resources for the classroom. This project aimed to develop a resource that teachers could easily integrate into their classroom curriculum. Through the development of educational materials that teach students and the public about how their agriculture products are grown, CFAITC was able to showcase California specialty crops and foster a better understanding of agriculture's role in the economy, nutrition, environmental stewardship, and pest management.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

The project began in July 2011 by sending invitations to teachers and industry experts to participate in a development team meeting to develop content for the 10th edition of *What's Growin' On?* (WGO) student newspaper, and six California educators were selected. In August 2011, the development team meeting was held in Monterey, California. The meeting included a half-day industry tour and two days of developing content for the student newspaper.

The team developed content for the 16-page resource with lessons and activities entitled: Pumpkins and Squash Treasures of the New World; Pistachios are Nut-astic; Fancy Free Floral-ly; Mmmarvelous Melons,; Colorful Fruits and Veggies; California Grows; The Garden Center; Have a Berry Special Day; Underground Edibles; Food Safety is a Team Effort; and Superb Herbs. In September 2011, the curriculum coordinator further refined the content, aligned the activities to California State Content Standards, and prepared the documents to be sent to industry experts for review and then to the graphic designer for layout.

Content for the newspaper was reviewed by staff and industry experts for factual accuracy. Industry experts participating in the review included:

- Bonnie Fernandez Fenaroli, Center for Produce Safety, University of California, Davis
- George Perry and Sons
- Steve Patricio, West Side Produce
- Janice Wills Curtis, California Cut Flower Commission
- Jerry Munson, California Cantaloupe Advisory Board
- Steven McShane, The Garden Center
- Deborah Beall, California Department of Education Nutrition Services Division

Finalized content was then provided to a graphic artist at The Fresno Bee (Fresno, California), who also produced the artwork for all previous editions of WGO. In February 2012, the content and layout were finalized and approved for printing and distribution.

The first printing and distribution occurred in March 2012. 30,000 copies were printed and distributed to teachers and county farm bureaus for use in their classrooms and agricultural education programs. The demand was so high that a second order was placed later in the month for an additional 30,000 copies.

The Sacramento Bee printed 190,100 copies of the supplement. Of that, 2,400 were used by the Sacramento Bee's Media in Education (MIE) program, 1,200 were used by CFAITC at California Agriculture Day, and 186,500 were inserted into The Sacramento Bee newspaper subscriptions and every Sacramento Bee newspaper printed on March 20, 2012. The circulation that day totaled 213,064. According to Scarborough Research, the readership on March 20, 2012 totaled 575,273. WGO was then promoted online at www.LearnAboutAg.org and www.sacbee.com/mie.

CFAITC's website, www.LearnAboutAg.org provides teachers with a wealth of educational resources that bring education to life by connecting students to agriculture. K – 12 grade teachers visiting the website will find an interactive online version of WGO newspaper, which includes interactive games, recipes, and teacher resources.

In May 2012, the content for WGO was translated into Spanish, and the graphic artist produced an 8-page, full-color layout for the Spanish version. Also in May 2012, The Fresno Bee included WGO in their MIE program (73,425 readers) and full-run subscriptions (217,800 readers).

In June 2012, CFAITC's curriculum coordinator worked with two educators to develop *What's Growin' On? Extra, Extra! Classroom Extensions.* This resource is 30-page guide that provides teachers with in-class activities related to each newspaper topic. A copy of the *What's Growin' On? Extra, Extra! Classroom Extensions* is included in each class set ordered by teachers, and is available, at no cost, online. By June 2012, requests for the resource continued to be strong and an additional 14,000 were printed to meet the need. Also in June 2012, a research assistant was hired to assist with evaluation design, data collection and analysis.

In July 2012, 30,000 copies of the Spanish version were printed and delivered to the CFAITC office and the Spanish version of the resource was placed online and promoted via CFAITC's e-newsletter, *Cream of the Crop*. A 20-question pre- and post-test student questionnaire was developed by the evaluation team and a 10-question teacher questionnaire was developed by the evaluation team.

In August 2012, demand for the resource continued and a fourth print order was placed for an additional 30,000 copies. Two teachers participated in a pilot study, and based on teacher feedback, the assessment was refined to improve the age-appropriateness of the survey and the clarity of questions.

In August 2012, the supplement was inserted into the subscriptions of the following newspapers:

- The Spanish version of *What's Growin' On?* was distributed via the Fresno Bee's Spanish newspaper, "Vida in la Valle" (469,000 readers).
- *What's Growin' On?* was inserted into the Orange County Register (125,000 readers).
- *What's Growin' On?* was inserted into the Humboldt Times-Standard (16,000 readers).
- *What's Growin' On?* was inserted into the Redding Record Searchlight (83,820 readers).
- *What's Growin' On?* was inserted into the San Francisco Chronicle (82,000 readers).
- *What's Growin' On?* was inserted into the Stockton Record (92,680 readers).
- *What's Growin' On?* was inserted in the California Farm Bureau Federation's weekly industry newspaper, Ag Alert (36,000 readers).

Also in August 2012, 31 teachers were recruited to participate in the project evaluation. Teachers received evaluation materials and a class set of WGO. In November 2012, data from student surveys were entered into Survey Monkey for analysis purposes. Data from the pre-intervention survey were compared to data from the post-intervention survey. Teacher surveys were completed and analyzed using Survey Monkey. Request for the paper continued, and an additional 30,000 copies were printed. In December 2012, findings from the evaluation were summarized in a report, *What's Growin' On? Student Newspaper Evaluation* (Attachment 1).

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The expected measureable outcomes for this project were:

(1) To distribute the resource to more than 1.5 million readers in California;
(2) Make the supplement available online to be accessed by the 207,000 individuals who visit CFAITC's Web site each year;
(3) To recruit and evaluate 20 classrooms to determine the impact of the resource on student understanding, appreciation and perception of California agriculture; and
(4) Students will exhibit an increased knowledge of how to procure and identify California specialty crops, willingness to consume specialty crops, and their appreciation for the farmers and ranchers who grow specialty crops. (The 23-page evaluation summary reports indicates that using the resource in the classroom achieved these goals)

CFAITC printed and distributed 165,000 printed copies of the resource through teacher orders and distributions at workshops and conferences, 45,000 more than proposed. CFAITC coordinated the insertion of the resource into the subscriptions of 10 newspapers, 4 more than proposed in the grant.

CFAITC proposed to establish 20 classrooms for field testing and was able to conduct field testing in 27 classooms, including more than 600 students taking pre- and post-tests. CFAITC proposed to use, and used with success, SurveyMonkey for data collection and analysis, resulting in a 23-page summary report.

Also, CFAITC's website, www.LearnAboutAg.org made available an interactive online version of WGO newspaper, which reached the 207,000 individuals who visit CFAITC's website each year.

Teachers and students from 27 classrooms in 16 different counties participated in a study to measure the outcomes of the project. The purpose of this study was to examine the impact of articles and activities from CFAITC's *WGO California Crop Talk – Specialty Crop Edition*. Specifically of interest was learning whether the articles and activities would add to teachers' and students' knowledge and appreciation of specialty crops in California. Pre- and post-test surveys were developed to collect data from students and online surveys were developed to collect data from teachers.

There were 22 questions on the student survey. The questions were developed from information provided in the specialty crops edition of WGO. Most of the questions (15/22) were designed to learn about knowledge gained about specialty crops from the newspaper and after completing the pre-selected activities.

A comparison of the pre- and post-responses to these questions indicates that for every question, with the exception of one (Q10), there were changes in the expected direction. Student responses indicated an increase in knowledge about the topic on the post-survey. As evident on the tables, there were noticeably large differences in the responses for question 9, 16, and 17.

There were several questions that reflected a positive change in direction (i.e., more knowledgeable about the topic), but the change was slight, indicating perhaps that students were already somewhat familiar with these particular topics. This is the case for questions 12, 14, 19, 20, and 21.

There were also three questions included to learn about taste preferences. Questions 6, 11, and 13 asked students about whether they liked a particular specialty crop food item. As noted on the tables, the responses in the post-survey indicated that students' preference for these items increased following the articles and activities.

The results from the teacher survey indicate that most teachers found the experience of using WGO to be very rewarding and engaging, and that the specialty crops edition provided them and their students with new information about specialty crops. They almost unanimously indicated a desire to receive additional editions and information about these types of activities and lessons.

A complete summary of the evaluation findings, *What's Growin' On? Student Newspaper Evaluation*, is attached to this performance report (Attacment 1).

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Approximately 45,500 specialty crop farms have benefited from this project. By inserting WGO into California newspapers, the supplement has reached an audience of more than 2 million consumers. This comprehensive outreach plan reached consumers with a unified message on behalf of all specialty crop farmers, and educated students about California specialty crops.

This project has also benefited California teachers and students. Teachers across the state have been provided with free class sets of the WGO newspaper supplement, a Spanish version of the supplement, a related teacher's guide, and online resources that will familiarize students with California's specialty crop industry while teaching problem-solving and critical thinking skills in all academic disciplines. Approximately 165,000 copies of the resource have reached California students and teachers directly.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

WGO was a project that engaged CFAITC staff at all levels. From the executive director and curriculum coordinator, who identified the goals and vision of the project, to the support staff who shipped thousands of copies to teachers throughout the state, WGO engaged the organization at every level.

Distributing the resource to the general public via newspaper subscriptions was an excellent way to market specialty crops and to broaden CFAITC's network of teachers. During the grant period, demand for WGO, as well as other CFAITC teacher resources, increased significantly. Many teachers were referred to the organization via the newspaper insertion of WGO. Prior to the grant period, CFAITC typically printed and distributed 60,000 copies through teacher orders and additional copies would be inserted into 3 newspapers for a total readership of 500,000. With the Specialty Crop Block Grant (SCBG), 165,000 print copies were distributed and 10 newspapers participated in the insertion for a total readership of 2 million.

Additionally, CFAITC learned the value of program evaluation. SCBG funds enabled CFAITC to thoroughly evaluate the teachers and students exposed to the resource. CFAITC learned that students experienced an increase in knowledge about specialty crops and an increased preference for specialty crop items.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 22	**Project Title:** Contra Costa Community CSA	
Grant Recipient: Brentwood Agricultural Land Trust	**Grant Agreement No:** SCB10022	**Date Submitted:** December 2013
Recipient Contact: Kathryn Lyddan	**Telephone:** (925) 818-1511	**Email:** brentwoodagtrust@sbcglobal.net

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The San Francisco Bay Area, home to more than seven million people, is surrounded with productive agricultural activity. While Contra Costa County specialty crop farmers produce an extraordinary volume and variety of fruits and vegetables, many residents in West Contra Costa County do not have access to fresh, local food. The "Retail Food Environmental Index" for Richmond, California shows that liquor stores and fast food restaurants outnumber grocery stores. One out of every four children in Richmond is obese, and Richmond is ranked among the top ten California communities at risk for obesity and diabetes.

In April 2009, the Richmond Community Foundation (RCF), Brentwood Agricultural Land Trust (BALT) and Contra Costa County Supervisor John Gioia (collectively, the Partners) joined together to create the Richmond Farm 2 Table Community Supported Agriculture (CSA). From April 2009 through October 2012, RCF operated CSA, contracting with a local Richmond nonprofit to source, assemble and deliver the CSA boxes to six sites in Richmond. The CSA provided fresh, local fruits and vegetables twice a month to between 60-100 Richmond households. About forty-percent of the CSA members were low-income families and seniors who received boxes at a significantly subsidized rate.

The Partners received the 2010 CDFA Specialty Crop Grant to (i) create a business plan for an economically sustainable CSA that would generate sufficient profits to continue to provide subsidized boxes, (ii) implement the business plan by scaling up the CSA to an economically viable size, (iii) take CSA members on tours of Contra Costa farms and (iv) work with the East Bay Municipal Utilities District (EBMUD) to develop a farm on EBMUD's Pinole watershed property.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Creation of Working Group. In November 2010, the Partners formed a working group to govern the project and make decisions about the CSA, and hired Kathryn Lyddan to manage the project. BALT and RCF took primary responsibility to overseeing the business planning process, and RCF operated the CSA.

Development of Business Plan. In December 2010, the Partners hired a contractor to develop a business plan for a scaled-up CSA. Unfortunately, the contractor team worked on the business plan for six months and then abandoned the project. Fortunately, the Partners no funds were paid to the contractor so no funds were lost. The Partners decided to work together to complete the business plan themselves. Kathryn Lyddan was the primary author. Several business and academic advisors reviewed drafts and provided input to the business plan, which was completed in September 2011. The business plan contains a competitive analysis, financial modeling, a discussion of the best method to source, assemble and distribute the CSA boxes, and recommendations for branding and marketing the CSA.

The business plan concluded that (i) there was a market in the Bay Area for an efficient, competitive expanded CSA, (ii) Brentwood, Contra Costa and neighboring farmers have the capacity to provide local food for an expanded CSA, and (iii) the CSA would need to scale up to at least 300 members to generate sufficient revenue to subsidize boxes for low-income subscribers. The business plan included research regarding existing Bay Area produce aggregation and distribution methods. The working group worked closely with specialty crop farmers to find the most efficient method to aggregate product for the CSA. The business plan concluded that an expanded CSA could increase food access in Richmond, create a new direct market for Contra Costa farmers, keep food dollars in the local economy, create jobs, and educate urban residents about cooking, nutrition and local farming.

Implementation of the Business Plan. The business plan directed the Partners to form an advisory committee to provide oversight of the CSA's strategic direction, financial performance and social mission. The Partners would hire an experienced CSA manager to handle the daily CSA operations.

Looking for a CSA Operator. In September 2011, the Partners published the Request for Proposal (RFP) for a contractor to source and aggregate produce for CSA. The RFP was structured based on the research the working group conducted of existing aggregation and distribution methods in the East Bay. The RFP was widely distributed on COMFOOD and other social media outlets, and the Partners followed up directly with local nonprofit organizations, specialty crop farmers and produce distributors as well. Only one bid was received and the bid equaled the total CSA revenues leaving no revenue to cover the administration, accounting, customer service or marketing functions of the CSA. The Partners agreed that the proposal was not financially viable.

In December 2011, the Partners held a community meeting to seek advice from produce distribution experts and community members. Based on the input received at the community meeting, the Partners revised the

RFP to provide that the "CSA Operator" would assume all the responsibilities for the operation of the CSA, including the sourcing, aggregation, delivery, billing, accounting, daily communication with members and customer service.

The revised RFP was widely distributed and the only response received was from the same bidder as before. Again, the bid was too high to create a financially viable CSA. The Partners worked closely with the bidder over the next couple of months to review costs and expenses of the scaled-up CSA and to create a refined working budget. Unfortunately, the negotiations based on the revised budget did not result in a financially viable proposal from the bidder.

In May 2012, an existing for-profit CSA contacted RCF about partnering on the Richmond Farm 2 Table CSA. This particular CSA delivers over 10,000 CSA boxes a week and expressed an interest in adding a social mission component to their business. Discussions of creating an "East Bay" CSA box featuring Brentwood and East Bay farmers to provide its customers with the option of participating in the social mission of the Contra Costa Community CSA. However, in September 2012, the non-profit CSA notified the Partners that it had other organizational priorities and withdrew from negotiations.

Building a Customer Base. During the fall of 2011, RCF met with representatives of the Chevron refinery in Richmond about offering CSA boxes to the several thousand employees in their Richmond facility. Chevron agreed to promote the CSA to their employees, and estimated that 300-400 employees would participate. While Chevron remained interested, the Partners have been unable to begin service to the Chevron refinery because they have not been able to engage a CSA operator.

Operation of the Richmond Farm 2 Table CSA. RCF continued to operate the Richmond Farm 2 Table CSA through October 2012. RCF continued to contract with the local nonprofit to source, assemble and deliver the boxes. The CSA continued to operate at a deficit because of the limited scale of the CSA, the number of deeply subsidized CSA boxes, and the cost of the contract with the local nonprofit. During the operation of the Farm 2 Table CSA, the local nonprofit sourced as much as the CSA box as seasonally possible from Contra Costa farms. Some farms expanded their winter production to serve the CSA.

Tours of Contra Costa Farms for CSA Members. On July 23 and October 1, 2011 the Contra Costa County Resource Conservation District (CCCRCD) held tours that brought CSA members to the Contra Costa farms in Brentwood and the Alhambra Valley that grow food for the CSA. On June 30, 2012, the CCCRCD held a farm tour to bring CSA members to the local nonprofit and urban farms in Richmond. While cooking lessons were provided, the lessons were not provided on a monthly basis as originally planned as efforts were focused on developing a business plan for the CSA and securing a CSA operator.

Development of a New Farm on East Bay Utilities District Property. During the winter of 2012, EBMUD conducted soil and water tests on their Pinole Watershed property. The testing confirmed that property would be a good site for specialty crops production. BALT and EBMUD met with farmers interested in leasing the land to grow fruits and vegetables for the CSA. In April 2013, a partnership of EBMUD, International Rescue Community, PUEBLO and EBMUD started the Pinole Incubator Farm Project, providing land and technical assistance to Lu Mien, Eritrean and Bay Area small-scale farmers who will sell their produce through the Phat Beets Produce CSA in Oakland.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

While the project was not able to scale the Richmond Farm 2 Table CSA, the Partners created and distributed a comprehensive business plan (see Attachment A) and a detailed budget for an economically self-sufficient CSA model that could provide subsidized boxes to low-income families. The Partners engaged local nonprofits, farmers and produce distributors in exploring different business structures for operating a scaled up CSA. RCF continued to negotiate with interested parties about operating the CSA and engaging their 10,000 customers with an opportunity to participate in the social mission of the Contra Costa Community CSA. The Chevron refinery in Richmond continued to be interested in providing their employees an opportunity to pick up a CSA box at work.

During the grant project, the Richmond Farm 2 Table CSA continued to provide between 60 and 100 CSA boxes to Richmond residents every other week. Sixty percent of the boxes were deeply subsidized boxes for low-income families and seniors. Three times during the grant period, CSA members had an opportunity to visit the local farmers that provided fruits and vegetables to the CSA.

While the Partners did not ultimately end up partnering with EBMUD, the water and soil tests that the Partners and EBMUD conducted during the project period laid the groundwork for the new Pinole Incubator Farm Project, providing immigrant farmers with land access and a CSA market through Phat Beets Produce.

Since the end of this project, Richmond Community Foundation contracted with a local Richmond nonprofit, Urban Tilth, which has been managing the CSA. Non-SCBGP funding was used to build upon this project and re-launch the CSA in the summer of 2013.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The CSA and the business planning process created new connections between Contra Costa farmers and the Richmond community.

The soil and water tests conducted by the Partners laid the groundwork for the Pinole Incubator Farm Project, providing tangible benefits for the immigrant farmers who will farm the land and sell their produce to a nonprofit committed to increasing food access in Oakland.

In addition, all Richmond residents had an opportunity to participate in the Richmond Farm 2 Table CSA, and the CSA provided low-income families and seniors CSA boxes twice a month at a deep discount. Richmond

CSA members and their children visited the CSA farms three times during the grant period, which created a direct personal connection between the farms and the CSA members.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The primary obstacle faced by the Partners was the inability to find a CSA Operator that was interested and able run the CSA in an economically sustainable manner. For profit farmers and produce distributors were not interested in participating in a CSA in which there was management oversight by the Partners and the profits were committed to funding subsidized boxes. Unfortunately, during the grant period, the Partners were not successful in finding a local nonprofit that was willing and able to operate the CSA. Nonprofit organizations in Richmond were primarily interested in increasing urban agricultural production in Richmond. Many did not have the organizational capacity to manage the CSA operations. However, the business plan was completed and available when the right CSA operator was found.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 23	Project Title: Data-Driven Targeted Education to Speed Adoption of Sustainable Winegrowing Practices	
Grant Recipient: California Sustainable Winegrowing Alliance (CSWA)	**Grant Agreement No:** SCB10023	**Date Submitted:** December 2013
Recipient Contact: Allison Jordan	**Telephone:** (415) 356-7535	**Email:** ajordan@wineinstitute.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The California Sustainable Winegrowing Alliance's (CSWA's) Sustainable Winegrowing Program (SWP) provides education and outreach to California's winegrape growers and vintners to document and improve the sustainability of vineyards and wineries and the industry as a whole. The project addressed the need to align targeted education with sustainability topics objectively determined by analyses of self-assessment data. Using data collected from winegrowers through the SWP online self-assessment system, CSWA provided educational workshops and resources designed specifically to address key areas for improvement opportunities in unique winegrowing regions throughout the state. As a cost-effective and results-oriented means to spur behavioral change, targeted education events and materials have enhanced CA winegrowers' competitiveness by helping them design and execute action plans to speed adoption of more sustainable practices and demonstrate continuous improvement on priority issues. This project is important and timely due to increasing market and regulatory pressure for winegrapes and wine produced in a sustainable manner, and has enabled winegrowers to demonstrate adoption of sustainable practices and associated environmental and social outcomes in the marketplace and with other key stakeholders. The project addressed several Specialty Crop Block Grant (SCBG) research priorities by transferring latest understandings on resource issues integration, regulatory challenges, water use efficiency, air and water quality, and climate change adaptation and mitigation.

This project built on the 2008 SCBG project that CSWA received for Certified California Sustainable Winegrowing, a 3rd-party certification program launched in January 2010 verifying adherence to a process of continuous improvement including annual self-assessment, identification of priority areas, and development and implementation of action plans. The project complemented and enhanced this SCBG project by providing education that enabled cost-effective action planning and execution in priority areas determined by analyses of winegrower assessment data (targeted education). Accordingly, certification applicants can more readily meet certification requirements and benefit from associated market incentives. Beyond those seeking certification, thousands more California winegrowers gained competitive advantage from the data-driven targeted education speeding adoption of more sustainable practices which lower costs, improve efficiencies, and enhance California wine's positive image in domestic and international markets.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Project Activity #1: Use SWP software to extract and analyze baseline regional and statewide winegrower assessment data (Completed January 2011). With assistance from SureHarvest and Viewcraft, CSWA extracted regional reports from the online self-assessment system that compares regional averages to statewide averages for 227 sustainability practices included in the self-assessment workbook. Regional reports were created for each major winegrowing region in California including Sonoma County, Napa County, Mendocino County, Lake County, Central Valley, Sierra Foothills, Central Coast and Southern California. CSWA, SureHarvest and Viewcraft analyzed the results to determine the strengths for each region and areas/practices in need of improvement.

Project Activity #2: Interpret results of data analyses and prioritize Code criteria and list associated key practices for targeted education (Completed May 2011). The regional assessment reports show the averages in a bar graph format and correlate to the content in the self-assessment workbook. To truly make the data useful for winery and vineyard regional association representatives, CSWA developed interpretation reports that provided highlights of the report in written format and identified and prioritized the key practices to focus on for targeted education events. CSWA developed both an in-depth report and a summarized report for many of the regions.

Project Activity #3: Develop printed educational materials (Completed June 2013). CSWA identified areas with opportunities for improvement in the regional and statewide assessment reports to use as content for educational materials at workshops and meetings and for outreach to winegrowers. CSWA developed five educational newsletters that highlighted the business and environmental benefits of adopting sustainable practices, water conservation and efficiency, energy efficiency, efficient nitrogen use, the social equity of sustainable winegrowing, and use of performance metrics. Each newsletter was sent to over 3,000 growers and vintners throughout the state, distributed at workshops and events, and posted on the CSWA website. In addition, CSWA translated self-assessment workbook chapters and educational materials into Spanish to address the need for Spanish-language educational materials, particularly for vineyard and cellar employees. CSWA also compiled new educational resources for two new workshops, one focused on biodiversity conservation and one on environmentally preferable purchasing, which were provided on USB drives to all grower and vintner workshop attendees. CSWA released the *3rd Edition of the California Code of Sustainable Winegrowing* self-assessment workbook in both hard copy and online in January 2013. Additional educational materials developed include a Small Winery Water Handbook designed to assist small wineries in conserving water and a handout for growers on the importance of using metrics to improve their resource use. (See Attachment A for a full list of educational materials and examples and www.sustainablewinegrowing.org to download a copy of the workbook.)

Project Activity #4: Develop web-based resources (Completed June 2013). In addition to posting all of the printed educational materials listed above on the CSWA website, CSWA identified several opportunities for web-based educational resources. CSWA compiled and created a new section on the CSWA website to post Spanish-language sustainability-focused educational materials (including the translated workbook chapters) to make the information accessible to more vineyard and winery employees. CSWA also created a new reporting feature in the online assessment system to help winegrowers easily develop action plans for improvement after they completed a self-assessment. Three to four minute educational case study videos were developed as an easy way to present the benefits of specific conservation and sustainability practices. Video topics developed include Water Conservation, Biodiversity in the Vineyard, Solid Waste Management, Value of Self-Assessment, and Value of Performance Metrics (Please see Attachment A for the list of educational materials and examples. View the videos at: http://www.sustainablewinegrowing.org/CSWA-video.php).

Project Activity #5: Plan targeted education events (Completed June 2013). CSWA planned 43 targeted education events in the major winegrowing regions in California with the assistance of regional association partners (funded in full or in part by the this grant). Event topics and expert speakers were identified using the information from the regional data analysis and through meetings with the regional winery and vineyard associations to ensure topics covered priority issues for the specific region. All vineyards and wineries in the surrounding area were invited to the events by CSWA, the local regional associations, Wine Institute and the California Association of Winegrape Growers.

Project Activity #5: Facilitate targeted education events (Completed June 2013). CSWA held 43 targeted education events with 1,622 winegrower participants between March 2011 and June 2013 (exceeding the goal of 20+ events reaching 800 growers). Workshops were held in Bakersfield, Ceres, Fresno, Hopland, Lakeport, Livermore, Madera, Modesto, Napa, Paso Robles, Plymouth, Ramona, Sanger, Santa Cruz Mountains, Santa Ynez, Sonoma, Temecula, Ukiah, and Visalia. Workshop topics covered water use efficiency, weed monitoring and knowledge, carbon sequestration by vineyards, dry farming, energy efficiency, environmentally preferable purchasing, heat stress prevention, integrated pest management, irrigation management, nutrition and efficient fertilizer use, performance metrics, soil analysis and amendment management, sustainable winegrowing communications, and sustainable vineyard and winery certification. (See Attachment B for a list of workshops and sample agendas.)

Project Activity #7: Measure project progress using SWP software to extract and analyze winegrower assessment data collected during and after targeted education (Completed June 2013). CSWA collected self-assessment data from winegrowers throughout the three year project period. Updated regional reports were extracted in May 2013 from the data in the online self-assessment system that compares the regional averages to the statewide averages for the 227 sustainability practices included in the self-assessment workbook before and after the project period.

Through the comparison of data in regional reports before and after targeted education workshops in regions where many targeted education events were held, CSWA was able to document an improvement in self-assessment scores in the chapters that relate to the event topics. For instance, assessment scores increased for 8 of the 10 energy efficiency practices and 10 of the 16 soil management practices in Sonoma County. In the Central Coast, all 16 soil management practices increased in scores, and 10 of the 13 water management practices improved.

Contributions and role of project partners: While CSWA was responsible for the educational events and materials, project partners were key to the project's success. CSWA worked with more than a dozen regional winery and vineyard associations to identify relevant topics for targeted education events, and to promote those events to their grower and vintner members. SureHarvest and Viewcraft were instrumental in the analysis and interpretation of regional and statewide reports. In addition, CSWA has worked with expert partners from UC Davis, UC Cooperative Extension, USDA Natural Resources Conservation Service, Resource Conservation Districts, industry experts, among others, to deliver education at the events. Finally the Sustainable Winegrowing Joint Committee, comprised of growers and vintners, was instrumental to the third edition of the California Code of Sustainable Winegrowing, as well as nearly 30 external reviewers from government agencies and academic institutions, among others.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Objective 1. Use SWP assessment and reporting software to extract and analyze regional and statewide assessment data. CSWA analyzed and interpreted 12 regional assessment reports and identified key areas in need of improvement to focus on at targeted education events and in educational materials.
Objective 2. Develop materials and web-based resources to reach and educate 2,000+ growers and vintners about key sustainable practices relevant to prioritized criteria. CSWA developed over 15 different educational materials and reached more than 3,000 winegrowers (exceeding the goal of reaching 2000+ winegrowers). CSWA also shared the educational materials at industry events and conferences (e.g, Unified Wine and Grape Symposium, the Sustainable Ag Expo, regional meetings, viticulture fairs, etc.) reaching additional winegrowers. CSWA tracks website hits to measure interest in both the educational and certification programs, and during the project period (Oct. 2010-June 2013) there were 45,336 unique visitors to the website visiting 72,899 times, and 7,333 unique visitors to the certification webpage. CSWA tracked 3,815 unique visitors to the CSWA publications page, 627 unique visitors to the video page visiting 778 times, and 157 unique visitors to the Spanish resources page visiting 192 times.
Objective 3. Plan and conduct 20+ targeted education events attended by at least 800 winegrowers. CSWA held 43 targeted education events attended by 1,622 winegrower participants between March 2011 and June 2013 (greatly exceeding the goal of 20+ events reaching 800 growers).
Objective 4. Use SWP assessment and reporting software to analyze, quantify, and report progress in grower and vintner performance in sustainable winegrowing via Code assessment data collected during and after the project's targeted education activities. CSWA collected assessment data throughout the project period and extracted and analyzed 12 new regional reports. Many of the regions where educational events took place showed an increase in relevant assessment scores.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

As detailed above, CSWA directly reached 1,622 winegrowers through 43 educational events and more well over 3,000 winegrowers through dissemination of educational materials. CSWA also shared the educational materials at industry events and conferences reaching an even greater number of winegrowers. CSWA tracks website hits to measure interest in both the educational and certification programs, and during the project period there were 45,336 unique visitors to the website visiting 72,899 times, and 7,333 unique visitors to the certification webpage. CSWA tracked 3,815 unique visitors to the CSWA publications page, 627 unique visitors to the video page visiting 778 times, and 157 unique visitors to the Spanish resources page visiting 192 times. Since all of the educational materials are publicly available on the CSWA website, many additional winegrowers, and other specialty crop producers, will benefit from the project results over time.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

A key lessoned learned by the project is the positive link between targeted education and the improvement and increased adoption of those practices. While CSWA was able to demonstrate a link between education and improvement through assessment data, encouraging more winegrowers to complete a new or updated assessment would be helpful to more clearly see the impact of the educational events over time. One favorable development for the project was the identification of topics in need of improvement that correlated with other CSWA projects, which enabled CSWA to leverage additional resources to host workshops that fulfill other projects' goals. By leveraging grant funds, CSWA was able to develop additional educational materials that will have a broad reach in educating and informing California growers and vintners about sustainable winegrowing practices.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

ATTACHMENTS:
Attachment A: List of Educational Materials and Sample Materials
Attachment B: List of Targeted Education Events and Sample Agendas

USDA Project No.: 24	**Project Title:** Scalable Solutions to Reduce Water Use and Salinity in CA Winery and Food Processing Cleaning Operations	
Grant Recipient: Wine Institute	**Grant Agreement No:** SCB10024	**Date Submitted:** December 2013
Recipient Contact: Allison Jordan	**Telephone:** (415) 356-7535	**Email:** ajordan@wineinstitute.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Salinity build up in the San Joaquin Valley has been identified as one of the most significant issues affecting water quality in California. Cleaning and sanitation chemicals are a source of salts that, if controlled, would assist in reducing salinity build-up throughout the state. In winemaking and other food processing operations, these practices are also among the largest uses of water and are typically some of the largest sources of salts in process wastewater. They can contribute to as much as 30% of processing energy use for a facility.

The wastewater salinity and disposal issues are raising questions about the future of wine making and food processing in California because of ever increasing treatment cost, limited wastewater treatment capacity in some areas, and increased regulatory requirements. According to Sunding et al. (2006), "a one percent increase in the cost of regulation will cause processors in all these industries to shift production out of region, ranging from 0.5% to 20% of production shifting out of region." The wastewater salinity and disposal issues are becoming major impediments to the growth and expansion of wine making and food processing in California and will impact the future of these industries if not addressed immediately. Research is urgently needed to develop technical solutions to reduce discharge of high salinity wastewater from wineries and food processing plants. The goal of this project was to adapt/develop green physical and/or chemical approaches to reduce wastewater salinity and fresh water use during cleaning operations in winery and food processing plants.

This project was built on the 2008 Project (SCB08003) to develop an eco-friendly system/technology for significantly reducing fresh water use and wastewater discharge containing high salt loads from tomato processing plants. The project director developed a system/technology that reduces discharge of high salinity wastewater by more than 80% during tomato peeling. The system/technology will also achieve a similar reduction in fresh water use. The current project also aimed at reduction of fresh water use and wastewater salinity during cleaning operations in winery and food processing plants.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

The research and project activities were guided by a six member steering committee and a six member technical committee made up of members from E & J Gallo Winery, Wawona Frozen Foods, Inc., Wine Institute, California League of Food Processors, National Grape and Wine Initiative, Kennedy/Jenks Consultants and California Polytechnic State University (Cal Poly), San Luis Obispo. The experimental sites were Gallo Winery (Fresno), Wawona Frozen Foods, Inc. (Clovis), and Cal Poly (San Luis Obispo)

The initial plan was to complete the project in five steps: 1) Survey, evaluate, and adapt green chemicals and/or processes for cleaning; 2) Work with suppliers to modify green cleaning approaches to meet industry need and environmental standards; 3) Examine potential reduction of fresh water use and wastewater salinity; 4) Facilitate industry wide adaptation; and 5) Measure industry wide impact. The implementation of the first step revealed information that changed the project direction. A survey of current winery and food industry cleaning practices, cleaning chemicals suppliers, and literature on new developments indicated that green chemicals are not utilized in the industry, chemical manufacturers are not producing green chemicals, and there were no new developments in this area. A survey of the allied industry (pharmaceuticals and electronics) revealed that most of the cleaning practices are not amenable for cleaning in wineries and food processing plants, are too costly, and are inefficient for large scale operations. The survey clearly showed the need for development of new green approaches.

The first step in the development of new cleaning approaches was to adapt/develop an objective method to determine clean surfaces. Cal Poly examined five approaches: Grazing Angle FT-IR, Optically Stimulated Electron Emission (OSEE) Spectroscopy, UV-VIS Reflectance Spectroscopy, and Total Organic Carbon (TOC) Determination. The project team finally adapted TOC estimation as a method to determine cleaning efficiency.

The TOC analysis by swabbing uses a polyester swab soaked in 1 N sodium hydroxide to test a surface for residual carbon left after cleaning. An area of 5cm x 5cm is thoroughly swabbed using a thermally attached polyester swab head soaked in 1 N sodium hydroxide. The swab head is then removed from the handle and dropped into a small flask where it is soaked in 1.0 mL of sodium hydroxide and 3.0 mL of nanopure water for one hour with stirring. After one hour the solution is neutralized with 1.0 mL 2N hydrogen chloride prior to injection into the TOC analyzer, which works by combusting all of the present carbon to carbon dioxide (CO_2). The CO_2 gas is then delivered by an inert carrier gas to a membrane conductivity detector. The signal is compared to standards made of potassium biphthalate in nanopure water in the range of 0 to 100 parts per million (PPM) organic carbon.

Cal Poly examined a number of cleaning technologies: Ice pigging (for pipe cleaning), cleaning with dry ice, and reduction of cleaning needs with hydrophobic surface were found to be unsuitable for our operations. The project team finally decided to pursue four green approaches (described below, a-d). The laboratory experiments were carried out by dipping a custom fabricated rack containing 10” x 10” stainless sheets (coupons) in wine tanks for soil deposition, followed by cleaning. Pieces of commercial process lines in food processing plants with soil deposit were removed at the end of the day and cleaned. Cleaning trials were carried out by cleaning wine tanks (Gallo Winery) and commercial process lines (Wawona Frozen Foods, Inc.)

a) *Electrolyzed water as a cleaning agent*: Electrolyzed water (EW), produced at Cal Poly using two pieces of equipment loaned by the Amano Corporation of Japan, was studied. They examined the pH stability when heated, sodium (Na)/potassium (K) concentrations in EW, and the input water quality requirements.

b) *Application of ozone infused water*: Ozone (O_3) infused water was studied at Gallo Winery to remove soil and stains in wine tanks. Research on application of ozone infused water on food processing surfaces to reduce soil build-up was studied by continuous application of O_3 infused water on commercial process, followed by an evaluation of soil build-up. This study is continuing at Wawona Frozen Foods, Inc. Cal Poly is designing a new system for effective application of ozone infused water on open food processing surfaces.

c) *Development of green chemicals in partnership with Madison Chemicals, Inc.*: Madison Chemicals, Inc. partnered with Cal Poly to develop and test nine chemicals (Green Cleaner MPD, Aqua 9,000, PBC, Liquid HS, Liquid Clean Ox-Low Na, Liquid Clean Ox NF-Non Foaming, Liquid Clean-Ox Extra, Acid Clean-Ox V1, Acid Clean-Ox V2 or Vitipure). The partnership will continue in the next phase of this project.

d) *Chemical free cleaning with a high pressure water knife:* Experimentation with a high pressure water knife, carried out at Cal Poly included, the effect of spray time (2, 4, 6, and 8 seconds), wand angle (30°, 45° and 60°), and nozzle distance (0.5, 1.0 and 1.5 inches) from cleaning surfaces on cleaning efficiency. Cal Poly has designed and fabricated systems for pilot-scale cleaning of tank and open surfaces. Testing of these systems will be carried out in the second phase of this project.

A Cal Poly economist, with input from a consultant, conducted an economic analysis of the impact of switching to green cleaning processes in the winery and food processing industry based solely on differences in explicit costs/benefits. The project results were presented to industry groups: California League of Food Processors, the Central Valley Salinity Coalition (CV Salts), National Grape and Wine Initiative Board of Directors, and project steering and technical committees.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

One of the important outcomes of this project is a quantitative method (TOC estimation) for cleaning validation instead of visual inspection to determine clean surface. This method detects virtually all food and organic detergent residues, is sensitive down to 0.05 mg organic carbon per sample (or 0.001% by weight of a 4 gram sample). Tests indicated >95% recovery of surface soils on stainless steel. The study on winery and food processing surfaces indicated carbon percentages of $\leq$0.0015% for clean surfaces, ~0.09-0.02% for unclean surfaces, and ~0.002-0.008% for incompletely cleaned surfaces.
The outcomes achieved are described below:

a) *Electrolyzed water as a cleaning agent*: The results clearly showed that electrolyzed water cannot be used as a cleaning agent. Although the high pH stream proved to be a good cleaning agent, it had significantly higher levels of K (569 ppm) and Na (416 ppm) content, and showed poor pH stability when heated (~3 hours). The process requires pure water for electrolysis, and is therefore, very expensive. The study on electrolyzed water has been discontinued.
b) *Application of ozone infused water*: Ozone (O_3) infused water was unable to clean and remove stains in wine tanks. The loss of O_3 during transportation and pumping is a major problem needing O_3 generation at a higher concentration. This may pose safety issues and may react with tank coating material. Applications of ozone infused water on food processing surfaces reduced soil build-up resulting in a savings of $14,000 (without optimization). The study will continue during the second phase at Wawona Frozen Foods, Inc. to design a new system for optimal application of ozone infused water on open food processing surfaces.
c) *Development of green chemical in partnership with Madison Chemical, Inc.*: Based on this study the company is now producing "Vitipure," a sodium/potassium hydroxide free patented green chemical for tank cleaning in wineries. Madison Chemical Inc. has been engaged with wineries to carry out commercial cleaning trials and will continue working with Cal Poly in the next phase of this project.
d) *Chemical free cleaning with high pressure water knife:* Experimentation at Cal Poly has shown great promise for cleaning surfaces with a high pressure water knife. Spray angles of 30° and 45° were statistically better at cleaning than at a 60° angle for nozzle heights of 1.0" and 1.5". At a spraying distance of 0.5", all three spray angles showed no statistical difference in cleaning ability. The three nozzle heights were statistically the same in cleaning ability at angles of 30° and 45°. No statistically significant differences were observed for cleanliness between water knife spray times, however a slight trend was observed with averages of 0.0019, 0.0017, 0.0015, and 0.0015 % C for 2, 4, 6, and 8 seconds, respectively. Single pass cleaning has shown better cleaning (0.0019% C) than the current chemical method of cleaning in commercial wineries (0.0041% C). Cal Poly has designed and fabricated systems for pilot-scale cleaning of tanks and open surfaces. Testing of these systems will be carried out in the second phase.

The economic analysis of the impact of switching to green cleaning process comparing Sterox K (current standard chemical for cleaning soiled wine tanks) and Vitipure was carried out based solely on differences in explicit costs/benefits. The analysis indicated a conservative annual cost savings of $16,200 for a large winery with accompanying reduction of potassium and sodium by 2.0 and 9.4 metric tons, respectively. The new green cleaner not only reduces potassium and sodium significantly but is relatively cheaper, especially with the offset 0.0035 $/gal cost of disposal of waste water. However, a comprehensive economic analysis of the impact of switching to green cleaner in the winery and food processing industry would necessitate a complete lifecycle analysis.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

California wineries and food processing industry that utilize specialty crops will be the beneficiary of the project outcomes. The green cleaning process/technology, when fully developed and commercially adapted, will diminish wastewater salinity, significantly decrease treatment costs, reduce the need for new regulation, and improve the profitability and overall economic viability of the wineries and specialty crops industry in California. For example, Table 1 illustrates cost comparisons of cleaning a 100,000-gallon tank with some of the green chemicals developed during this study.

1. Cost comparison for cleaning a 100,000-gallon tank

100K Gallon Tank	Sterox K	Liquid Clean Ox NF	Acid Clean Ox V1	Vitipure	Water Knife*
Cost of Cleaning ($)	95.09	90.56	101.97	90.87	57.03
Water Usage (gal)	1,100	1,100	1,100	1,100	4,721
K (g/Tank)	442	26.20	-	-	-
Na (g/Tank)	2,054	90.20	-	-	-

*This is a rough estimate, the Water Knife system is under development

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The initial survey came as a surprise as the project team could not find any scalable green chemical or process for adaptation by the industry. The team was also surprised by the lack of research and development efforts in this area, and the lack of response for partnership for development of green chemicals. One company, Madison Chemicals, Inc. decided to partner on the project, and this partnership has led to the development of the green chemical "Vitipure." The project team believes that a combination of physical and chemical approaches will be the final green solution for cleaning. The majority of soil (75-95%) will be removed by the physical method followed by a chemical cleaning with a green chemical to remove the remaining residual soil (5-25%).

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Reference: Howitt, R. E., Kaplan, J., Larson, D., MacEwan, D., Azuara, J. M., Horner, G. and Lee, N.S. 2008.The Economic Impacts of Central Valley Salinity. Final Draft, 10-27-08.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 25	Project Title: Extending Knowledge of IPM for Orchard Crops	
Grant Recipient: Department of Pesticide Regulation	**Grant Agreement No.:** SCB10025	**Date Submitted:** December 2013
Recipient Contact: Mark Robertson, PhD	**Telephone:** (916) 324-2451	**Email:** mrobertson@cdpr.ca.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Many orchard specialty crop growers have successfully transitioned to using safer, environmentally friendly pest management practices such as biological control, mating disruption, cultural methods and host plant resistance. These successes contribute to reducing: a) water pollution in our streams, lakes, and rivers; b) health risks among farm workers and consumers of fruits and vegetables; and c) volatile organic compounds (VOC's) in our air. Ideally, these economically and environmentally effective pest management practices should allow risk-adverse consumers to feel safer about their orchard crop purchases as well as promote further adoption of integrated pest management (IPM) by conventional growers . However, barriers still remain, which include:

- Inaccurate perception by public that these practices are high risk
- A lack of familiarity among conventional growers regarding the use and efficacy of many of the lower risk practices.

To address these barriers, the goal of this project was to collect first-hand accounts of IPM from a wide range of stakeholders and present these testimonials via a website of informational videos, interviews, surveys and resources. The website will serve to assist orchard crop growers and consumers to recognize that pests can be managed economically, while reducing risk to the environment and human health.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Website Activities and Development:

Videos: The website for this project can be found at http://ucanr.edu/sites/OrchardIPM//. It is housed on the University of California (UC), Agriculture and Natural Resources server, and managed using Site Builder 3.0, software created by the Communication Services Web/IT team. The IPM information and experiences contained in the website are relevant to a wide range of specialty orchard crops, including almond, apple, apricot, cherry, nectarine, peach, pear, pistachio, plum and walnut. The website contains a video library highlighting an extensive, detailed subject video about a target sensing sprayer, the Smart Sprayer, as well as

7 interviews with researchers, 10 interviews with educators, 9 interviews with IPM consultants and growers ("Users of IPM"), 6 interviews with registrants and innovators of IPM ("Facilitators of IPM"), and 3 interviews with other groups of stakeholders ("Those Benefiting from IPM"). In total, the website contains 36 videos.

Surveys: In addition to the video library, the website contains an orchard IPM survey section. This section has links to 3 surveys and current results relevant to 4 orchard crops: peach, nectarine, walnut and cherry. The peach and nectarine were combined into one survey due to similarities in pest management. The purpose of these surveys was twofold:

- The first goal was to increase the sharing of experiences regarding how well various IPM practices work on different crops, pests or regions. Using the surveys, growers can anonymously answer questions on a wide range of IPM practices regarding how effective they feel each practice is. They can use the numerous text boxes to add their own insights or commentary, which will then be posted to the website to serve as a type of forum. In addition, results can be viewed to see graphical summaries of how their answers compare to the responses of other growers. Finally, results and analyses from past surveys conducted prior to the grant can also be reviewed.
- The second goal of the surveys was to implement a 'Citizen Science' project, where growers can contribute their real time experiences to be used in future decision making and prediction tools that can assist in anticipating pest problems and recommend effective options. Grower-generated data can greatly complement data generated through experimental research, as it can better reflect actual field scale production experiences. Surveys will continue to be offered for each year, and spatial and temporal analyses of the data will be posted when available.

IPM information: To further increase the sharing of IPM knowledge, the website includes two sections with links to numerous IPM projects that promote outreach and education; The Pest Management Alliance results section contains links to grants funded by CDPR since the late 1990s. The final reports of each of these projects can be downloaded, providing a wealth of information regarding many effective IPM programs for various orchard crops. In addition, the Pesticide Reduction Success section provides a summary of a stone fruit project that was successful in implementing use of a target sensing sprayer, pheromone mating disruption and use of horticultural oil, without organophosphate pesticide, as a dormant season spray.

Economic Information: Finally, an IPM Cost Information section was included to help growers estimate costs and benefits of IPM practices as compared to conventional pest management. In addition to an extensive report on the economics surrounding multiple IPM practices prepared for the Central Valley Water Board by team members in 2010, additional links were included to economic sources for biological control, hedgerows, pheromone mating disruption, smart sprayers and financial assistance opportunities.

Outreach:
Postcard: A post card summarizing the website and surveys was printed and mailed to all orchard crop growers with valid mailing addresses on file with their Agricultural Commissioner in May 2013 and again in

Post Card:

early June 2013. A QR code was included on the post cards to allow growers easy access to the website.

UC IPM Collaboration: In addition to the postcards, UC IPM included links to the project website via surveys on their UC IPM online website at the bottom of relevant crop pages in the 'More Information' section. Also, UC IPM drafted short blurbs about the survey and video website to forward to Farm and IPM Advisors via various UC Blogs.

California Department of Pesticide Regulation (CDPR): The CDPR announced the website and surveys via its official Facebook page and a press release. Videos are continually being added to its website via a playlist on the CDPR YouTube channel.

Publication: Finally, an announcement of the website and website content was published in the newsletter of the Association of Natural Biocontrol Producers, Volume 10 Issue 2.

Data Analyses: Website metrics including counts of website, survey, and video visits were gathered. Survey responses were automatically analyzed and posted to the web in real-time after each survey submission. Further analyses of survey content and comments will be posted to the web when a sufficient number of survey responses have been gathered. Economic data were gathered and posted on the website in the IPM Cost Information section.

Significant Contributions: Marshall Johnson (UC Riverside) and Andrew Molinar (UC Kearney Agricultural Station) had lead roles in the creation of the videos, including subject matter, recording and editing. Walt Bentley (UC Davis) has provided significant technical IPM advice to the project and was the main narrator in videos. Marshall Johnson plans to complete more videos for the website in the future. Jeanette Warnert (UC Kearney Agricultural Station) had the lead role in designing the layout of the website and uploading the various informational components for public viewing. Jeanette plans to continue being the webmaster for this site after the grant period has ended. Kimberly Steinmann (CDPR) had the lead role in designing the surveys to serve as an interactive forum for citizen science. Kimberly plans to continue updating the survey annually after the grant period has ended. In addition, Kimberly Steinmann has had the lead role in designing and mailing a post card announcement of the website. The entire team has provided continual feedback and suggestions on all aspects of the website and outreach.

Changes in Project Approach: Thirty four videos were planned—4 subject videos and 30 interview videos. Due to time limitations that arose after a delay in subcontract negotiations, 5 interview videos were substituted for three of the subject videos. These 3 subject videos are still in progress and are expected to be uploaded in the near future. Due to the success of outreach efforts, 35 interviews were completed, 5 more than the 30 initially proposed for the project. The delay in the videos resulted in a delay in outreach of the surveys and website as well, since CDPR did not want to direct the public to an unfinished website. The delay prevented the surveys from being available to the public for a long enough time period to generate sufficient data for analyses by the end of the grant period. Currently there have been a total of 7 responses; however, UC IPM has put links to the surveys on their UC IPM Online website on relevant crop pages in the 'More Information' section. UC IPM also plans to forward blurbs about the survey and video website to Farm and IPM Advisors via various UC Blogs. CDPR expects this outreach effort to generate more responses. Finally, the contracting delay prevented announcement of the website at the planned outreach events. In place of these events, notifications via post cards were sent to all California orchard growers in two successive mailings, with the expectation that the medium of direct mail has reached an even greater audience than the previously planned outreach events.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Goal 1: *Increase knowledge and use of IPM by pest management professionals and growers of orchard crops*

Videos: Although time delays required project approach adjustments to video content, the project exceeded its overall goal of 34 videos with a total of 36 IPM videos uploaded for public viewing. (See table below)

- **Interviews:** Thirty five video-recorded testimonials on the value of IPM in California orchard crops were completed, 5 more than the 30 interviews expected at the time of contract execution. Those IPM interviews were produced, edited and uploaded to YouTube for public viewing: 7 Researchers, 10 Educators, 9 Users of IPM (growers and consultants), 6 Facilitators of IPM (registrants and innovators) and 3 groups falling into the last category, "Those Benefiting from IPM", http://ucanr.edu/sites/OrchardIPM/Video_Library_875/ .

- **Subject Videos:** The subject video "On Target: Reducing Pesticide Drift and Runoff Using a Smart Sprayer" was completed and is on the website for viewing, http://ucanr.edu/sites/OrchardIPM/Video_Library_875/Topics/
  Videos expected be completed in the future include: 1) Why practice IPM in orchard crops; 2) Monitoring for arthropods in orchard crops; 3) Biological control by natural enemies; 4) Conserving effective natural enemies in orchard systems; 5) How and why mating disruption works; and 6) Use of cultural controls to suppress orchard pests.

Video views: Number of times each video was viewed as of September 2013

Video	Views	Video	Views	Video	Views	Video	Views
Yokoyama	72	Gallagher Horton	63	Zalom	9	Nay	1
Walse	45	Smart Sprayer	192	Wunderlich	15	Burrow	3
Larsen	56	Abbott	5	Boyd	15	Norton	2
Sparks	33	Hester	7	Weir	3	Marrone	5
Goodell	235	Thompson	10	Beede	2	Klassen	3
Molinar	47	Pickett	9	Carroll	2	Weddle	6
Krugner	52	Ohmart	8	De Boer	2	Long	2
S. Johnson	74	Fichtner	9	Nydam	1	Batkin	1
Morrow	43	Grafton-Cardwell	8	Stewart	4	Jones	3

Post card announcements: A post card promoting the website and surveys was mailed to 5,425 orchard crop growers in California in May 2013 and again in early June 2013 for a total of 10,850 cards. This number represents essentially all orchard crop growers who had a valid mailing address on file with their Agricultural Commissioner. The post card described the website as a place growers could hear about the latest IPM tools and practices that California growers are using to increase profitability and market share, while remaining sustainable stewards of the land as well as a place where they could share their own opinions and observations. In addition to the URL and contact information, the post card included a QR code for easy access to the website. While the time delay prevented presenting at planned outreach events, the post cards were able to reach a much larger and diverse audience.

Economic Data: The cost of IPM practices relative to conventional practices can be an important consideration to adoption. Although costs can be highly variable, a number of resources and information was included where growers can get a general idea of the material and labor costs of various IPM practices. In addition, Comparative cost estimates between conventional and IPM practices links to a report completed by team members in 2010, which details cost benefit analyses for multiple best management practices (BMP) and IPM practices.

Survey data: Peach and nectarine, Walnut and Cherry surveys are available on the website. The questions in these surveys are specific to the 2012 growing season. Currently, summaries of the responses are available via links on the website. Thus far, there have been 7 responses (6 for the peach/nectarine survey, 1 for walnut, 0 for cherry), but an increase in response is expected in the future given UC IPM’s recent assistance in outreach. Surveys for the 2013 season will be added to the website during winter 2013. In the future, the hope is to add more orchard crops. Once there is sufficient data or commentary, analyses and comments will be posted to the website.

Goal 2: *Increase consumer confidence in product quality and environmental stewardship in orchard crops*
Increasing consumer confidence is a long term goal of this project. The videos offer a diverse assortment of IPM perspectives through an accessible, enjoyable medium that will hopefully appeal to the general public as well as growers. The hope is to have raised public awareness of the site through collaborative outreach with CDPR and UC IPM; two organizations that are valuable resources for the segment of the general public with high concern about pesticide issues.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project’s accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project’s accomplishments and/or the potential economic impact of the project.

The direct beneficiaries are all California specialty orchard crop growers (approximately 14,000 producers) who can benefit from learning about new IPM tools and potentially gaining increased market share as the general public improves their understanding of IPM as a low risk agricultural solution. In addition, the consumers of specialty orchard crops benefit from increased confidence in the safety of their produce as they better understand IPM and as IPM increases in adoption.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

One challenge this project faced was the loss of time due to contracting issues. Because this was the first grant of its kind awarded to CDPR, and because of staff shortages at CDPR and UC Riverside it took longer than anticipated to execute the grant agreement. A better understanding of the process will help avoid delays in executing the grant agreement.

Delays in filming occurred as the project team discovered additional supplies were needed to meet the expected levels of professionalism desired in the video production. Additionally, initial editing of the first few videos took longer than expected; however, editing experience was gained through practice and learning. To avoid these issues, CDPR would recommend more extensive consultation with other experts in video production be conducted to better understand the aspects of video production.

Busy schedules of interviewees, long travel distances, and complicated set up procedures caused greater delay than had been expected in regards to completing interview videos. To avoid these challenges, CDPR found that using a few rooms in different regions that could be used for multiple interviews in a row solved many problems. Thus, interviewees did not have to drive long distances, the room met professional lighting and audio standards, and set up/take down time was minimized by having multiple interviews in one day.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 26	**Project Title:** Assessing Growers' Needs to Accelerate Adoption of Beneficial Management Practices in Specialty Crops	
Grant Recipient: American Farmland Trust (AFT)	**Grant Agreement No.:** SCB10026	**Date Submitted:** December 2013
Recipient Contact: Victoria Edwards, CFO/COO	**Telephone:** (202) 378-1214	**Email:** vedwards@farmland.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.

If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Project Purpose: California agriculture supplies more than half of the fruits, vegetables, nuts and other specialty crops consumed in the United States and a good deal of the nation's exports of these crops. The state's Mediterranean climate, one of only five such growing regions in the world, is ideal for producing these healthy foods. And California growers have taken advantage of it, along with massive public and private investments in irrigation water supplies, to increase their annual production of specialty crops to $20 billion on just 5.4 million acres of farmland (roughly 5 percent of California's land area).

This success has not come without costs. Among these are the environmental impacts of the California agriculture, in particular the impacts associated with the use of irrigation water and plant nutrients (fertilizers). As a result of the depletion of natural stream flows, ground and surface water pollution, and concern about greenhouse gases, government regulators and consumers are calling for greater accountability on the part of growers for reducing the environmental impact of agriculture.

A significant number of California growers have risen to the challenge by improving irrigation efficiency – getting more "crop per drop" – and applying nitrogen fertilizers more carefully and precisely so that less runs off into streams or finds its way into underground aquifers. But the adoption of such beneficial farm management practices is not as widespread as it could or should be if California agriculture is to continue to contribute to national food security while helping to maintain a healthy environment for all Californians. The purpose of this project is to better understand the factors affecting specialty crop growers' decisions related to implementing beneficial management practices (BMPs), particularly barriers to their adoption, but also motivations for adoption and their decision-making process. Many proven BMPs have been developed and are available to specialty crop growers. However, they have not been adopted as widely as they could or should be to improve both environmental performance and the economic position of growers. As environmental regulations become stricter and more purchasers in the supply chain demand higher environmental standards from growers, it is becoming increasingly important for growers to overcome the barriers to BMP adoption. Prior research into barriers to BMP adoption has not focused specifically on specialty crops in California or other regions where they predominate. AFT's research will benefit from the findings, but will break new ground by focusing specifically on specialty crops. By disseminating the project findings to those who provide technical and financial assistance to specialty crop growers, including government agencies, not-for-profit organizations, technical service providers and commodity groups, AFT will facilitate and encourage the adoption of BMPs by more of these growers. The project findings will also be used to design new strategies, incentives, technical assistance and risk management tools to expand grower adoption of BMPs.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Project partners including the California Association of Resource Conservations Districts (CARCD), the California Farm Bureau Federation (CFBF), Western Growers Association and Sustainable Conservation were consulted on the design and implementation of the project. The team decided to conduct both a survey to gather quantitative data and a series of structured focus group discussions to achieve a more in-depth understanding of growers' behavior. The survey was developed and reviewed by the partners and by experienced survey developers and conductors and then tested by having 20 growers and 30 crop consultants take the survey during the November 2010 Fertilizer Research and Education Conference in Fresno, California. At the same time locations for focus groups were identified by working with CARCD, CFBF, local Resource Conservation Districts (RCDs), and county offices. Instructions were given to local partners to recruit 8 to 12 specialty crop grower participants with the goal of representing the diversity of growers in each area as best as possible, including size, crop mix and approach to farming. Nine focus groups were conducted from October 2011 through June 2012. Partners including Sustainable Conservation, several RCDs, and county Farm Bureaus assisted with recording the focus group discussions. It should be noted that all surveys and focus groups were conducted on a confidential basis to protect growers' identity and allow for open and honest responses. Survey and focus group information was compiled and analyzed and a draft report was prepared from July 2012 to January 2013. The draft report was reviewed by participants and finalized in April 2013. The report was posted to the AFT website and directly emailed to more than 450 people. 500 printed copies were made with more than 300 distributed to date. Outreach efforts were conducted by presenting the results at meetings including the CARCD annual meeting, the California Roundtable on Agriculture and the Environment, the California Roundtable on Water and Food Supply, and to the Agricultural Water Quality Alliance. Individual meetings were held with CFBF leadership, the CARCD Executive Director, the Secretary of Food and Agriculture, and numerous industry and environmental stakeholders. Since the report was delayed by one year – primarily by the unavailability of specialty crop growers due to weather-related changes in their growing operations – there was not time to measure the extent of use of the focus group information and how effectively it is translating into greater adoption of BMPs. However, an additional outreach effort that included a workshop on improving grower incentives to support adoption of BMPs was held on June 25, 2013. A summary of that workshop is included with this final report and is posted to the AFT website and distributed to the same email list used to distribute the survey and focus group report.

The survey and focus group discussions were, to AFT's knowledge, the first comprehensive investigation of the motivations, barriers and processes of adoption of irrigation and nutrient BMPs by specialty crop growers in California. The survey and the focus group questions are now available for others to use as templates for further investigations into specialty crop grower behavior.

The survey was completed by 78 growers and 35 crop consultants and other technical assistance providers. 58 growers participated in the nine focus groups conducted in various regions throughout California.

AFT's research found that the three most important grower motives for adopting new BMP are reducing production costs, improving crop yield and/or quality and improving competitiveness. Improving the environment is also important to them, but as a secondary motivation. To AFT's surprise, regulatory requirements and the demands of buyers in the food value chain were cited less frequently as reasons for adopting BMP.

The three most important barriers to specialty crop grower adoption of BMP were the up-front costs – by a large margin – followed by risk of diminished crop yields and/or quality and, finally, lack of information about BMP or the unavailability of technical assistance. Up-front costs appear to be an especially significant obstacle because AFT's research also found that the overwhelming majority of growers self-finance implementation of new BMP rather than seeking funding from commercial banks or government cost-share programs.

Specialty crop growers recommended that BMP adoption could be accelerated if they had better access to timely information from trusted sources concerning all aspects of irrigation and nutrient management. They are interested in the potential impacts of BMP on crop yield and quality, how easily BMP would fit into their existing operations, what equipment would be needed and at what cost, how much training would be needed for them and their field workers, what type of outside service might be required to implement BMP, how easy it would be to scale up BMP across their farming operation and what regulatory implications might be associated with adopting BMP.

To remain competitive, growers are willing to assume some financial risk associated with BMP adoption. A common risk management strategy among those who have experimented with new BMP is to apply the practices on a small scale in collaboration with technical assistance providers; then, once the grower is comfortable with the new practice and its results, expanding it to whole fields and eventually across their operation. In general, growers are unfamiliar with, but interested in, strategies that combine technical assistance with risk reduction through indemnification for potential crop yield and/or quality loss.

As a financial incentive to BMP adoption, growers recommend tax incentives more often than cost-share programs. They would also like to have the market recognize and reward BMP adoption, for example, through ecosystem services credits or buyer contract preferences. Finally, growers also recommend greater collaboration from regulators to reduce reporting requirements while supporting BMP adoption.

A BMP Adoption Support Summit was convened at the USDA-Natural Resource Conservation Service (NRCS) Office in Davis, California on June 25, 2013 that included 21 participants representing growers, private technical assistance providers, UC Cooperative Extension, environmental organizations and water quality regulators. A summary of the proceedings was prepared. Findings included that communications with growers needs to be tailored and targeted to meet their needs; that having empirical performance data is essential; that private consultants are key technical assistance providers; that better organized, timely, accessible and targeted information is needed; and that a diverse suite of financial incentives should be available.

The following collaborators provided invaluable support by providing guidance during project design and implementation; by reviewing the survey and focus group questions; by identifying grower participants, and providing focus group venues; and by assisting in recording the focus group sessions, and reviewing the draft report:

California Association of Resource Conservation Districts and participating local Resource Conservation Districts
- Yuba Sutter RCD
- Sotoyome RCD
- Cachuma RCD
- East San Joaquin RCD
- Westside RCD
- North Kern RCD

California Farm Bureau Federation and participating county Farm Bureaus
- Yuba County
- Sonoma County
- Santa Barbara County
- Monterey County
- San Joaquin County
- Fresno County
- Kern County

Western Growers Association

Central Coast Agricultural Water Quality Alliance
California State University Fresno – California Agricultural Technology Institute
Kings River Conservation District
University of California Davis – Agricultural Sustainability Institute
United State Department of Agriculture – Natural Resources Conservation Service
Sustainable Conservation

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Nine out of 10 focus groups were conducted. 78 growers completed the survey. 58 growers participated in focus groups. A report was completed with good quantitative data as well as good qualitative information providing new and in-depth insight into specialty crop growers' decision-making process when considering adoption of new BMPs. Extensive report distribution resulted in many discussions with stakeholders interested in improving grower support for BMP adoption. A Strategic Planning Summit Meeting to improve support to growers to facilitate more rapid and extensive BMP adoption was convened and successful in building momentum for collaboration to improve services to growers.

It took much more time, much more communication, and many more phone calls and emails to get growers to attend the focus group sessions. Late spring rains in 2011 forced delays to setting up focus group meetings. Therefore, nine rather than 10 focus group meetings were held and only 58 growers were interviewed. The delay drastically shortened the time for the report to be studied and used to improve grower support systems for BMP adoption. Therefore, it was more difficult to assess how extensively the report recommendations were used. Although all goals were not achieved, based on the response the report received during the three months since its release, and the strong attendance and commitment obtained from partners at the Strategic Planning Summit, it is apparent that the project has had a substantial and beneficial impact that will lead to improved support to specialty crop growers for implementing BMPs.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

By informing the technical and financial support community of growers' ideas and thoughts on how and why they adopt new BMPs, both the growers and the support partners will benefit by achieving more rapid and wide-spread adoption of BMPs, resulting in improved water, air and soil quality. Additional grower benefits are reduced costs and improved compliance with environmental regulations. The information compiled from the focus group sessions and provided in the project report is an effective means of conveying grower recommendations to the support community.

There are about 50 thousand growers who produce specialty crops on 5.4 million acres of California farmland. With an improved support system, long-term growers will benefit from adopting new BMPs in at least three ways: first, a potential market advantage with purchasers in the supply chain who are demanding improved environmental performance from specialty crop growers; second, improved regulatory compliance and a corresponding reduction in potential liability for violating environmental laws; and third, potential reductions in input costs, e.g., fertilizer, water, etc., contributing to growers' bottom line.

The general public will also benefit from the improvement in environmental performance resulting from expanded adoption of BMPs by growers. Specifically, expanded BMP adoption should result in better water and air quality, improved wildlife habitat and populations and more efficient use of energy and water resources.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The lessons learned from analyzing the grower surveys and listening to them carefully during the focus groups are many.

- It is very difficult to get growers to a meeting and away from their farming operation, even in the winter time and with assistance from the local agricultural community leaders.
- Growers want empirical information, hard data to make informed decisions. They do not trust indirectly generated data such as those generated by environmental or economic models.
- Growers are as varied as the general population and therefore need targeted communication and education strategies tailored to their farming operation and their approach to farming. This is probably the most important finding of AFT's work.
- While growers are primarily motivated by increasing crop yield and reducing costs, improving the environment is also important to them. To AFT's surprise, regulatory requirements and the demands of buyers in the food value chain were cited less frequently as reasons for adopting BMP.
- The overwhelming majority of growers self-finance implementation of new BMP rather than seeking funding from commercial banks or government cost-share programs. Therefore, while AFT failed to suggest tax credits as economic incentives for BMP adoption, growers were quick to suggest it.
- Specialty crop growers want better access to timely information from trusted sources that is targeted to their needs. While some were hesitant to share information with peers, most wanted expanded opportunities to share information and collaborate with other growers.
- Growers value technical assistance and use small-plot trials to gain knowledge and then, if comfortable, scale it up gradually. AFT was surprised to learn that a significant number of growers (approximately 30%) were not familiar with USDA-NRCS or RCDs and the technical assistance they provide.
- Growers would also like to have the market recognize and reward BMP adoption, for example, through ecosystem services credits or buyer contract preferences.
- Growers recommend greater collaboration from regulators to reduce reporting requirements while supporting BMP adoption.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Attachment: "Encouraging California Specialty Crop Growers to Adopt Beneficial Management Practices for Efficient Irrigation and Nutrient Management - Lessons from a Producer Survey and Focus Groups"

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 27	**Project Title:** Correcting Misconceptions About Pesticide Residues	
Grant Recipient: Alliance for Food and Farming	**Grant Agreement No.:** SCB10027	**Date Submitted:** December 2013
Recipient Contact: Marilyn Dolan	**Telephone:** (831) 786-1666	**Email:** mdolan@foodandfarming.info

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The project objective was to correct the misconception that some fresh produce items contain excessive amounts of pesticide residues. Claims about unsafe levels of pesticides have been widely reported in the media for many years, but have largely gone uncontested. Continued media coverage of this misleading information is damaging to producers of California specialty crops and may also have a negative impact on public health. Utilizing sound science backed by a team of nutrition and toxicological experts, the Alliance for Food and Farming (AFF) set out to provide the media, the public and various target audiences with information about the safety of fresh fruits and vegetables. The goal was to generate more balanced media reporting and change public perception about the safety of produce when it comes to pesticide residues.

Media reports are simple and easy for consumers to understand. In the past, media did not present an alternative view. The result worked to create concern among consumers about the safety of fruits and vegetables. Nutritionists and dieticians have begun to see a trend for people to reduce their consumption of fruits and vegetables because they cannot afford an organic alternative. The high level of concern among consumers about pesticide residues, coupled with the emerging trend of reduced fruit and vegetable consumption was becoming increasingly concerning for California producers of specialty crops.

The project's objective was to provide the media and other communicators with fact-based science on the topic of pesticide residues and encourage them to insert more balance in their reporting on this issue. The ultimate messaging of this campaign was to encourage increased consumption of healthy fruits and vegetables by assuring consumers that both conventionally and organically grown fruits and vegetables are safe and nutritious.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

All activities associated with the Specialty Crop Block Grant Program (SCBGP) project were designed to provide science-based information to media, consumers and other audiences to ease common fears about pesticide residues. The primary vehicle used to house and disseminate this information was a website www.safefruitsandveggies.com. Throughout the grant period, information was continually added to this website to provide science-based information in an easy-to-use format. One of the most important tools created as part of the grant program's activities is the Pesticide Residue Calculator, an interactive means of illustrating just how small pesticide residues really are when they are found on fruits and vegetables sold in the United States. Web analytics continue to show this Pesticide Residue Calculator is the most popular and most-often visited section of the website with 61 percent of the total visits directed to this feature. Other tools added to the website during the grant period include: a database of research projects; a series of videos featuring farmers and other experts who answer common questions about produce safety and farming; a news video depicting children faced with the very large amounts of fruits and vegetables described in the Pesticide Residue Calculator that could be eaten without any impact from pesticide residues that may be present; and a regular blog featuring news and information about the nutrition and safety of produce.

The SCBGP funding was also able, in part, to fund research providing information on the topic of pesticides. Research reports developed included: a peer-reviewed, published paper on the benefits of eating fruits and vegetables in reducing cancer; an analysis of long-term pesticide use trends in California; and a report called "Scared Fat," in which a panel of experts review consumer research examining attitudes and fears concerning the safety of eating fruits and vegetables that results from media coverage about pesticide residues.

Throughout the grant period, AFF project managers utilized research reports and web-based tools to respond to media reports on pesticide residues and to proactively provide the media with news and information on this topic. Over the course of the grant, over 30 press releases were written and distributed to encourage media to carry balanced reporting and bring consumers useful information on the topic of pesticide residues. Countless interviews were also conducted with reporters and opinion pieces were developed and published.

In addition to news and written releases, the AFF and its experts met face-to-face with media reporters to talk about the issue of produce safety and pesticides. Visits were conducted with media reporters in the major markets of Los Angeles, Chicago and Washington DC and a series of meetings was held with media in New York. In every instance reporters expressed appreciation for the information and the AFF became a regular source of information for many of these reporters in their coverage of pesticide residues.

Throughout the grant period AFF staff conducted daily monitoring of media stories looking for trends in the kind of information carried in the reports on pesticide residues and looking for evidence of more balance. Final results of this media monitoring is included in the next section.

In addition to media, grant activities also extended to registered dieticians and nutritionists. Presentations were made by AFF staff and experts at the following conferences: American Dietetic Association Nutrition News Forecast Conference, April 2011; Food Marketing Institute Consumer Affairs/Communications Conference, October 2011, American Dietetic Association Michigan Chapter Conference, April 2012; Society for Nutrition Education & Behavior Conference, July 2012; and the Produce for Better Health Foundation Supermarket Dieticians Summit, October 2012. Three webinar sessions were also held for registered dieticians. These activities allowed the AFF information to reach hundreds of health experts and their clientele with science-based information on produce safety.

AFF began a program to utilize data that analyzes and monitors Internet conversations concerning pesticide residues on fruits and vegetables. This information was then used to develop an effort to insert key campaign messaging into social media channels. These activities provide a thorough analysis of social media channels and resulted in a content strategy that will be used to expand social media reach in the future as the AFF continues in its efforts to become a resource for information on produce safety.

Scientific experts were invaluable resources for providing independent, science-based facts to target audiences, making presentations and serving as spokespeople on behalf of the campaign.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The stated long-term goal of this project is to correct misconceptions about pesticide residues. While not fully realized, this goal will be achieved by providing consumers with better access to science-based information on this topic to help them make informed purchase decisions. Key to achieving this long-term goal is increasing traffic to the Safe Fruit and Veggies website and social media properties. Analytical and monitoring tools give the ability to gather and monitor ongoing conversations occurring in social media channels via the Internet. Since the Internet is now where most consumers conduct their own research on purchasing decisions, it is an ideal place to learn how and where consumers are seeking information about fruits and vegetables and food safety. Data indicates that since the creation of the Safe Fruits and Veggies website, more consumers are being exposed to the campaign's messages. Analysis indicates that since the launch of the Safe Fruits and Veggies website in July 2010, over 45,000 people have visited the site. In addition to the website, AFF created a Facebook page and Twitter account in an effort to reach an even wider audience and attract more users to the website. The Twitter account has 227 followers and the "social authority" -- a measurement used to gauge relevance of the information provided – of this account has grown from a 1 to a 15 in a very short time. The estimated reach and exposure of the Twitter followers is estimated at over 250,000. The Facebook account, which has been in place for several months, now has 371 "likes" and has grown 6 percent in just the past month. The estimated reach of this platform is also much larger as the friends of the fans total more than 137,000 users. The AFF will continue to leverage these social properties to grow its audience and reach. The Data Feed will enable the collection of data for the a six-month period.

The short term goal of the project was to convince the media to include key campaign messages in coverage of the pesticide residue issue so that consumers are presented with an alternative perspective in media stories. Specifically, the goal was to increase the number of stories which carried an alternative view and/or utilized Safe Fruits and Veggies campaign messaging. Progress toward this goal was measured through monitoring and analysis of media reports and Internet conversations. The AFF conducts daily monitoring of media reports on food safety issues. As part of this process, the AFF has quantified the number of times campaign messages have appeared in media reports over the course of the grant period to help determine if the campaign is having an impact on media coverage as compared to pre-campaign coverage using past AFF media monitoring findings as a benchmark.

The progress toward achieving this short-term goal has greatly exceeded expectations. Throughout the course of the grant period, the AFF's media monitoring has shown marked increases in the number of times positive campaign messages and balance has been included in media stories. Media monitoring for the year prior to the grant, which serves as a baseline, recorded 160 stories with none providing an alternative, balanced message. Media monitoring conducted throughout the grant period indicates that when the Safe Fruits and Veggies campaign was launched in July 2010, an increase was immediately seen in articles containing alternative messaging. The number of articles and percent of those carrying messaging fluctuated throughout the grant period, but ran between 20 and 50 percent in terms of those providing balance or utilizing Safe Fruits and Veggies campaign messaging. In looking at media monitoring for the entire grant period, the overall percentage of stories carrying balanced information ended up at 30 percent.

The grant has allowed AFF to provide accurate and credible information to reporters covering this topic in a way they had not seen before and the campaign has provided greater access to alternative messaging via social channels. Thus, the short term goal of increasing scientific-based media information was achieved with this project.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

It is a definite benefit for the California specialty crop industry to reduce the amount of negative news reports involving the healthy, safe and nutritious fruits and vegetables they produce. Consumers are also beneficiaries of this project.

The bottom-line message of the Safe Fruits and Veggies campaign is to eat more fruits and vegetables – whether conventional or organic. Government regulation and testing indicate that both are very safe.

This is a message that is beneficial to fruit and vegetable farmers of all sizes and to consumers from a health perspective.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The most unexpected outcome of this campaign was how quickly the short term goals of this project were achieved. Another lesson learned was the need to provide scientific information to consumers in a way that is simple and easy to understand. At the beginning of this project AFF was convinced that its messages were complex and confusing. As the campaign developed, the messages become increasingly simple. In the end, project staff landed on simple messages: encourage people to eat more fruits and vegetables; read the actual government reports on the safety of produce; seek more information about both conventional and organic options; and that both have been shown to be safe. AFF will continue providing information about the safety of the foods consumers eat in the future, past this grant period.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

See Attachments

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 28	Project Title: California Almond Sustainability Program: Integrating Resource Issues with BMP Implementation	
Grant Recipient: SureHarvest	**Grant Agreement No.:** SCB10028	**Date Submitted:** December 2013
Recipient Contact: Clifford P. Ohmart	**Telephone:** (530) 601-0740	**Email:** cohmart@sureharvest.com

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Almonds have been a financial success story for California agriculture over the past decade, and have an annual farm gate value exceeding $1 billion. Nevertheless, challenges have occurred and continue. These include an increase in farm input costs and the associated need to improve operational efficiencies, concerns about impacts of farming practices on natural resources, additional regulations, more inquiries from almond buyers and retailers about sustainable production practices, and questions about food safety and quality. Realizing these and other challenges and consistent with their “crop of choice, nut of choice” strategy, the Almond Board of California (ABC) worked with SureHarvest to launch the California Almond Sustainability Program (CASP) in 2009. CASP includes the interrelated components of grower and handler self-assessment of practices and metrics, the reporting and interpretation of results, and the application of results for strategic communications, targeted education, and continuous improvement. Funds from a previous SCBGP grant (2009 Project 12) were used to initiate these interrelated components for the first two self-assessment modules, Irrigation Management and Nutrient Management. Modules for Air Quality and Energy Efficiency subsequently were developed using ABC funds. This project complemented and enhanced previous work by: 1) expanding CASP’s scope to include self-assessment content for pest management, ecosystem management, water quality, and soil quality; and 2) increasing CASP participation and providing pest management targeted education via a partnership with the Community Alliance with Family Farmers (CAFF). The execution of this project has helped characterize and progress the sustainability of almond production, and enhance the reputation of ABC and the California Almond Industry as leaders in environmental stewardship and sustainable agriculture.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

A series of project tasks involved the development of self-assessment content for pest management, ecosystem management, water quality, and soil quality. This was achieved by drafting content, assembling two stakeholder committees (almond growers, handlers, ABC staff, UC research and extension personnel, pest control advisors (PCAs), representatives from regulatory and other government agencies, and other experts), holding two face-to-face meetings and one webinar to review and agree on content, and editing and incorporating changes. Other tasks were to partner with CAFF to co-host six workshops for 300 growers and PCAs to collect pest management self-assessment data and present complementary educational information. A related task was to analyze pest management data collected during and after workshops to determine the adoption of Best Management Practices (BMPs) and educational needs (targeted education).

Much effort was devoted to the capture and analysis of pest management self-assessment information to ascertain BMP adoption by California almond growers and targeted education opportunities to expedite improvement. Accordingly, a comprehensive Pest Management module was drafted, reviewed, edited, piloted, and then finalized and printed in 4Q 2011. Growers used the module to assess their pest management practices, which included assessments at 6 CAFF co-sponsored workshops funded by the project. Two CAFF workshops each were held during 4Q 2011 (Yuba City, CA and Woodland, CA), 1Q 2012 (Turlock, CA and Arbuckle, CA), and 1Q 2013 (Bakersfield, CA and Visalia, CA). The workshops were attended by 53 almond growers and PCAs. Feedback from surveys distributed at each workshop indicated that participants generally were satisfied with workshops and acknowledged the importance and benefits of self-assessment activities for individual operations and the greater industry. CAFF workshops alone did not achieve the project goal of 300 new CASP participants. But when combined with results from other CASP activities, 1,051 unique growers and PCAs had participated and 685 assessments had been submitted (226 for the Pest Management module which exceeded the goal of 100) by the end of the project. Of these 1,051 unique participants, 966 were newly added during the course of the project.

Consistent with project tasks for the analysis of assessment data and application of results, statistical analyses of cumulative pest management data have been and continue to be used to provide snapshots of BMP adoption by the California almond industry and to identify educational needs. Although not funded by the project, the development and 2Q 2012 launch of the online assessment and reporting system (includes the Pest Management module for which one hour per year per PCA/applicator of online continuing education was obtained), has been instrumental in accomplishing project tasks for increasing CASP participation and the submission of assessments, and for calculating BMP adoption rates and identifying educational priorities. Using confidential User Names and Passwords, growers and handlers access the online system at https://www.sustainablealmondgrowing.org/. Additional detail about the online system and CASP is available on the ABC and CAFF websites, including a down

loadable copy of the pest management module:
http://www.almondboard.com/growers/sustainability/Pages/Default.aspx and
http://caff.org/programs/bio-ag/almonds/.

Results from project-funded 4Q 2012 analyses of cumulative pest management assessment information (included assessments completed at the first 4 CAFF workshops) supported the selection of content for presentations included in the final 2 CAFF workshops. Presentations included: 1) maintaining and operating pesticide spray equipment to maximize on-target deposition, 2) judicious, environmentally friendly weed management, and 3) relevant technical guidance and cost-share funding by the USDA Natural Resources Conservation Service. Results of analyses also were detailed in 6 posters (including a Pest Management poster) at the 2012 ABC Annual Conference, and via 7 trade articles and ABC newsletters. Because most growers participating in CAFF workshops did not reassess their practices before project completion, analyses to document progress in BMP adoption by growers attending CAFF workshops could not be done. Analysis of all assessment data, however, is underway to quantify statistically significant baseline results for 4Q 2013 publication in the first California Almond Sustainability Report. Albeit after project completion, continual progress in the adoption of pest and other BMPs will be determined and tracked in future years.

Except for professionally printing finished modules, most project tasks associated with the production of self-assessment content for ecosystem management, water quality, and soil quality were achieved. Significant effort resulted in the drafting, reviewing, and refining of an Ecosystem Management module and additional water and soil quality BMPs. Because many practices relevant to water and soil quality exist in current modules, ABC leadership decided to minimize duplication and not produce new modules for water and soil quality, but instead integrate additional complementary practices into revised and retitled Nutrient Management and revised Pest Management modules for printing and being available online in January 2014. By doing this and configuring the online system to generate grower-specific and industry-wide cross-module reports, the full complement of pertinent practices for water and soil quality will be conveyed and assessed, and adoption rates measured. ABC and partners are committed to the evolution and long-term success of CASP, which includes measurements of progress in BMP adoption and the printing of the new Ecosystem Management module and revised and retitled Nutrient Management and revised Pest Management modules not completed during the project.

Key project partners were ABC and CAFF. ABC leadership and staff provided invaluable contributions via matching funds for developing and reviewing self-assessment content, helping arrange and facilitate workshops, and assisting with the evaluation and dissemination of results. CAFF assisted with workshop logistics, recruitment, facilitation, and evaluation. Other partners included the two stakeholder committees (growers, handlers, ABC staff, UC personnel, pest control advisors (PCAs), representatives from regulatory and other government agencies, and other experts) who reviewed draft versions of self-assessment content.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Project goals were: 1) develop and print a Pest Management module; 2) work with CAFF to conduct six events for 300 almond growers and PCAs to secure 100 pest management assessments, provide targeted education, secure feedback from surveys, and measure progress in the adoption of pest management BMPs by participants; 3) develop and print an Ecosystem Management module; and 4) develop and print Water Quality and Soil Quality modules. The comprehensive Pest Management module was drafted, reviewed, revised, and then printed in 4Q 2011. Although attended by only 53 growers and PCAs, the six CAFF co-sponsored workshops involving pest management assessments, targeted education, and surveys were achieved. The cumulative number of pest management assessments collected by all CASP activities during the project timeframe was 226 (exceeding the goal of 100). Moreover, efforts have contributed significantly to the CASP participant total of 1,051 unique growers and PCA participants at project termination. Each CAFF workshop included targeted education and participant surveys per project goals. Progress in the adoption of pest management BMPs by CAFF workshop participants could not be measured because of few repeat participants. Data collected, however, is supporting the ongoing analysis and generation of results for statewide baseline adoption rates to be published in the 4Q 2013 California Almond Sustainability Report. Progress against these baselines will be quantified with future efforts. Except for adding several educational sidebars and printing, project goals for the development of assessment content for ecosystem management and water and soil quality have been done and will result in professionally printed Ecosystem Management and revised Nutrient Management and Pest Management modules and will be available on the CASP program website listed above after January 1, 2014.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Key beneficiaries include individual almond growers and handlers, the California Almond Industry, and ABC. Through the process of developing and applying the Pest Management module and being exposed to associated targeted education, growers were and will continue to be able to systematically review their operations to improve efficiencies, increase profits, and enhance environmental protection. The California Almond Industry and ABC have and will continue to benefit by being able to share definitive information about CASP and grower adoption of BMPs with commercial, regulatory, public policy, and consumer stakeholders. Having and sharing this information is crucial to ABC's "crop of choice, nut of choice" strategy and has important economic implications. Moreover, ABC has benefited by demonstrating and reinforcing their commitment to innovation and delivering value to growers and handlers. The people and environment across California have and will continue to benefit from the improvements in natural resource conservation generated from project achievements and the continued execution of CASP activities.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

A key lesson learned/reinforced is the difficulty and rewards in developing and executing agricultural sustainability programs. Organizations and their constituent growers and processors can be reluctant to invest effort in self-assessment and related activities because of misunderstandings and/or lack of clarity about program intent and value. Growers typically require hands-on experience to appreciate the value of sustainability programs. The delay in securing adequate participation and pest management assessments during this project confirmed these challenges and understandings. After experiencing workshops, nearly all participants enhanced their appreciation of CASP and its benefits. Another lesson learned/reinforced is the importance of having an online system to enter, report, and manage assessment data and participation statistics. The unanticipated delay in the design and implementation of the online system delayed the completion of some project tasks. After system implementation, participation and assessments increased and data was processed more effectively.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Attachments:

- Pest Management module
- Nearly finished Ecosystem Management module
- Lists of the additional practices for water and soil quality
- Example flyer for CAFF co-sponsored workshops
- Pest Management poster displayed at the 2012 ABC Annual Conference

Project 29 - Valley Fig Growers (VFG)

Final Performance Report

ProjectTitle
Developing New Fig Products to Increase Grower Returns

ProjectSummary
The VFG based in Fresno, California, represents 25 fig growers and over 50 percent of all California dried fig sales. Historically, well over half of the California fig crop has gone into low-value bulk fig paste. Cost pressures from imported pastes (Greek, Spanish and Turkish) have resulted in very poor grower returns for figs, and as a direct result nearly half of all the commercial fig trees in California have been pulled out since 1997. In order to preserve the remaining fig orchards and provide the growers a return that allows them to continue to farm these orchards, a product needs to be developed which profitably utilizes fig paste.

ProjectApproach
When the Specialty Crop Grant (SCG) application process was announced, VFG contacted Pete Mattson, Mattson Incorporated to ascertain a role in this proposal. Mattson Incorporated is considered the premier food development company in the United States and Mr. Mattson has a soft spot in his heart for California agriculture and cooperatives. When Mr. Mattson agreed to take on the project of researching additional uses of fig paste quality figs, Linda Cain completed and submitted a SCG application on behalf of VFG.

Once the grant was awarded, VFG had an official "kick-off" meeting with Mr. Mattson and his team in February 2011. During this meeting, VFG President, Chief Financial Officer, Vice President of Industrial Sales and Vice President of Consumer Sales and Marketing were present. The VFG reviewed with Mr. Mattson and his team the opportunities and constraints of selling paste quality figs. Mr. Mattson shared with VFG the market opportunities for products made with figs.

Based on these discussions, six new fig product line concepts were presented to VFG on March 8, 2011. The goal was to hone in on a product that had the ability to add 20 to 30 percent in revenue potential within 18 to 24 months of being introduced.

Objectives included:
1. Have a product prepared to market/manufacture by the end of 2011.
2. Achieve pro forma increase in grower returns of 25 percent.
3. Little to no fixed capital requirement.
4. Provide compelling concepts and prototypes that appeal to consumers and co-packers.

In April 2011, Mr. Mattson and VFG determined which two of the six concepts to move forward with based on internal research. The criteria were set up for consumer research panels to test these two items. In May 2011, the two concepts were expanded upon to include multiple flavors and choices for consumers. Over 500 online consumers were selected to participate in this study; consumers were selected based on established criteria. The 500 were exposed to the product concepts and responses were tabulated reflecting the popularity of the two concepts. Once the concepts were vetted, 300 consumers were selected in June 2011 to assist with further testing. The group of 300 was broken into two groups of 150 each, and each group was provided live product samples.

The two concepts that were tested included a fruit (fig) and nut bar, and a fruit nugget. The fruit and nut bar was a huge hit with consumers, hitting a top box of 49 percent and a top two box of 81 percent for purchase intent. These scores are extremely high and well in excess of feedback norms. Additionally, nearly 90 percent of respondents indicated they would buy the product at least once a month; a very robust number.

Also performing well was the fruit nugget (yo-fruit). This item was remarkably successful with consumers too, scoring a top box of 49 percent and a top two box of 82 percent for purchase intent. The raspberry, blueberry and strawberry flavors were most desired (in this order).

Mr. Mattson was very excited about these very positive results and encouraged VFG to explore a product launch. Simultaneous to these results, VFG secured a long term contract with a key buyer for paste quality figs. In addition, the international market for VFG California figs grew dramatically due to the addition of new markets, a new agent and new products available, while the 2011 crop came in below the forecasted tonnage. All these factors combined to dramatically reduce the availability of the paste quality figs that had been so abundant in prior years. Due to the sudden reduction in available inventory of paste quality figs, VFG has put a temporary halt on further production plans for these items.

The VFG is confident that the fruit/nut bar and the fruit nugget are two winning products that can be taken to market when the inventory situation for figs improves, likely in 2013 or 2014. In the interim, VFG has discovered an array of solutions, which will allow VFG to dig out of excessive inventory issues. The stakeholders and industry supporters of this project will reap the benefits of the product launches when they occur, and are currently enjoying the benefits of other VFG efforts to strengthen the fig paste market.

Mattson Incorporated, the food product design and research company hired to spearhead this project, did an excellent job defining the opportunity, developing products that fit the needs criteria, and ably performed the research needed to quantify the opportunity. In particular, Kathy Westphal and Mr. Mattson were critical to the success of this project. Gary Jue and Ms. Cain were instrumental in driving the project from the VFG side.

GoalsandOutcomesAchieved

The stated goal of "create a major incremental business with the ability to add a minimum of 20 percent in revenue within two years of introduction" seems reasonable given the excellent consumer research feedback. According to Mr. Mattson, the fruit/nut bar and the fruit nugget performed better than 94 percent of similar items that Mattson Incorporated have tested.

These fig bars and nuggets provide VFG the option of either producing and selling them, or licensing the final product to a co-packer.

Although two new products utilizing fig paste were developed, tested and approved for production, no surplus fig paste was available to produce the new products. Therefore, it is not possible to determine an increase in value-added sales of fig paste based on the new products developed in this project. However, when a surplus of fig paste occurs, the growers will be in a position to begin production of the new products and begin increasing value-added sales.

Growers experienced record returns in 2011 – grower returns on paste were forecasted to rise 47% from 2007 levels. Similar record-making returns are expected in 2012. These returns have allowed the growers to continue to invest in planting and experimenting with new fig varieties, which are expected to yield increased returns to the growers and future generations of growers.

The chart below summarizes the project goals and outcomes achieved:

Activities	Performance Indicator	Performance
1. Review/finalize target customers, assess process capabilities.	Product development history reviewed, situational analysis completed. Mattson identifies VFG's issues, offerings, and processing capabilities.	Meetings on February 2, 2011 and March 8, 2011 with Mattson, Jue and Cain. Mattson developed six concepts for exploration that were discussed in March 8, 2011 meeting. Next step is live samples of three of the protocepts in April.
2. Set up consumer research guidance panels (CGP) feedback mechanism; discuss concepts, protocepts and samples.	Online CGP feedback survey established. Protocept assessed for suitability for industrial application and VFG's manufacturing processes.	Protocept presentation on April 13, 2011 at Mattson with three concepts. Global consumer panels discussion. Key personnel from Mattson at VFG plant on April 19, 2011 to assess plant capabilities.
3. Get VFG feedback on protocepts and revise. Recruit 100 to 140 consumers for CGP, test samples and revise protocepts for VFG review.	Eight to 10 concepts tested, approximately three revised and presented to VFG.	Consumer testing criteria established on May 4, 2011. Five-hundred consumers meeting on May 9, 2011 that established two concepts to move ahead with (yo-figs and fig nut bars). Critique of flavors to pursue within each concept.
4. Prepare samples and packaging, micro-test and ship to test sites/consumers. Get feedback from CGP, in-home consumers.	Samples shipped; collect feedback from consumers via online survey based on normative key measures.	Six bars and six nuggets sent to 300 consumers for in-home testing. Concept results were very high (81 percent and 82 percent) top two box for both items.

Activities	Performance Indicator	Performance
5. Analyze results from step number 4, revise protocepts, make samples for testing and trial sales calls and review results.	Protocepts revised and tested, protocepts reviewed with VFG and food manufacturers for development.	Consumer feedback was incorporated into final formulations. Final product for bars and nuggets is outstanding.
6. Compile and transfer product binders with ingredients, product specs and nutritional information.	Product binders to VFG.	July 27, 2011 final meeting for transfer of data/binders.
7. Final approval of product concepts.	Mike Emigh and VFG Board approve products for production.	Reported to Board August 16, 2011. Next steps on hold due to poor availability of figs.
8. Increase value-added (non-bulk) sales of fig paste (target 1,300, 1,450, 1,590, 1,740 and 1,990 tons in years one to five).	Measured by production and sales reports.	TBD due to lack of fruit availability this year, it is not possible to determine an increase in value-added sales of fig paste.
9. Increase fig paste returns (goal of 25 to 30 percent increase by end of year one after end of project timeline).	Measured by returns paid to growers.	TBD - Grower returns on paste were forecast to rise 47% from 2007 levels, and similar returns are expected in 2012.

Beneficiaries

Although VFG represents 22 fig growers and approximately 50% of the dried fig sales, the entire California fig industry potentially benefits from increased returns that will be generated when the fruit/nut bar and the fruit nugget products are launched. Consumers will also benefit from these products being launched due to their healthful and nutritious nature.

LessonsLearned

A significant crop surplus problem for the California dried fig industry disappeared almost overnight via a new long term contract with a key paste buyer, new sales in international markets, a reduced crop in 2011, expanded international sales, and surplus removal projects from the United States Department of Agriculture. In the absence of inventory to work with, VFG has temporarily shelved launching the bars and nuggets due to the lack of available fruit. VFG anticipates investing time and resources in this project when there is fruit availability, perhaps from the 2013 crop. Fortunately, all the data, history and positive market research is available in order to facilitate this launch when it is deemed appropriate.

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CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 30	Project Title: Building Successful Farm to School Models to Enhance Markets for Specialty Crops	
Grant Recipient: Regents of the University of California, Davis	**Grant Agreement No.:** SCB10030	**Date Submitted:** December 2013
Recipient Contact: Gail Feenstra, EdD.	**Telephone:** (530) 752-8408	**Email:** gwfeenstra@ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complemented and enhanced previously completed work.

The rising incidence of obesity and diabetes in children is well documented, and the link between children's health and eating fruits and vegetables is clear. Yet fewer than 10% of California youth consume the minimum recommended daily servings (CDC 2009). Developing life-long healthy eating habits requires both knowing about healthful food *and* having access to it in balanced meals. Schools are uniquely positioned to address these issues by building successful Farm to School programs that increase children's access to fresh, seasonal produce, educate future consumers about health and food choices and provide tangible connections to California agriculture. Farm to school programs can also provide an additional market for regional specialty crop farmers.

This project was designed to increase availability of fresh fruits and vegetables for school children, while providing resources, technical assistance, and training required to develop fully functional programs. The project expanded SCB07007& SCB08006, which provided California schools with resources and professional development for making fresh fruits and vegetables the centerpiece of a healthy school environment and for using school gardens to enhance academic knowledge, nutrition education and eating habits. The team for this project worked with three committed school districts (Oakland Unified School District OUSD; Winters Joint Unified School District WJUSD; and Enterprise Elementary School District, Redding, CA EESD) and their regional partners to 1) expand their procurement of local, seasonal fresh produce; 2) enhance their ability to integrate school food, nutrition education, school gardens and classroom lessons by providing outreach and professional development to food service personnel, teachers, administrators and parent volunteers; and 3) assess changes in food preferences and dietary behaviors of children in participating schools. The goal was to directly impact children, professionals and regional farmers in the these school districts while developing farm to school models for other districts to emulate.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

This project's activities were designed to provide support for the farm to school efforts of three California school districts: Oakland Unified School District (OUSD); Winters Joint Unified School District (WJUSD); and Enterprise Elementary School District (EESD) in Redding, CA. The project had three broad goal areas: procurement of local produce for school meals; nutrition education and related professional development support to the school districts; and evaluation of the nutrition impacts of the intervention activities. In addition, the project team assembled all three districts each year of the project in order to share results and lessons learned.

Procurement of local fruits and vegetables: In order to determine the definition of "local," the project team met with food service directors and their community partners to develop criteria and district-specific definitions. Further research was required to be able to confidently identify sources of produce. Once determined, baseline procurement data was collected, and continued to be collected for each year of the project. This involved tracking all produce invoices for each district each year, determining and quantifying the products that were sourced locally, compiling and analyzing the data. Results have been positive: all three districts increased their procurement of fresh, seasonal, local produce. Oakland USD spent $794,027 on total produce in their baseline year (2009-10), of which 11.2% ($88,573) was local. In the final year, their total produce purchases increased to $1,363,027 with 31.2% locally sourced. Winters JUSD went from a total of $7,707 and 6.6% local to $43,208 and 51.1% local produce. Enterprise ESD increased from $79,531 and 4.4% local to $177,488 and 20.8% local. (Attachment A: Summary Produce Expenditures all districts)

Additional accomplishments resulting from activities in the procurement sector include the following:

- OUSD developed a new Request for Quotes (RFQ) and bid process for produce purchasing which allowed the district to select different vendors committed to sourcing more local produce for different food programs—Harvest of the Month (HOTM), school Farm Stands, Fresh Fruit and Vegetable Program (FFVP), and the regular school meal program. This was a major accomplishment in sustainability for the farm to school program. As a result, over 82% of farmstand produce was fresh, seasonal and locally sourced, as was 100% of the HOTM and FFVP produce. Over the course of the project, OUSD increased the number of school-site farmstands from 12 to 25 schools.
- WJUSD developed strong direct buying relationships with local farmers, as evidenced by their >50% overall local produce purchases. These relationships extended into the community, and their newly established farm to school program raised over $20,000 per year for two years running with their "Bastille Day—Dinner in the Olive Grove" signature fundraiser. (No grant funds were used for this event.)
- EESD expanded and solidified their relationship with Happy Valley (HV) Growers/Distributors, establishing a nascent aggregator model, with HV adding growers to their enterprise in response to increased demand. EESD increased their local purchasing by over 300%.

Professional Development Support: The UC Davis team offered a variety of professional development opportunities in order to enhance the districts' ability to integrate school food, nutrition education, school gardens farmer contacts within their program. Highlights included:

- Helped install a school garden in a WJUSD Middle School. UCD gave instruction on gardens and maintained plant starts, which students planted in early spring. Before school let out, they harvested veggies with the Food Service Director and got to taste them on their salad bar.
- UCD team sponsored a day-long visit by OUSD Claremont High School students to the UC Davis campus, touring them around the Student Farm complex, hosting a tasting of seasonal specialty crops in the dining commons, and introducing them to the Landscape & Environmental Design department for talks on Urban Ag. (Attachments B-1, B-2: photos of students' visit)
- The UCD team held three consecutive workshops for EESD at the annual meetings of School Nutrition Association's Far North (CA) Chapter. Topics included using CA specialty crops in school meals.

Nutrition Impacts Study: The Nutrition Impacts Study was designed to evaluate the impact of Farm to School (F2S) programming on dietary behavior outcomes, specifically fruit and vegetable preferences and consumption patterns among school aged children in the project districts. Data were collected at baseline, prior to initiation of F2S programming in each district, and at follow-up, following a period of exposure to F2S programming. Methods included administering taste tests to students with preference questionnaires. Students were asked to identify, taste, and rate each (fresh, raw) item. The UCD Nutrition Team (UCD-N) also conducted a school lunch plate waste lunch observation to assess consumption, and administered parent surveys to assess impacts at home. All data were analyzed for significance. Results are discussed in the next section.

UC Davis Program Contribution: Each year, the UCD team hosted a forum, where all district participants and their community partners gathered to network, share success stories, exchange lessons learned, and plan for sustainability of their programs. The first was held in Davis, where participants presented their successes to date. The second was held at an Oakland school and included tours of the farm stands, school gardens, and demonstrations by food service chefs.

The Final Forum was held at the Robert Mondavi Institute for Wine and Food Science and was extremely successful. The Forum brought together over 100 school food service, school district, agency and community representatives to share insights and lessons learned from the three-year project. In the morning session, we featured a panel of Food Service Directors from the three school districts, as well as two other prominent Northern California Food Service Directors. Rotations on University Food Systems and Garden-based Learning followed. A highlight of the Forum was the preparation of award-winning recipes by five school district Chefs, followed by tastings. The afternoon was comprised of breakout sessions to disseminate information on current local and state developments in farm to school, farm to school policy, impacts, and distribution issues. An added bonus was a presentation (with tastings!) by Dan Flynn of the Olive Center on olive oils and their potential for use in school meal programs. The post-forum survey showed between 70-84% of respondents rating individual sessions as valuable or very valuable.

(Attachments C-1, C-2, C-3: Final Forum flyer; Agenda; Sample survey responses)

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Increase procurement of regional produce in school meals by 20%:
All school districts met and exceeded this goal.

- OUSD increased its local procurement by <u>381%</u> in dollar volume of local produce and 20 percentage points from 11.2% to 31.2% of total produce purchases;
- WJUSD increased its local procurement by over <u>4,211%</u> in dollar volume of local produce and almost 45 percentage points from 6.6% to 51.1% of total produce purchases;
- EESD increased its local procurement by <u>953%</u> in dollar volume of local produce and more than 16 percentage points from 4.4% to 20.8% of total produce purchases. (Attachment A: Summary Produce Expenditures)

Increase fresh, regional produce sales to school districts for approximately 30 farmers:
The project increased regional produce sales for at least 30 farmers across all three school districts.

- <u>New</u> sales contracts of fresh, regional produce to individual farms were established for a minimum of 75 farmers. Maximum numbers are difficult to determine because some new vendor contracts were made through small, regional aggregator/distributors who work with varying numbers of farmers depending on season.
- In addition, the school districts' regular distributors began identifying the sources of some of their produce, resulting in produce sales that could be identified as within the districts' local range. In those cases, the number of identified regional farm companies supplying the school districts is a minimum of 25. However, each of these farm companies sources from more than one farm in their region. Farms in this group could have been supplying to the districts before the grant, but were not identified as local until the grant was implemented. (Attachment D List of Farms for local sourcing)

Increase the percentage of children who participate in the school lunch program by 10%-15%
School meal participation increased in some districts, and not in others. Note: Although the outcome is stated as the school "lunch" program, school "meal" or school "food" program is a more accurate reflection of how the farm to school produce purchases are put to use.

- OUSD: In OUSD, participation in the school meal program increased by 17% from baseline to the final year.
- WJUSD: Participation in the school lunch program decreased by approximately 3% between 2009-10 and 2012-13. One reason is that student enrollment declined (by 4%) during those years. Also there were fewer serving days in 2012-13 than in 2009-10 (178 vs. 180).

- EESD: EESD participation from baseline to final year decreased by 11%. However, the two intervening years each showed an increase of 10% over baseline. The Food Service Director reported that demographics in the area have changed—fewer families qualified for meal benefits starting in 2011. Also, according to the Food Service Director, the new (2012-13) USDA meal requirements resulted in menu changes that children do not like as much.

Increase the number of menu items in each school district incorporating seasonal, regional produce by 25%

- OUSD: Exact data is not available. Using a combination of menu data, produce variety data collected from invoices and procurement data, staff estimate that local produce items featured in the school lunch program rose from 17 to 27, a 58% increase. In addition, OUSD instituted a Harvest of the Month program which brought seasonal, local produce to elementary schools each month. OUSD made many additional changes to their school food program that increased students' and families' access to locally procured produce.
- WJUSD: WJUSD: Food Service Director reported that menu items using local produce increased from 11 items in the baseline year to 63 in 2011-2012. This is an increase of 52 items and 472%.
- EESD: EESD reports increasing their menu items that contain local produce by three items or 15% (20 to 23). USDA regulations require a very tight menu cycle and that combined with the availability of seasonal, local produce was challenging for the Food Service Director.

Obtain commitments from at least 30 additional school districts to enhance or initiate local procurement

The project met this goal through the contacts it made throughout the project and at its Farm to School Final Forum. Over 100 attendees were present. Of these, 26 were direct representatives of school districts who showed interest in establishing or enhancing a farm to school program in their district. In addition, the Forum brought six UC Cooperative Extension representatives who work with districts in their counties specifically to enhance farm to school and nutrition programs. Also, significantly, state and county representatives who promote farm to school programs attended.

Nutrition Impacts Study

Overall, results from the eating behavior component of the study suggest that the F2S intervention had some positive impacts on the eating behaviors and food preferences of the students exposed to the program. Here staff report primarily on results that show statistical significance. (Attachment G: Poster "Evaluating the Impact…"; Attachment H: Composite Results of Impacts Study)

Increase children's taste preferences for select vegetables by 20%

Students' taste preferences were measured with a standard, validated survey tool: Students that were willing to taste each of the four featured produce items subsequently rated the item on a scale from 1 to 5; 1=really did not like it and 5=really liked it.

- Results in children's taste preference for featured produce items were mixed. Overall, the study made 12 presentations of fruit and vegetables to the children (4 items at each of 3 schools). The statistically significant increases for taste preference were OUSD for cabbage (by 7%) and EESD for bell pepper (by 13%).

- Willingness to taste a fruit or vegetable was considered an indication of possible preference. Here, WJUSD students' willingness to taste radishes decreased significantly, and no significant increases were found in any of the districts.

Increase children's consumption of fruits and vegetables during school lunch by 20%
Consumption at school was measured by a plate waste observation & assessment.
The results are as follows:

- WJUSD students significantly increased their consumption (measured as percent of produce consumed) of fruit by 115% and of total produce by 115%.
- EESD students showed no significant differences in consumption from baseline to follow-up.
- OUSD students showed a significant decrease in consumption of fruit (by 100%). The significant decrease in students' consumption of fruit in OUSD may be attributed to the fact that, unexpectedly, the item being tested at baseline was not offered on the one follow-up assessment day. Therefore, a comparison could not be made. Had measurements been taken over the course of several days, results would be more reflective of student's true dietary behavior.
- Though a measure of intention rather than behavior, students' self-reporting of willingness to eat a select item as a snack was also measured. Significant results showed a (self-reported) increase in willingness to eat asparagus (WJUSD by 51%) and salad greens (OUSD by 15%).

Lessons/Implications
The Nutrition Impacts Study included measures in addition to those reported here. Overall, results showed that the farm to school intervention had some positive impacts on the eating behaviors and food preferences of students exposed to the program. However, positive results were not consistent, and therefore staff cannot say conclusively that preference and consumption overall increased as a result of this intervention.

- In certain cases where results in preference and consumption were positive, it may be because the school district included other common farm to school elements such as school gardens and local farm visits. Research suggests that school gardens can be instrumental in fostering positive behavior changes in students. Also, local farm visits can familiarize students with seasonal produce and the farmers who grow it. Winters JUSD successfully incorporated both these elements since the grant began and was the only district to show significant increased consumption.
- In general, this study points to the need for well-designed interventions that employ a mixed method approach to assess multiple determinants of dietary behavior in children. Increased awareness and understanding among the parents, policy makers and the public will help target farm to school programs as an important component of a healthy school environment.

Procurement: As described above, a major goal of the project was to increase students' access to and consumption of fresh, seasonal, and local specialty crops. Districts specified different targets, from a general increase to an increase in dollars by 25%. OUSD increased by 20 percentage points and in dollars showed a 381% increase. Winters showed the greatest increase at 44.5 percentage points and in dollars a 4,211% increase. In terms of percentage points, the minimum increase was 16.4 percentage points (4.4% to 20.8%) by EESD. In dollars, this represents an increase of 953%. A large reason for this success is the strong motivation and commitment of the Food Service Directors to implement meaningful changes coupled with the assistance of their community partners and the funding provided by the grant. In all three cases, to varying degrees, the district has implemented changes to ensure the sustainability of these efforts: for OUSD, the RFQ and the more nuanced vendor contracts allow for better purchasing power with commitments to procuring more local produce. In addition, OUSD was able to hire a full-time Farm to School Coordinator, who will carry the work forward. Finally OUSD conducted a complete feasibility study for the building of a new central kitchen, and an Oakland bond was passed in 2012 to finance the construction. For WJUSD, the direct relationships with farmers and the newly formed farm to school 501c3 provides a consistent produce source and funding stream. The Bastille Day event is already established as a community-wide effort to support farm to school. In the Enterprise Elementary district, the further development of the connection with Happy Valley provides convenient and cost-effective sourcing. (Attachment E: poster "Building Successful F2S Models…")

Professional Development: Professional development (PD) was designed to correspond to the needs identified by each district, and the target goal was to deliver at least two professional development opportunities per year to each district. This goal was accomplished (Attachment F: PD Outcomes)

- PD for Winters centered primarily around the establishment of a school garden, and this was accomplished in the fall of 2012. Students planted vegetables and harvested them in the spring of 2013. It was deemed a great success, and will continue after the grant.
- PD for Enterprise consisted of workshops for food service personnel at their annual meetings as well as presentations to farmers and community members about direct marketing to schools. In addition, we provided advice and support regarding a community garden effort.
- PD for Oakland was a mix of some nutrition education, some school garden support, and the major event of bringing Oakland high school students to the UC Davis campus to introduce them to the Student Farm and other UCD opportunities.

Nutrition Impacts Study:

As mentioned, the goal of the Nutrition Impacts Study was to assess the impact of F2S programming on students' dietary behavior outcomes, specifically fruit and vegetable preferences and consumption. (Attachment G: Poster "Evaluating the Impact…"; Attachment H: Summary of Impacts Study Results)

- ***Student Food Preferences:*** In each district, students showed a trend in increased ability to correctly identify some of the featured vegetable and fruit items from baseline to follow-up testing. Significance was shown in the proportion of students able to correctly identify asparagus (WJUSD), cucumber (OUSD), and bell pepper (EESD). In most cases, willingness to taste remained the same or went up. In the case of radishes (WJUSD), willingness to taste went down significantly. Preferences also stayed the same or went up in 10 of the 12 items presented. In the case of cabbage (OUSD), the increased preference was significant.
- ***Student Consumption:*** In WJUSD, students selected <u>and</u> consumed a significantly larger amount of fruit and total produce from baseline to follow-up. OUSD students showed a significantly smaller amount of total produce selected from baseline to follow-up, and no differences in consumption. EESD students showed a significantly larger amount of vegetables, particularly red bell pepper, and total produce selected and consumed from baseline to follow-up. Also, a significantly greater number of students reported that they would ask a family member to purchase broccoli, spinach, and bell pepper and that they would eat them as a snack.
- ***Parent Reporting:*** WJUSD's parents reported a significant increase in child's consumption of kiwi at home and a slight increase in overall consumption of vegetables. They also reported a significant

increase in their own awareness of nutrition-related activities in school. No significant changes were noted by OUSD parents; surveys were not collected from EESD parents.

Overall, despite some scheduling difficulties, the goals of the Nutrition Impacts Study were met.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

While it is beyond the scope of this project to assess economic impacts, the increase in procurement of local produce in each of the school districts (reported in an earlier section) gives an indication of the substantial increase in purchasing of California specialty crops. Certain small-to-mid-size grower/distributors—for example, Capay Organic in the Capay Valley, and Happy Valley in Shasta County—significantly increased their sales to schools over the life of the grant. All distributors increased their produce sales, a direct benefit to the farmers they buy from.

Also benefitting from this project are the students (and their parents) of the three school districts, who benefitted greatly from increased exposure to fresh, seasonal, regional produce in their school meals and snacks. The total 2011-12 enrollment for all three school districts was approximately 51,739 students. The project had the most direct benefit for students participating in the National School Lunch Program. The overall average percentage of students eligible for Free & Reduced Price Lunch across the three districts was 68.9%, so we can say that minimally 35,648 students directly benefitted from this program. Additional students benefitted from program activities such as nutrition education at select schools and school garden support for several schools and/or entire districts. In addition, we predict that the benefit will expand beyond these three districts, as the project's Final Forum attracted representatives from 26 school districts in Northern California. These participants attended because they are establishing or expanding their farm to school programs.

The school staff (teachers and food service) also benefitted from the results of the professional development provided, particularly from the school gardens, the increased nutrition education, and exposure to information about California agriculture and farmers.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

Unexpected Outcomes, Lessons Learned and Obstacles from OUSD:

- OUSD created an innovative Request for Quotes process, incorporating local procurement requirements into the produce bid language and splitting bids among the various parts of their meal program. This has subsequently been used as a model by other districts to increase their purchasing of local product.

- OUSD doubled (from 12 to 24) the number of school farm stands in the district, involving more parents and community members and increasing students' access to fresh produce. (Attachments I1-2: photos of Produce Stands)
- OUSD created a district-specific branding of their farm to school program: Oakland Eats Garden Fresh. (Attachment J: Oakland Eats Garden Fresh Logo)
- OUSD hired a full time Farm to School Coordinator to ensure sustainability after the grant.
- It is crucial to have a funded Farm to School Coordinator on board to make the connections between the district food service operation and farmers.
- Creating a more nuanced Request for Quotes was instrumental in moving the local produce procurement forward and getting distributors better educated about farm to school.
- Obstacles encountered have to do with costs: Funding to support training for front line school food service staff; labor costs for Oakland's Produce Markets; produce procurement costs for produce stands that do not get as much traffic.

Unexpected Outcomes, Lessons Learned and Obstacles from WJUSD:

- Rominger Middle School has a new school garden that is contributing to students' education about growing their own food.
- These programs need strong community partners and support. This makes a huge difference in terms of sustainability.
- The establishment of their community-based farm to school committee was not easy in the beginning. However, they worked through the difficulties and formed a strong committed group, and this made all the difference in being able to put on a new, signature, and very successful fundraising event. (Attachment K: Poster for Winters' Bastille Day Event; this event was not funded by the SCBGP grant and therefore did not generate any program income.)
- Grants such as this one helped to instill a love of fresh, locally grown food in the students. Students started asking when their favorite produce would be in season. It served an educational as well as nutritional service.
- ***"This grant really worked – it launched Winters Farm to School – so the work continues – this has been amazing for this Districts students and the community" Cathy Olsen, Food Service Director, Winters Joint Unified School District***

Unexpected Outcomes, Lessons Learned and Obstacles from EESD:

- Workshops and collaborations provided by the UC Davis team were ***"extremely inspiring and provided a guiding light for my staff and me."***
- Need for more staff time to implement programs such as these effectively.
- Long term planning of menus and school district needs will facilitate an effective supply and distribution system.
- A comprehensive outreach and education program is needed to educate parents and the community of the importance of these efforts.
- The development of a sustainable Farm to School program is a long term process that must involve many parties: school personnel, farmers, community members, parents. There is a need for both health & nutrition education and for technical assistance to farmers and school food service directors.

Unexpected Outcomes, Lessons Learned and Obstacles from Nutrition Impacts Study:

- Overall, results from the eating behavior component of the study suggest that the F2S intervention has had a positive impact on the eating behaviors of the students exposed to the program. Positive results are encouraging though additional research is required to adequately assess the relationship between dietary behavior patterns and F2S.
- This study points convincingly to the importance of, and need for, well designed, controlled interventions that utilize a mixed method approach capable of assessing multiple determinants of dietary behavior in children. Increased awareness and understanding among the parents, policy makers and the public as a result of well-designed control intervention studies will help target F2S and other school food environment programs as important and permanent components of the public school environment.
- Sustainability plans to foster the F2S efforts beyond the funded project are needed. Site-specific wellness committees with site-specific school community stakeholders have showed promise in other studies.
- Some unexpected outcomes include the difficulty of scheduling assessment days at several school sites. For example, an assessment day had to be rescheduled at one of the school sites due to a school shooting.
- A more clear record of what types of promotional and/or nutrition education materials implemented in each school site is needed in order to measure the impact of these materials on student behaviors with confidence.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Please see Attachment L for a complete list of publications, poster sessions and presentations.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 31	**Project Title:** Best management practices for hybrid onion seed production to improve crop sustainability in California	
Grant Recipient: The Regents of the University of California, UC Cooperative Extension	**Grant Agreement No.:** SCB10031	**Date Submitted:** December 2013
Recipient Contact: Rachael Long	**Telephone:** 530-681-7661	**Email:** rflong@ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The purpose of this research was to develop best management practices for hybrid onion seed production to address the variable, unpredictable, and declining yields in California. Hybrid onion seed production in California is primarily in Colusa County and the Imperial Valley, on about 2000 acres, and valued at $12 million annually to growers and $40 million in retail sales to industry. While clearly a specialty, small acreage crop, onion seed production is important to these local economies with different varieties shipped worldwide. Although acreage harvested has increased by about 50% during the past 5 years, yields (lbs/ac) have declined by about 75% statewide, resulting in millions of dollars in losses (county crop report data, 2008-10). These declines have coincided with increased insecticide use to control onion thrips (*Thrips tabaci)*, which vectors iris yellow spot virus (IYSV, Long and Morandin 2011).

Onion seed production involves planting male and female parent onion lines in the same field, with honey bees relied on for cross-pollination during bloom. Research to date suggests that yield variations are due to a lack of adequate pollination. This may be a result of insecticide use targeting onion thrips, a vector of the iris yellow spot virus. Additional issues affecting pollination and yield may include irrigation management, and floral nectar production. The University of California, Cooperative Extension (UCCE) research has developed best management practices for onion seed production in California with a focus on pollination ecology, iris yellow spot virus (newly introduced to California in 2002), and onion thrips control (Voss et al., 2013). Given growing concern about the maintenance of pollination services across many agricultural crops, this project addresses questions of timely concern to growers of many pollinator-dependent crops.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Summary: To address whether insecticides affect honey bee activity and pollination service, a large-scale 1.5 acre onion seed production trial was planted, where project staff experimentally manipulated insecticide applications. eight insecticides were evaluated with different active ingredients and modes of action, three spray timings, and three levels of application number. All treatments were replicated five times within a randomized complete block design and were compared to an untreated control. Project staff observed honey bee and native bee visitation and pollen viability relative to the different treatments and collected umbels to measure seed yield from each treated plot.

Results and conclusions: Select insecticides had negative impacts on pollinator attraction and pollen-stigma interactions, with certain products dramatically reducing pollen germination and pollen tube growth. Decreased pollen germination was not associated with reduced seed set; however, reduced pollinator attraction was associated with lower seed set and seed quality for one of the two female onion lines examined. The results highlight the importance of pesticide effects on the pollination process. Over-use may lead to yield reductions through impacts on pollinator behavior and post-pollination processes. The results of this study are currently in press in the Journal of Economic Entomology. A draft of this manuscript is attached.

Field surveys 2012-2013

Summary - Onion seed fields were surveyed during bloom in May and June (17 farms in 2012 and 12 farms in 2013). Project staff quantified pollinator visitation, nectar production, pollen germination and pollen tube growth, soil moisture, insecticide use and seed set. In 2013 nectar sucrose concentration was also measured. Project staff then examined how the effects of soil moisture (and thus irrigation practices), and insecticide use may affect ultimate seed set via indirect effects on the pollination process.

Results and conclusions - In 2012, it was found that both excessively low and high soil moisture reduced nectar production, which in turn reduced honeybee visitation rates (Attachment 1Fig. 2). Furthermore, high insecticide use also tended to reduce honeybee visitation. Honeybee visitation was strongly linked to seed set, indicating that by reducing visitation, field management can impact seed yields (Attachment 1Fig. 3). Pollen tube data from 2012 was inconclusive, and data for 2013 is still being analyzed, as insecticide use data was not available until late July 2013. However, 2013 patterns for irrigation and nectar production match those from 2012. Overall, results from field surveys show that field management can have indirect effects on the pollination process. Under or over-irrigation reduces nectar rewards and honeybee attraction, while high insecticide use further reduces visitation.

Onion thrips surveys 2012-2013

Project staff sought to determine when onion thrips numbers peaked during the winter and spring, to help farmers' better target insecticide use for onion thrips and IYSV control. Onion thrips abundance was surveyed at 14 onion seed fields in Yolo and Colusa counties. Methods similar to those used in previous studies on thrips in tomato fields were used, placing a yellow sticky card on each of the four corners of the field, just above the level of the vegetation. Cards were swapped out every two weeks, and the total number of thrips and number of onion thrips caught was estimated.

Results and conclusions - Thrips did not appear in fields in significant numbers until early February, and it was approximately mid February when the proportion of *Thrips tabaci* peaked. While total thrips numbers continued to rise into April, the proportion of *T. tabaci* in each sample declined until bloom (Attachment 1Fig. 1). Furthermore, *T. tabaci* numbers were highly variable among farms, and total thrips number was not always indicative of *T. tabaci* density. The results suggest that insecticide use prior to mid-late February will not aid in *T. tabaci* control and IYSV management. Furthermore, surveys of general thrips abundance that do not involve species identification may overestimate *T. tabaci* abundance. Finally, the timing of *T. tabaci* presence in onion seed fields has been pinpointed, but what proportion of these thrips carry IYSV is not known yet, and at what thrips density treatment is necessary. This will require further research.

Field surveys in Oregon

Project staff travelled to the Willamette valley, in Oregon, where native pollinator visitation is much higher and seed yields are more consistent than in California. Native pollinator and honeybee abundance was measured at 10 onion production fields using pan traps, net sampling and observations of visitation. Pollen deposition, pollen tube growth and seed set per umbel were also measured. Oregon visitation patterns, seed yield, and pollen deposition and field management practices were compared to California to develop hypotheses regarding why yields are more reliable in Oregon.

Results and conclusions - Working in Oregon provided an interesting contrast to onion seed production in California (summarized in Table 1-Attachment 1). In Oregon, insecticides are rarely used (none at study sites). Native bee visitation rates were higher in Oregon, though they still represented a low proportion of pollinators. However, Oregon fields have similar visitation rates by honeybees compared to California, despite lower stocking rates. Furthermore, they have higher pollen tube germination on their stigmas. Finally, besides rarely spraying insecticides, overall disease pressure is lower in Oregon, leading to less field to field variation in seed set due to the impacts of fungal disease (especially by downy mildew and purple blotch, UC IPM).

IYSV Research

Collaborators in Imperial County examined the efficacy of both organic and conventional pesticides in controlling thrips populations, and in reducing incidence of IYSV. They also examined patterns of abundance of onion thrips over time in production fields. Finally, they sampled 34 fields for IYSV via genetic tests using Enzyme-Linked Immuno-Sorbent Assay (ELISA), and compared yields to IYSV incidence.

*Results and conclusions: S*ome organic pesticides significantly suppressed thrips populations, as did conventional insecticides. In 2011 thrips suppression via pesticides did not reduce IYSV, however, in 2012; insecticides reduced the incidence of IYSV by 73%. Yields were not significantly changed in either 2011 or 2012 due to reduced ISVY incidence. Similar results were found in onion seed production fields in 2012, where 10 out of 34 fields tested positive for IYSV with no yield reduction. Four fields tested negative via ELISA, and 20 fields showed no visual symptoms of IYSV. Yields in these fields were variable with no apparent correlation with IYSV. Finally, thrips abundance was low throughout the winter, but by spring, about 50% of the thrips present were onion thrips, suggesting thrips control should not begin until early March, when onion thrips become more abundant in onions, to try to minimize the spread of IYSV within fields, as found for the Northern Sacramento Valley. Impacts of different insecticides on thrips control are currently being evaluated.

Current data evaluation suggests that other factors besides IYSV play a more important role in onion seed production, including variety, irrigation management, weather, pollination, and pollinator services by honey bees and other pollinators. Both organic insecticides and conventional insecticides controlled onion thrips, and potentially IYSV. However, as with conventional insecticides, use should be minimized, because organically registered pesticides can negatively impact the pollination and pollinator activity. Finally, IYSV incidence did not correlate significantly with yields, thus minimizing insecticide use to reduce impacts on pollination should not negatively impact yields. However, more studies are needed to understand the epidemiology of IYSV in California, and in particular, an evaluation of weeds that harbor and vector this disease.

Outreach and dissemination of work

Extensive presentations have been given on the results of this project, including at the Entomological Society of America annual meeting, the Columbia Basin Vegetable Seed Association Annual Meeting, the California Garlic and Onion research advisory board meeting, and at a Pollination. This work has been featured in the UCCE Yolo grower newsletter and on the UCCE Yolo website (http://ceyolo.ucdavis.edu). The Onion Seed Production guidelines for California have been revised.

Present the significant contributions and role of project partners in the project.

Set up, design, and implementation of field research at UC Davis was conducted by co-Project Directors (PDs) and the Post doc. Data collection was conducted by the PDs, post doc and field assistants. Data organization and analysis was the planned by PDs and the Post doc, and conducted by the Post doc. Communication of results was conducted by PDs and the Postdoc

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Comparison of accomplishments with goals, progress towards set targets

The focus of this project was to develop best management practices for hybrid onion seed production to address the problem of variable, unpredictable and declining yields in California. The project focused on the causes for these yield declines and to develop grower and industry recommendations to bring onion seed yields back to economically stable levels. Data documents that the use of four or more insecticides in onion seed production for thrips and IYSV control will reduce honey bee activity and seed yields. It was also documented that both excessively dry and moist soil conditions will reduce nectar production and honey bee visitation. As a result of this work, onion seed growers in the northern Sacramento Valley reduced the number of insecticides applied to onions from an average of 3 (range 1-7) in 2009 to 2.2 (range 0-6) in 2012. Yields are still variable, but have increased from a low of 50 lbs/ac in 2008 worth $1.2 million to 201 lbs/ac in 2012 worth $7.8 million on similar sized acreage (Colusa County Agricultural Crop Report).

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Approximately 60 growers and seven seed companies have directly benefited from this research by giving them better information on how pollination issues interact with crop management, production, and honeybee activity. This will help both parties understand potential issues that may occur during onion seed production. Growers were previously unaware that irrigation practices could impact pollinator attraction. Furthermore, pollen viability is a new factor that seed companies are considering in the development of new varieties. Some have even been trained in this methodology. A greater variety of seed options is beneficial to the growers.

Beneficiaries are most concerned with the negative effects of crop management on both pollinators and pollen germination. They are concerned with finding effective ways to reduce insecticide use, given the projects results showing negative effects on both pollinators and pollen germination. They further should be concerned with modifying irrigation practices to maintain optimal soil moisture for nectar production and pollinator attraction; that is, not over or under watering production fields.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

This research showed several surprising results. First, the negative impact of insecticides on pollen tube growth has not previously been documented, to project staff's knowledge, though fungicides have been shown to have similar effects. Second, both organic and conventional insecticides both negatively impacted pollination, suggesting that insecticide use of any type should be minimized. This implication is further supported by results showing that IYSV incidence is not a major correlate of seed yields in California as much as honey bee activity and pollination.

Several lessons are taken away for future research. While the field experiment yielded clear results, work on pollen tubes was challenging in surveys of grower fields. It was difficult to reliably conduct crosses and account for varietal differences as well as impacts of insecticides. Further studies of pollen tubes would be best conducted experimentally in the lab or greenhouse. However, challenges also occurred working with onion in the greenhouse – plants were highly susceptible to disease in this context, and likely require larger pots than space allowed. Such problems will have to be overcome for more mechanistic studies of pollen germination to be possible.

Finally, it was found that there is lack of clear information in the incidence of IYSV in Yolo and Colusa counties, and it's actual economic impacts on yields. While it could be documented when onion thrips were abundant in fields (vectors of IYSV), the economically damaging threshold where disease transfer is likely is unknown. More studies on the epidemiology of IYSV in California, and in particular, an evaluation of weeds that harbor and vector this disease, will help growers develop IPM based strategies for reduced-pesticide disease management to facilitate adequate pollination.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

References

Long RF and L Morandin. 2011. Low hybrid onion seed yields relate to honey bee visits and insecticide applications. J. of Cal. Agr. 65(3):155-58.

Long RF. Website information onion seed production (Pest Management/Field Crops drop down menu), http://ceyolo.ucdavis.edu

Gillespie S, RF Long, N Seitz, and NM Williams. In press. Insecticide use in hybrid onion seed production effects pre and post-pollination processes. J. of Econ. Ent.

Voss R, M Murray, K Bradford, K Mayberry, I Millar, R Long, S Gillespie. 2013. Onion Seed Production in California, UC ANR Publication 8008.

UC IPM Guidelines for garlic and onions, http://ipm.ucdavis.edu

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 32	**Project Title:** Beginning Farmer Training & Incubator Program	
Grant Recipient: Center for Land-Based Learning	**Grant Agreement No:** SCB10032	**Date Submitted:** December 2013
Recipient Contact: Jennifer Taylor	**Telephone:** 530-795-4146	**Email:** jennifer@landbasedlearning.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The approximately $22 billion California specialty crop industry produces nearly half of the nation's fruits, nuts and vegetables, yet farmers in the state over age 65 outnumber young farmers under 25 by about 60 to 1. With the average age of U.S. farmers nearing 60 and seventy percent of the nation's farmland expected to change ownership in the next decade, there is an immediate need to ensure there is a next generation of farmers to raise food for California's increasing population.

Current farm families often do not have a younger family member who is interested in operating the farm into the future. However, with the widespread interest in sustainable food systems and regionally produced food continuing to grow, adults of all ages and backgrounds, from recent college graduates to mid-career urban professionals, are now interested in becoming farmers; yet the entry or transition into agriculture is a large hurdle for working adults with little experience and no direct connection to the industry.

Thus, this project was undertaken to design and implement the only beginning farmer training program of its kind for specialty crop production in northern California. The educational non-profit Center for Land-Based Learning (CLBL), located on a farm with rich soils in a diverse specialty crop growing region near Winters, California, is ideally poised to train, mentor and provide land access and networking opportunities for beginning farmers.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

- Program Manager (Director, California Farm Academy) and Program Coordinator designed and implemented beginning farmer training and incubator program.
- Assembled an Advisory Committee of about 25 farmers, agriculture agency and non-profit partners, lenders, and workforce development, university educators who provided key input to the program through six face-to-face meetings during the project and by phone or email, as needed.

- Graduate student conducted a Needs Assessment for the region, who surveyed beginning and prospective farmers, established farmers and agricultural educators to help determine what kind of training, obstacles, and interests the project should address.
- Curriculum consultant conducted comprehensive collection and review of beginning farmer training programs around the country. Many documents were collected and models examined to help shape the new program in the Sacramento Valley.
- Finalized training program curriculum, instructors, sites, and schedules and advertised for students, mostly using free online farming websites, blogs, and partner email lists. Received over 40 applications for twenty spots in the 2012 training program session and 55 applications for 2013.
- Enrolled and educated 20 student-farmers in production, business planning and marketing of specialty crops in 2012, from February to August. Enrolled 21 student-farmers in current 2013 session, from January to October.
- 75% of the Class of 2012 is currently involved in agriculture. Three 2012 students have purchased farmland since graduation, eight are farming leased or family land, four are employees in agriculture production or education, and four are actively looking to purchase farmland in California.
- Started the California Farm Academy (CFA) incubator program on five acres at CLBL and on 2 acres of partner land at UC Davis Russell Ranch. Seven beginning farmers from CFA are currently leasing land at subsidized rates and accessing CFA support, tools and expertise in the incubator program.
- A surprising development of starting the California Farm Academy is the nearly weekly calls and emails from interested landowners, other non-profits, retired business professionals, educators and farmers from across California, the nation and even foreign countries. Some want to visit and get a tour, others have land they would like to have farmed by a new farmer, and many request similar programs for their region or want to know how they can be involved.
- Another accomplishment of the CFA is the short time in which the students and graduates have been able to enter farming or make a leap forward in their careers. For example, from one being hired to run a café garden within two weeks of graduation to two current CFA students getting jobs as farm managers while still in training, the networking opportunities attending the program have opened up for students have been key to their early success.
- Program partners have made significant contributions by guest teaching classes on their areas of expertise; hosting farm visits and field trips; consulting on curriculum; advising on incubator program design and management; donating supplies; and being references for graduates.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The performance goals for the project were all met, although the initial timeline was delayed due to extensive search and hire processes for the main two staff members.

- Needs Assessment was completed; final report and presentation to the Program Manager and Advisory Committee

- Curriculum research and recommendations completed and presented to Program Manager and Advisory Committee; Program model, structure, curriculum and schedule created.
- Publicity materials created and disseminated. Enrolled 20 students in year 1, 2012 training session and 21 students in year 2, 2013 training session.
- Incubator program model researched, designed and implemented on two sites and seven acres, initially. Four graduates from 2012 program leased land through incubator program in 2012-13 and three students in 2013 program have started in incubator program to date.
- Program evaluation is ongoing and was conducted during and after first training session in 2012 by a) student evaluation of guest speakers, topics and field trips, b) oral and written student evaluation of entire program and experience they had in it, c) solicitation of feedback from program partners and Advisory Committee meetings, d) staff retreat program evaluation session with program staff, and e) regular discussion between program and teaching staff about effectiveness of each class, farm activity and site visit.
- Measurable outcomes to date include:
  - 41 new farmers educated through the 2012 and 2013 CFA training program.
  - 7 beginning farmers in the CFA incubator program.
  - 75% of 2012 class currently in agriculture; remainder still planning to enter.
  - 50% of 2013 own land and/or farming during training program; remainder writing business plans to enter farming.
  - Three graduates and one current CFA student have purchased farmland since CFA.
  - Food Bank Farmers initiative started; landowner-donated land being managed by current CFA student; food being donated to Food Bank of Yolo County.
  - 1 acre CFA plot run by training program students producing fresh produce being donated to Kids Farmers Market program of the Food Bank of Yolo County.
  - CFA Program Manager consulting on proposed Cannery Park urban farm in Davis, California; may become incubator program site / adjunct to CFA program.
  - CFA Program Manager working with program partner California FarmLink to develop Individual Development Accounts for new farmers from CFA program (non-grant funding was cut from this program since the implementation of the project which has slowed progress).

Baseline data was zero since there was previously no beginning farmer training or incubator program in the Sacramento Valley. New farmers leasing land directly from CFA in the incubator program is reduced from original expectation of half of students per year (10), however in large part that has been due to CFA students and graduates obtaining farming jobs in other farm operations or at other sites, purchased or leased, so quickly upon graduating, or even while still participating in the program.

The need to expand the CFA incubator program still exists because access to land for many of the younger new farmers in the region, especially those with little capital, is a large challenge. In the future, the CFA incubator program may be opened to qualified beginning farmers beyond the pool of CFA graduates who have had sufficient training or experience to manage a plot of land.

The need to support, provide ongoing mentorship, field-based supervision and trouble-shooting, and networking to new farmers in years 1 through 5 of their early careers cannot be overstated. With the creation of the California Farm Academy, more farmers are contacting staff for advice, job openings, land or production questions and seeking what are now free consulting services. With limited (two full-time) staff, the CFA must focus first on its program students, graduates and incubator farmers; however, it is clear that beginning farmer and part-time farming landowners in the region require and seek support services for continued success.

The California Farm Academy intends to be a long-standing training and farm business incubator program in the region, with continued funding from a variety of sources.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

- New farmers: primarily the 41 students directly involved in the program, as well as others in the region who are networking with CFA.
- Established specialty crop farmers: several have hired CFA students or graduates as employees on their farms or as consultants. Many have called and obtained information or references from Center for Land-Based Learning.
- Specialty crop industry: The three farms purchased by CFA graduates/students totaling 200 acres is just the start of the impact within the industry. Other CFA students and graduates are farming on existing farms or teaching dozens of youth and other adults about agriculture as part of their new careers. It is too early to assess the economic impact of the CFA program directly; however the multiplier effect of each farmer producing crops, managing land, impacting the food system and educating future farmers and consumers is large. The program will make an attempt to assess these impacts, as it tracks and stays in communication via online and in person networking, with all of its participants.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The California Farm Academy has shown strong early success according to interviews with the participants and their determination to pursue farming careers, the program partners who are excited about continuing to work with CFA, and the public who is eager to learn where its food comes from and ensure a continued supply of healthy fresh produce. The challenges staff have faced have been those of starting something new and engaging many different interests and groups in the region. Largely, these have been positive opportunities, with the staff having too much to do as a result of the interest being the primary downside. Impact will take time to assess and to grow as participant numbers increase, but hiring experienced staff and maintaining individual support of new farmers are key.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

- Food Bank Farmers website: http://www.foodbankfarmers.org/
- Facebook page: https://www.facebook.com/FoodBankFarms
- CBS Sacramento TV Channel 13 news piece: http://sacramento.cbslocal.com/video/9153312-farmers-help-supply-yolo-county-food-bank-with-fresh-produce/
- Woodland Daily Democrat article, California Farm Academy and Food Bank Farmers, Aug 2013
- Sidecar Farm Facebook page: https://www.facebook.com/sidecarfarm1
- CBS Sacramento TV channel 13 evening news piece Aug 8, 2013 on California Farm Academy: http://sacramento.cbslocal.com/2013/08/08/program-younger-farmers-learn/
- Davis Enterprise article, California Farm Academy graduation, August 2012: http://www.davisenterprise.com/local-news/ag-environment/growing-new-farmers-in-yolo-county/
- Davis Enterprise article, California FarmLink and CLBL supporting new farmers, July 2013: http://www.davisenterprise.com/local-news/nonprofit-helps-match-up-farmers-landowners/
- CDFA Growing California video on California Farm Academy: http://www.cdfa.ca.gov/egov/video/?id=59
- California Farm Academy website: www.californiafarmacademy.org

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 33	**Project Title:** Increasing Sales of CA Mandarins by Identifying and Preventing Dryness	
Grant Recipient: Cuties Clementine Cooperative	**Grant Agreement No.:** SCB10033	**Date Submitted:** December 2012
Recipient Contact: Dr Etienne Rabe Scott Owens	**Telephone:** Rabe (661) 337-860 Owens (661) 720-2508	**Email:** erabe@paramountcitrus.com sowens@paramountcitrus.com

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Project Purpose: The purpose of the project was to non-destructively identify dry (non-juicy) clementine fruit with the aim of providing the consumer with a consistent eating experience, expanding the demand for California-grown mandarins in the presence of other northern-hemisphere-produced imported mandarin product. Research shows that when consumers get dry mandarins they put off future purchases, often until the next crop year. Addressing this issue is critical to the continued growth of the California (CA) mandarin industry and to position it against potential competition from foreign imports. The CA mandarin industry is relatively young; the first large-scale plantings were done in 1999 in response to the success of Spanish imports to the East Coast. A 2007 study by the Florida Department of Citrus indicated that imports of mandarins from Spain have grown from 67,000 95 lb boxes in 1989 to 1.5 million boxes in 2006, primarily to East Coast markets. Spanish fruit has posed heavy competition for Florida mandarins, and to some extent for CA navel oranges. Research published by the Florida Department of Citrus demonstrates that Spanish imports negatively impact prices for Florida growers; Cuties Clementine Cooperative (CCC) wished to avoid this. The first Spanish mandarins began to reach the West Coast in 2005; while the eating quality of CA mandarins is good, CA fruit does have a higher incidence of dryness than the Spanish fruit due to Spain's cooler growing conditions. This had led to concerns about the CA mandarin industry's continued competitiveness and market growth. Consumer preference for easy-peel citrus fruit is increasing and additional volumes of mandarins - without dryness problems - will be required to meet this demand. If CA cannot meet consumer demand, the volume of imported fruit will increase not only on the East Coast but to the West Coast as well. CCC's project would research and test CA grown mandarins in hopes of finding a solution to the high incidence of dryness. Solving this problem will assist in CCC's primary objective: increasing the purchase frequency and consumption of CA mandarins and position CA grown fruit against expansion of imported mandarins to West Coast markets.

This project did not build on any previously-funded SCBGP project.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Overhead cooling to modify orchard microclimate: [Note: due to the commencement of this sub-project prior to the grant approval, it could not be funded under this grant. CCC nevertheless viewed this as an integral part of the field portion of this proposal]. CCC conducted overhead cooling trials on a 10 acre test plot. This task included erecting misters on trellises over the trees in the test plot, which is not a standard method of irrigation in the citrus industry. Equipment to be purchased included piping, trellising, and computer software and control systems to control on/off values relative to vapor pressure deficits. Bennett & Bennett Irrigation Inc. executed the installation under Sun Pacific supervision. Sun Pacific personnel also oversaw the day to day aspects as well as data collection.

MicroAcoustic Instruments, Inc. investigated various interactions between **ultrasonic waves** on a limited number of fruit samples to try and locate a dominant interaction mechanism that could be used as an ultrasonic indicator of "juiciness." MicroAcoustic attempted to determine if the dominant interaction mechanisms (if any) would provide a high enough signal-to-noise ratio for an air-coupled ultrasonic measurement system to be practical for commercial development. A greater portion of funding was dedicated to year one because of the need to evaluate the applicability of the technology at the onset of the study and to refine the detection mechanism (signal and receiving). Thus, follow-up tests measured different sources of signal and receivers to refine and optimize the methodology, and to eventually integrate it with commercial packing line equipment.

Aspect Technologies in conjunction with Paramount Citrus personnel tested the ability of Nuclear Magnetic Resonance and Magnetic Resonance Imaging **(NMR/MRI)** to detect fruit dryness. Aspect also evaluated the applicability of modifying current in-line processing facilities, including issues such as the speed of the machinery and the number of machines necessary to process all fruit as it is harvested. Aspect's work included developing appropriate software for use with NMR/MRI equipment.

Compac (and Autoline) Sorting Equipment tested the applicability of **Near Infrared (NIR)** technology to detect dryness by executing in-line trials. The aim was also to develop appropriate software necessary to incorporate NIR technology on existing processing equipment.

Biogold USA analyzed **climatic data** from CA clementine and mandarin growing regions with comparisons of climatic data from other foreign clementine-producing countries (i.e., Spain, Morocco, South Africa, Chile, and Australia). Analysis included evaluating climatic patterns (specifically heat unit accumulation and vapor pressure deficits –-- integrating heat units and relative humidity to identify how certain climatic differences affect fruit dryness).

The following aspects proposed in the grant were not addressed due to the lack of a non-destructive method of separating fruit on dryness being available, including (i) Consumer taste test (Tragon), (ii) the online surveys (Luth Research), (iii) Consumer data collection (Perishables Group) and (iv) Postharvest Analysis (UC

Riverside). CCC could not categorize the subject material suitably to subject it to additional consumer taste tests to verify the level of dryness which the public can tolerate/find acceptable.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

1. **Impact of climate modification on dryness levels using overhead misting**: Equipment was installed and supplied by Bennett & Bennett, and research was overseen and data was collected by Sun Pacific Farming. The 2010 summer turned out to be unusually cool compared to other years. Only a few days of high heat were experienced and the overhead mister initiated at 95 degrees Fahrenheit (F). Overhead cooling reduced the canopy temperatures on average of 4 to 8 degrees F. For example, from a high of 103 to 108 down to 95 to 104. Overhead cooling increased juicy fruit to 66%, up from 47% in the control. Brix levels in the juice were marginally lower in the cooled trees (9.8) vs. control (10.1). During 2011, another relatively cool summer, essentially similar results to those of 2010 were obtained. The 2012 summer was, by contrast, classified as hot, exhibiting above normal temperatures with higher heat unit accumulation, especially during the late summer/fall period.

   Application: Since the overhead cooling presented undesirable side effects such as tree canopies being wet for longer periods resulting in higher fungal problems, it is unlikely that this technology will be applicable in practice, even if the data proved to be very good.

2. **Ultrasound tests (Microacoustic Inc)**: During year 1 of the research, air-coupled ultrasonic transducers were used to send ultrasonic waves through the fruit. The data obtained to date has not shown the positive results hoped for at this time. The morphology of the citrus fruit juice sacs causes the dispersion of ultrasound waves, not allowing movement across the juice sacs. The juice sac membranes cause obstacles and redirect the waves. Additionally, the level of “free” space (air) in the fruit between the peel and edible portion and the central cavity cause the waves to lose intensity and weak recapture signal.

   A follow-up study (2011/12) was conducted using resonant acoustic spectroscopy at frequencies below 40kHz to define a method for detecting "juiciness" of fruit. The two shaker systems proposed for this follow-up study have been successfully established and much work has been undertaken to characterize and calibrate these systems. Extensive measurements have been performed both on various calibrating resonators and on clementines at frequencies up to 40kHz using both the low frequency and high frequency shaker systems. Results to date seem to indicate that no vibrational responses of any practical use occur in clementines above a frequency of ~2kHz, but that an encouraging trend, seemingly correlated with a dry-to-juicy scale, does occur in vibrational responses below a frequency of 2kHz.

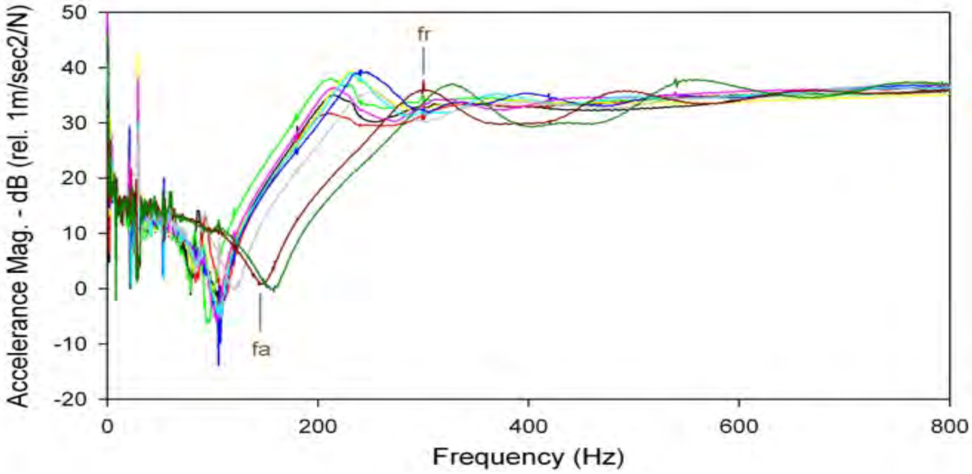

Figure 1: Experimentally obtained frequency response functions for 10 different clementines, as obtained by the low-frequency shaker system. The positions marked “fa” and “fr” on the brown curve indicate the first antiresonance and first resonance frequencies, respectively, for one of the two very dry clementines.

The encouraging trend is best summarized by Figure 1, where typical results obtained by the low-frequency shaker system are displayed for initial shipments of clementines sent to MicroAcoustic. Shown here are 10 frequency response functions, each for a different clementine in a mass range near ~150 grams. The curves plot what is termed the accelerance as a function of the shaker’s vibrational frequency. Accelerance is a measure of how easy it is to accelerate the clementine upon the shaker for a given force, and it varies with frequency as various vibrational resonances or anti-resonances are excited within the clementine. All clementines display essentially the same characteristic accelerance curve, differing primarily in the positions of resonance and antiresonance frequencies. In particular, at low frequencies (near zero) each clementine simply moves up and down on the shaker as a rigid non-vibrating mass, such that the accelerance value is directly related to the inverse of the clementine’s static mass. As the frequency of the shaker increases, the accelerance drops as the first antiresonance frequency (fa) of each clementine is reached. Above the first antiresonance frequency, the accelerance climbs towards a first resonance frequency (fr) after which the clementine undergoes a series of higher-order antiresonant and resonant vibrations with increasing frequency. By a frequency of 800Hz (at the upper frequency in the figure) the clementine is barely vibrating at all and the accelerance trends toward a value related to the inverse of the mass of the support structure (i.e., at this point it is as if the clementine is not on the shaker at all). The vibrational mode shapes for the first antiresonant and resonant vibrations of a clementine (fa and fr) have been separately mapped by a roving accelerometer and so the shapes of these characteristic vibrations are now well understood.

The important trend to note from Figure 1 is that two of the curves in particular (the brown and green curves) are shifted significantly towards the right (towards higher frequencies) compared to the others which are more closely clustered together to the left. Acoustically, such shifting of vibrational modes toward higher frequencies indicates that these two clementines are acting as if they are much stiffer than the others (i.e., have higher elastic constants). Indeed, upon dissection it was found that the 8 clementines with curves to the left were juicy and colorful and flavorful compared to the two clementines whose curves were shifted to the right which were comparatively very dry and with little flavor. Recall that such a relationship was predicted in the Microacoustic first stage feasibility study for ultrasonic characterization of clementines, where simplified load-cell measurements suggested that Young's modulus (stiffness) was considerably higher for the dryer fruit. The results shown in Figure 1 were not isolated of course, but repeatable, even for different size- (mass-) groupings, as subsequent tests on the remainder of the initial shipments of clementines showed.

By the end of testing the initial shipment of fruit, there was every indication of a possible route forward for development of a practical online inspection system for detection of juicy fruit. The subsequent research was somewhat hampered due to some batches of fruit arriving into Canada at the lab in non-optimal condition, presumably over-nighted in unprotected warehouses and the fruit being frozen, losing the acoustic abilities. Much time was unproductively spent on fruit which lost its characteristics. The final results were thus inconclusive at the end of the present study, but with enough data obtained from the initial fruit shipments to provide reason for optimism that this approach will be able to practically differentiate between dry and juicy fruit.

3. **Climatic Analysis**: The main conclusions were: (i) comparing the clementine growing regions in the Central Valley of CA with Valencia, Spain, as the benchmark climate based on quality clementine production (plus a few other regions of known quality clementine production) it is clear that there are both higher heat unit but more specifically substantially higher vapor pressure deficits (VPD). [The VPD's are an indication of the level of "stress" the plant experiences under high temperatures and accompanying low humidities]; (ii) the one area (Marakech, Morocco) with higher VPD's than Arvin, CA, grows a different, more juicy selection of clementines to what is grown in CA; (iii) due to urbanization in Spain in the Valencia region, the Spanish industry is moving south into hotter, less humid regions (eg, Sevilla, with slightly lower VPD's than the Central Valley) but where they are also starting to experience more dryness, especially on the early-maturing selections of clementines.

4. **NMR/MRI tests (Aspect Technologies)**: After some initial testing it became clear quite soon as to the challenges that will be faced to convert this into a usable technology, even in the longer term, and further evaluation was ceased.

5. **Near-infrared tests (Compac/Autoline)**: Initial evaluation, soon after the commencement of the grant, indicated promise but repeatability was unsatisfactory. The technology will have to be refined by the manufacturers to render it usable in this regard.

   A very large part of the proposed study was predicated on finding a non-destructive method to quantify dryness. It became apparent that a non-destructive method using two of the three proposed methods could not be utilized without extensive time and challenges to convert the methods into usable technologies. Due to the higher potential for results, CCC shifted the focus to the ultrasound technology; however, the ultrasound method requires refinement to develop it into a reliable non-destructive method to quantify dryness. Lack of a reliable non-destructive method to quantify dryness combined with an overly optimistic work plan and timeline resulted in the expected measurable outcomes not being met.

   Although, the expected measurable outcomes were not realized, CCC did find encouraging information relating to the ultrasound technology which will be pursued beyond this grant. Additionally, the climatic survey of Clementine-growing regions in the world, comparing optimal vs less optimal climates allowed CCC to separate growing regions by variables such as heat unit levels and vapor pressure deficits.

During the last 3 years, via a concerted marketing effort from the Cutie Clementine Cooperative, the goal of growing the market to per capita consumption in excess of 2 lbs per person has been achieved. In fact, the per capita consumption of California mandarins is estimated to be closer to 2.5 lbs per year at this time.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The CCC and its associated members (Paramount Citrus, Sun Pacific and Fowler Packing) were all to a more or lesser degree involved in the planning and subsequent execution of the research. While Paramount Citrus took the overall coordination role, Sun Pacific performed the overhead cooling project. The CA mandarin industry, with the CCC being a very major component in terms of acreage and volume (in excess of 60% of volume) has learnt a lot, even if some aspects may have yielded no implementable technology to date. It at least closed certain avenues of research for future similar endeavors. There is no quantitative data available yet that can be applied. The Microacoustic/Ultrasound research holds the most promise and will be continued with via own funding from the group. A good foundation exists in this regard and proof of concept is nearly completed and expected after the 2012/13 harvest season. The group is willing to continue to build on this investment to eventually establish a commercial unit to sort non-destructively via ultrasound technology. In addition, CCC has reason to be optimistic that the NIR technology is moving towards being able to sort on dryness, at least at some level. The climatic information and overhead cooling data will be used by the group to (i) mitigate orchard stress as much as possible and (ii) look at changing the clementine selection planted towards juicier subvarieties where possible.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The initial premise of the project was to develop non-destructive technology to separate fruit on dryness/juiciness levels. The execution of the other subprojects was dependent on having a non-destructive technology available. To the end of finding a non-destructive technology, CCC proposed to evaluate one existing technology (near-infrared), one technology fairly well advanced to evaluate such tools (nuclear magnetic resonance) and one totally new technology (ultrasound). NIR (to date) and NMR (seemingly too difficult to be adapted to obtain commercial speeds) fell by the wayside early on. Ultrasound ended up the only avenue of promise. This was, and is, a pleasant surprise to us. Thus, most of the other subprojects dependent on a technology to sort for dryness could not be adequately performed. The submitted proposal was too optimistic relative to the timelines.

The group learned valuable information as outlined in the previous section: (i) CCC believes the final proof of concept for the ultrasound technology would be achieved with additional research during this harvest season; if the data obtained on the sound fruit of 2011/12 study is re-demonstrated, it would have be achieved and (ii) the microclimate mitigation aspects in the orchard coupled with possible changes, where practical, to the juicier (but smaller-fruited) subvarieties provides helpful avenues to mitigate the dryness issues, even in the absence of quantitative dryness separation technology.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 34	Project Title: Bird Depredation to Almonds, Lettuce, Melons and Ginseng	
Grant Recipient: United States Department of Agriculture, National Wildlife Research Center	**Grant Agreement No.:** SCB10034	**Date Submitted:** December 2013
Recipient Contact: Scott Werner	**Telephone:** (970) 266-6136	**Email:** Scott.J.Werner@aphis.usda.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Several bird species cause monetary losses to agricultural production throughout the world. For example, migratory birds cause substantial damage to ripening fruit crops. Scientists at the USDA National Wildlife Research Center (NWRC) previously estimated that birds caused \$8.5 million of damage to blueberry production in the United States (Avery et al. 1993). Whereas lettuce is an important economic crop in California, bird depredation to recently planted crops is a primary concern throughout many production areas. Most respondents associated with a recent NWRC survey reported that wild turkeys were present (83%) and cause damage (60%) at their ginseng facilities every year (Werner et al., unpublished results). These losses have motivated the use of several bird damage management techniques, including chemical repellents.

It is imperative that California develop a comprehensive integrated pest management program to identify and mitigate potential hazards associated with bird depredation to specialty crops. Although methyl anthranilate is currently registered for agricultural applications, Werner et al. (2005) concluded that Bird Shield® (a.i. 26.4% methyl anthranilate; Bird Shield Repellent Corp., Pullman, WA) was not effective for repelling blackbirds.

Although anthraquinone repellents are not currently registered for agricultural applications, the manufacturer (Arkion Life Sciences, New Castle, DE) was issued labels (FIFRA Section 18) for corn seed treatments in Louisiana, Michigan, Minnesota, Mississippi, North Dakota, South Dakota, Texas, and Wisconsin; and rice seed treatments in Louisiana, Mississippi, and Missouri during the 2009 growing season. Through laboratory efficacy testing, Werner et al. (2009) recently estimated threshold concentrations of an anthraquinone-based repellent (a.i. 50% 9,10-anthraquinone; Arkion Life Sciences) for Canada geese offered treated corn seeds (threshold concentration needed for ≥80% repellency = 1,450 ppm anthraquinone), red-winged blackbirds offered treated rice (>5,000 ppm anthraquinone) and sunflower seeds (1,475 ppm anthraquinone), and ring-necked pheasants offered treated corn (10,450 ppm anthraquinone) and sunflower seeds (>2,000 ppm anthraquinone). Laboratory efficacy data are currently needed for small fruit, vegetables, and other specialty crops affected by bird depredation.

NOTE: It was determined that lettuce seedlings as a food source would not yield suitable data for this project; therefore, rice, wheat, corn, oat and almonds, treated with anthraquinone, were used as the food sources.

Horned Larks

Horned larks (*Eremophila alpestris*) severely damage lettuce, carrots, beets, spinach, turnips, and peas in California (Neff 1948). California's lettuce crop (*Lactuca sativa*) is economically important; it comprised approximately 77,000 ha of lettuce valued at $735 million in 1996 (California Farm Bureau Federation web page, 1998), 101,000 ha valued at $1.3 billion in 2002 (cfbf.com, 2002), and $1.6 billion in 2010 (CDFA.ca.gov/statistics 2011–12). In 1974, approximately 45% of survey respondents regarded bird damage as a serious problem among California lettuce growers (DeHaven 1974). Bird damage to newly-planted lettuce remains a major problem in several production areas in California, including the San Joaquin Valley, the central coast, and southern California (Hueth et al. 1998; Gebhardt et al. 2011).

York et al. (2000) suggested that horned larks cause the majority of damage to California lettuce production. Horned larks consume lettuce seeds, uproot seedlings, and graze seedling leaves (cotyledons). Damaged lettuce seedlings are typically stunted or disfigured, and thus disrupt harvest schedules. Horned larks are most abundant and cause most damage to lettuce seedlings from November–January in the Central Valley of California (York et al. 2000). Lettuce seedlings are most susceptible to bird damage during the two weeks subsequent to seedling emergence, unless cold weather delays growth (York et al. 2000). Lettuce damage typically continues until seedlings are approximately 8 cm tall, and severe damage caused by horned larks typically occurs first near the center of lettuce fields (Cummings et al. 2006). These damages have motivated the use of several bird damage management techniques, including chemical repellents.

Although methiocarb-based chemical repellents effectively reduced horned lark damage to lettuce seedlings during an aviary test (Cummings et al. 1998) and a field enclosure study (York et al. 2000), methiocarb is no longer registered as a bird repellent for use on food crops.

Anthraquinone-based repellents have also been previously tested with horned larks and lettuce seedlings. York et al. (2000) observed 60% damage (505 of 841 lettuce seedlings "destroyed") among field enclosures that contained horned larks and lettuce seedlings treated with "2.79 kg ha^{-1}" Flight Control™ (a.i. 50% 9,10-anthraquinone; Arkion Life Sciences, New Castle, DE). Cummings et al. (2006) observed 8% damage (44 of 522 lettuce seedlings consumed) among field enclosures that contained horned larks and lettuce seedlings treated with 10 L Flight Control™ per ha. The present study was designed to evaluate repellency of foliar applications of an anthraquinone-based repellent on emergent lettuce seedlings and develop an anthraquinone concentration-response relationship for horned larks in captivity.

Great-tailed Grackles

Great-tailed grackles (*Quiscalus mexicanus*) have caused damage within Texas citrus groves (Hobbs & Leon 1987; Johnson et al. 1989; Glahn et al. 1997). Recent laboratory efficacy studies have estimated the threshold concentration of anthraquinone as a chemical repellent for common grackles (*Quiscalus quiscula*; Werner et al. 2011). The present study was designed to evaluate repellency of an anthraquinone-based repellent and develop an anthraquinone concentration-response relationship for great-tailed grackles in captivity.

American Crows

The 2006 NWRC Research Needs Assessment revealed the priority for damage management research. Specific research needs include the development of new and improved methods (e.g., repellents) to mitigate the impacts of crows (Bruggers et al. 2002). Gebhardt et al. (2011) estimated that the expected yield loss per damaged acre of almonds was 5.1% in California; crows were most commonly regarded as the vertebrate pests associated with California almond depredation. This study was designed to evaluate an anthraquinone-based repellent for American crows (*Corvus brachyrhynchos*) in captivity. The purpose of this present study was to predict the threshold concentration (i.e. 80% repellency) of an anthraquinone-based repellent for American crows offered treated almonds.

Wild Turkeys

Wild turkeys negatively impact ginseng production during seed production (Scott et al. 1995) and late-winter scratching by flocks within partially-melted ginseng gardens (i.e., crown scarification; Joe Heil-President, Ginseng Board of Wisconsin, Inc., pers. comm.).

The most difficult human-wild turkey conflicts may occur with high-value specialty crops (e.g., ginseng) on small acreages interspersed in woodland turkey habitat (Miller et al. 2000). Wild turkeys negatively impact ginseng production during seed production (Scott et al. 1995) and late-winter scratching by flocks within partially-melted ginseng gardens (i.e., crown scarification; Joe Heil- President, Ginseng Board of Wisconsin, Inc., pers. comm.). An oat seed treatment as an avian repellent for wild turkeys was evaluated; active ingredient of the repellent seed treatment is 9,10-anthraquinone (Arkion Life Sciences, New Castle, DE). The study reported herein was designed to develop a concentration-response relationship of an anthraquinone-based repellent for wild turkeys.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Horned Larks

<u>Preference testing with treated lettuce seedlings.</u>

This study involved preference testing among individually-caged horned larks offered untreated lettuce seedlings and lettuce seedlings treated with a foliar application of an anthraquinone-based repellent. The anthraquinone-based repellent used for lettuce treatments included 50% 9,10-anthraquinone (Arkion Life Sciences).

Acclimation: Experimentally-naïve horned larks (N = 54) acclimated within individual cages for five days. During the acclimation period, one food bowl was presented on each of the north and south sides of each cage. Both food bowls contained 150 g of the maintenance diet. The project team measured maintenance diet consumption, assigned larks to one of five test groups, and randomly assigned treatments among groups at the conclusion of the acclimation period.

Preference test: Two pans (21 cm × 11 cm × 6 cm) were presented at approximately 0800 hrs, daily for up to four days of testing (dependent upon daily lettuce consumption). One pan contained repellent-treated lettuce seedlings; the remaining pan contained unadulterated lettuce seedlings. The north-south placement of pans was randomized on the first day and alternated on subsequent days of the preference test. Treatment groups (n = 10–11 horned larks per group) were exposed to untreated lettuce seedlings and lettuce seedlings treated with foliar applications comparable to 2.3 L repellent ha-1, 4.7 L ha-1, 9.4 L ha-1, 14 L ha-1, and 18.7 L ha-1, respectively (Werner et al. 2011). Lettuce seedlings were counted in all pans prior and subsequent to the preference test. The test was concluded when <10% of untreated lettuce seedlings remained among cages.

Due to the low amount of lettuce seedlings consumed by the larks during the preference test phase, the NWRC determined that using lettuce seedlings as the food source would not yield sufficient usable data to develop an anthraquinone concentration response relationship. Therefore, NWRC used wheat seeds as the food source.

This study involved concentration-response testing among individually-caged horned larks offered whole wheat seeds treated with an anthraquinone-based repellent. The anthraquinone-based repellent used for wheat seed treatments included 50% 9,10-anthraquinone (Arkion Life Sciences).

Acclimation: The horned larks associated with the previous preference test (N = 54) acclimated within individual cages for five days (Wednesday–Sunday). During the acclimation period, one food bowl that contained 30 g of maintenance diet was presented within each cage at approximately 0800 hrs, daily.

Pre-test: One bowl (30 g of unadulterated wheat) was presented within each cage at approximately 0800 hrs, daily for three days (Monday –Wednesday). The birds were ranked based upon average pre-test consumption and assigned them to one of six test groups. Test treatments were randomly assigned (i.e., 0.02–0.5% anthraquinone; wt/wt) among groups. Daily consumption was measured on Tuesday–Thursday.

Test: One bowl (30 g of repellent-treated wheat) was presented within each cage at approximately 0800 hrs on Thursday. Horned larks in treatment groups 1–6 (n = 9 horned larks per group) received one bowl of 0.02%, 0.035%, 0.05%, 0.1%, 0.25%, or 0.5% anthraquinone during the test, respectively. Daily consumption was measured on Friday. Linear regression was used to analyze lark feeding repellency as a function of tested anthraquinone concentrations. The NWRC Analytical Chemistry Unit used high performance liquid chromatography (Werner et al. 2009, 2011) to quantify anthraquinone residues among wheat seed treatments.

Great-tailed Grackles

This study involved concentration-response testing among individually-caged, great-tailed grackles offered untreated food and food treated with an anthraquinone-based repellent. The anthraquinone-based repellent used for food treatments included 50% 9,10-anthraquinone (Arkion Life Sciences, New Castle, DE). Rather than melons, rice seeds were selected as the food source for this feeding experiment based upon previous observations of seasonal food preference and energetic requirements of great-tailed grackles under captive and field conditions. Water was provided ad-libitum throughout the feeding experiment (acclimation, pre-test, test).

Acclimation: Experimentally-naïve, great-tailed grackles (N = 54 females) acclimated within individual cages for five days. One bowl of rice seeds was presented on the north side of each cage throughout the acclimation period.
Pre-test: One food bowl was presented at approximately 0800 hrs, daily during the three-day pre-test. The bowl contained 75 g of unadulterated rice seeds. Consumption was measured, grackles were assigned to one of five test groups, and treatments were randomly assigned among groups at the conclusion of the pre-test.

Preference test: One food bowl was presented at approximately 0800 hrs on the day of the test. The bowl contained 75 g of repellent-treated rice seeds. Treatments for test groups 1–5 (n = 10–11 birds per group) included targeted concentrations of 0.25%, 0.5%, 1%, 2%, and 4% anthraquinone, respectively (Werner et al. 2011). Consumption was measured at approximately 0800 hrs on the day subsequent to the preference test. The NWRC Analytical Chemistry Unit used high performance liquid chromatography to determine actual anthraquinone concentrations (± 10 ppm) among rice seed treatments.

American Crows
This study involved concentration-response testing among American crows offered anthraquinone-treated almonds. Forty five American crows were live-captured in Oklahoma and transported to Colorado for this study. All crows were maintained in a group during quarantine and holding by the NWRC Animal Care Unit. Crows were quarantined for a minimum of 5 days prior to testing. Water was provided throughout the study (quarantine, holding, acclimation, testing). The maintenance diet was provided throughout quarantine and holding.

Experimentally-naïve American crows (N = 45) acclimated within individual cages for five days (Wednesday–Sunday). During the acclimation period, one food bowl that contained untreated almonds (raw, shelled) was presented on the north side of the cage at 0800 hrs, daily.

Pre-test. One bowl (untreated almonds) was presented on the north side of the cage at 0800 hrs, daily for three days (Monday–Wednesday). Crows were ranked based upon pre-test consumption and assigned to one of five test groups (n = 9 birds per group) at the conclusion of the pre-test. The project team then randomly assigned test treatments among groups.

Test. One bowl (anthraquinone-treated almonds) was presented on the north side of the cage at 0800 hrs on Thursday. Groups 1–5 received almonds treated with 0% (control), 0.5%, 1%, 2%, or 4% anthraquinone, respectively (target concentrations, wt/wt). Daily almond consumption was measured on Friday. The NWRC Analytical Chemistry Unit used high performance liquid chromatography to quantify actual anthraquinone concentrations among almond treatments (± 100 ppm anthraquinone).

Wild Turkeys
<u>Gobbler concentration-response experiment.</u>
Acclimation: Male wild turkeys (*N* = 16, experimentally naïve) acclimated within individual cages for five days (Wednesday–Sunday). During the acclimation period, one food bowl that contained 500 g of unadulterated oats was presented in each cage at approximately 0800 hrs, daily.

Pre-test: One bowl (500 g of unadulterated oats) was presented in each cage at approximately 0800 hrs, daily for three days (Monday–Wednesday). Gobblers were ranked based upon average pre-test consumption and assigned them to one of four test groups. Test treatments were randomly assigned among groups. Daily consumption was measured on Tuesday–Thursday.

Test: One bowl (500 g of repellent-treated oats) was presented in each cage at approximately 0800 hrs on Thursday. Birds in treatment groups one–four (n = four gobblers per group) received one bowl of 0.5%, 1%, 2%, or 4% anthraquinone (target concentrations, wt/wt) during the test, respectively. Daily consumption was measured on Friday. Gobbler repellency was calculated as test consumption of anthraquinone-treated oats relative to average pre-test consumption of untreated oats (Werner et al. 2009, 2011). Logarithmic regression procedures were used (SAS v9.2) to analyze gobbler repellency as a function of actual anthraquinone concentration (± 100 ppm anthraquinone; high performance liquid chromatography [HPLC] analyses were performed by the NWRC Analytical Chemistry Unit for each tested anthraquinone concentration) and predict a threshold anthraquinone concentration (i.e. 80% repellency; Werner et al. 2009, 2011). Descriptive statistics ($\bar{x}$ ± SE) were used to summarize gobbler repellency associated with anthraquinone-treated oats.

Hen concentration-response experiment.
Acclimation: Female wild turkeys (N = 40, experimentally naïve) acclimated within group cages (two hens per cage) for five days (Wednesday–Sunday). During the acclimation period, one food bowl that contained 1000 g of unadulterated oats was presented in each cage at approximately 0800 hrs, daily.

Pre-test: One bowl (1000 g of unadulterated oats) was presented in each cage at approximately 0800 hrs, daily for three days (Monday–Wednesday). Cages were ranked based upon average pre-test consumption and assigned them to one of five test groups. Test treatments were randomly among groups. Daily consumption was measured on Tuesday–Thursday.

Test: One bowl (1000 g of repellent-treated oats) was presented in each cage at approximately 0800 hrs on Thursday. Hens in treatment groups one–five (n = four hen cages per group) received one bowl of 0%, 0.5%, 1%, 2%, or 4% anthraquinone (target concentrations, wt/wt) during the test, respectively. Daily consumption was measured on Friday. Hen repellency was calculated as test consumption of anthraquinone-treated oats relative to average pre-test consumption of untreated oats (Werner et al. 2009, 2011). Again, logarithmic regression procedures were used (SAS v9.2) to analyze hen repellency as a function of actual anthraquinone concentration (± 100 ppm anthraquinone; NWRC Analytical Chemistry Unit) and predict a threshold anthraquinone concentration (i.e. 80% repellency; Werner et al. 2009, 2011). Descriptive statistics ($\bar{x}$ ± SE) were used to summarize hen repellency associated with anthraquinone-treated oats.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The goal of this project was to generate repellent efficacy data necessary for development and registration of an avian repellent for managing agricultural depredation of specialty crops.

Horned Larks

Preference testing with treated lettuce seedlings.

Horned larks consumed fewer than 10 lettuce seedlings during the first day of the preference test (i.e., from treated and untreated pans, combined). For the purpose of developing an anthraquinone concentration-response relationship for horned larks in captivity, the project team therefore terminated the lettuce seedling preference test and completed a concentration-response test with anthraquinone-treated wheat seeds.

The project team observed 38–100% feeding repellency among horned larks offered wheat seeds treated with target concentrations of 0.02–0.5% anthraquinone. Actual anthraquinone concentrations for the 0.02%, 0.035%, 0.05%, 0.1%, 0.25%, and 0.5% anthraquinone seed treatments were 168, 323, 312, 716, 2150, and 3010 ppm anthraquinone, respectively. Lark repellency was not related to actual anthraquinone concentrations ($r2 = 0.55$; $P = 0.091$). However, 100% feeding repellency was observed among horned larks offered wheat seeds treated with 3,010 ppm anthraquinone; the project team previously targeted ≥75% repellency for the concentration-response experiments (Werner et al. 2008a,b, 2009, 2010, 2011). Thus, horned larks were effectively repelled from wheat seeds treated with a target concentration of 0.5% anthraquinone. Subsequent field efficacy testing is recommended for horned larks exposed to lettuce seeds (i.e., preplant seed treatments) and lettuce seedlings (i.e., foliar applications to emergent seedlings) treated with ≥3,000 ppm anthraquinone.

Great-tailed Grackles

Great-tailed grackles exposed to rice seeds treated with target concentrations of 0.25–4% anthraquinone exhibited 90–99.5% repellency during the concentration-response experiment. Actual anthraquinone concentrations for rice seed treatments were: 2060 ppm, 3710 ppm, 8480 ppm, and 16500 ppm, and 35400 ppm anthraquinone, respectively. Great-tailed grackle repellency (y) was a function of anthraquinone concentration (x): $y = 3.110 \ln(x) + 67.366$ ($r2 = 0.78$, $P = 0.0471$). Thus, laboratory efficacy (i.e. ≥ 80% repellency) of this anthraquinone-based repellent was observed at lower concentrations for great-tailed grackles offered treated rice seeds (≥ 2060 ppm anthraquinone) than common grackles offered treated sunflower seeds (≥ 9000 ppm anthraquinone; Werner et al. 2011).

American Crows

American crows exposed to almonds treated with 0.5–4% anthraquinone exhibited 80–100% repellency during the concentration-response experiment. Actual anthraquinone concentrations for the 0.5–4% anthraquinone-treated almonds were: 2980 ppm, 7380 ppm, 14700 ppm, and 31500 ppm anthraquinone, respectively. Crow repellency (y) was a function of anthraquinone concentration (x): $y = 17.130 \ln(x) - 66.246$ ($r2 = 0.99$, $P < 0.001$). Therefore, a threshold concentration of 5200 ppm anthraquinone is predicted for American crows offered treated almonds.

Wild Turkeys

Gobbler concentration-response experiment.

Gobblers exposed to oats treated with 0.5–4% anthraquinone exhibited 78–99% repellency during repellent exposure. Actual anthraquinone concentrations for the 0.5–4% anthraquinone-treated oats used for both the gobbler and hen experiments were: 4120 ppm, 8820 ppm, 19100 ppm, and 34400 ppm anthraquinone, respectively. Gobbler repellency (y) was a function of anthraquinone concentration (x): $y = 9.921 \ln(x) -$

2.260 ($r^2 = 0.93$, $P = 0.034$). Therefore, predict a threshold concentration of 4,000 ppm anthraquinone is predicted for gobblers offered treated oats.

Hen concentration-response experiment.
Hens in the control group (<0.5 ppm anthraquinone; HPLC method limit of detection) consumed 216.1 ± 21.0 g of untreated oats during the test; their average, pre-test consumption of untreated oats was 193.3 ± 22.5 g. In contrast, hens exposed to oats treated with 0.5–4% anthraquinone exhibited 75–98% repellency during repellent exposure. Hen repellency (y) was a function of anthraquinone concentration (x): $y = 10.746 \ln(x) - 12.029$ ($r^2 = 0.94$, $P = 0.030$). Therefore, a threshold concentration of 5,300 ppm anthraquinone (i.e. 80% repellency) is predicted for hens offered treated oats.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The eventual registration of an anthraquinone-based repellent will impact over 9,000 specialty crop growers, and the specialty crop growers will benefit from reduced control costs, reduced avian depredation and increased yields. The ultimate effectiveness of chemical repellents is dependent upon their efficacy under field conditions, cost relative to expected damages of unmanaged crops, environmental impacts, and food and feed safety. Thus, the efficacy data generated by this project will be reconciled with these economic, environmental, and safety thresholds. No such repellent currently exists for managing avian depredation of specialty crops. This active ingredient has the potential to be a more cost effective and efficacious alternative to other control methods.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The Expected Measurable Outcome of this Specialty Crop Block Grant was successfully achieved by generating repellent efficacy data for an anthraquinone-based repellent offered to horned larks, great-tailed grackles, American crows, and wild turkeys associated with specialty crop depredation. The eventual registration of an anthraquinone-based repellent will impact over 9,000 specialty crop growers, and agricultural producers that experience avian depredation of their emergent and ripening crops. Many lessons were learned throughout the project about feeding response to an anthraquinone-based repellent under captive conditions. Unexpected outcomes included less than 80% repellency of wheat seed treatments including up to 0.5% anthraquinone (wt/wt) in horned larks.

It was unexpected that lettuce seedlings as a food source for the birds would not yield sufficient data. Another food source had to be found, and rice, wheat, oats, corn, and almonds treated with anthraquinone were successfully used.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

USDA Project No.: 35	Project Title: California Agricultural Communications Coalition Social Media Outreach Plan	
Grant Recipient: Western Growers	**Grant Agreement No.:** SCB10035	**Date Submitted:** December 2012
Recipient Contact: Cory Lunde	**Telephone:** (949) 885-2264	**Email:** clunde@wga.com

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

There was an obvious disconnection between California consumers and the farmers who produce their food supply. To address this challenge, the California Agricultural Communications Coalition (CACC) was formed to help develop and deliver proactive, positive, farmer-driven messages to California consumers. The 2009 Specialty Crop Block Grant Program (SCBGP), Project 6 (SCB09001), was secured to help launch the CACC and the www.KnowACaliforniaFarmer.com (KACF.com) website, the hub of all CACC- related activities. The KACF.com website served, and continues to serve, as an online platform to connect consumers to the source of their food supply, and for consumers and farmers to engage in genuine dialogue around the key issues facing the California agricultural industry.

The purpose of this SCBGP (SCB10035) was to amplify the work being done with the 2009 SCBGP, Project 6. In recent years, California consumers have increasingly relied on social media as a source for news and other information about the topics that matter most to them, including California agriculture. In addition to receiving much of their information from social media sites, many consumers are also engaged in online communities and participate in robust conversations about important issues, including food and agriculture. The project team felt that it was important for the specialty crop industry to be aware of these discussions and become involved in the type of dialogue that influences consumer perceptions of California farmers.

This current project was designed to equip the specialty crop industry to connect with consumers using the KACF.com website and other social media tools.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

The primary focus of the project was to provide social media training for specialty crop farmers throughout California. All total, ten (10) social media workshops with more than 335 specialty crop farmers and affiliated industry members were conducted. Workshops were held in Yuba City, Lodi, Modesto, Fresno, Bakersfield, Santa Rosa, Monterey, San Luis Obispo, Ventura, and Temecula. The workshops emphasized the development of content (i.e. blogs, videos, photos) for the KACF.com website and other social media platforms. Participants were also provided with an opportunity to learn how to utilize social media to enhance their relationships with customers. Other key topics covered in the workshops included how to generate thoughtful social media content around the issues facing California agriculture, how to develop social media networks to push content out to California consumers, best management practices for engaging in dialogue with online detractors, and basic Facebook and Twitter mechanics/strategies. The workshops were well-received and resulted in a spike in content on KACF.com after each session. Following each workshop, the AdFarm team reached out to all of the participants encouraging contributions to the KACF.com website, and has remained in contact with key attendees to keep them engaged as champions for the effort.

During and after each social media training session, key allies emerged; these participants were the most engaged and ready to actively support the CACC and the KACF.com effort. Relationships have been maintained with the key influencers and they continue to be some of the biggest supporters of the CACC. The strongest farmer allies represent a wide swath of the specialty crop industry, including growers of almonds, peaches, strawberries, fresh cut flowers, lettuce, cantaloupe, wine grapes, olives, walnuts, asparagus, and more. These farmers carry the Know a California Farmer message with them, passionately sharing with other farmer groups, friends, and non-agriculture organizations. They are now the foundation of the CACC effort. The relationships established with these farmers are immeasurable. They are highly influential, engaged in social media, engaged with food audiences, active in numerous organizations and willing to speak out to tell their multi-generational family farming stories.

In addition to the social media workshops, a number of other activities were conducted including a blogger tour, which was conducted to better connect urban food bloggers to California specialty crop farmers. Two bloggers from the Bay area, two from Fresno and one from San Luis Obispo participated in a two-day farm tour on the Central Coast. Bloggers visited six specialty crop farms that produced commodities ranging from wine grapes to olives and bok choy to bell peppers. The tour focused on a variety of agricultural practices and covered key agricultural issues such as labor, water supply, government regulation and nutrition. Social media played a key role in disseminating messages during the tour. Bloggers and AdFarm staff blogged, tweeted and posted information they were learning over the two-day tour. Results showed more than 1.8 million impressions were made on Twitter alone.

Another project activity was social media monitoring, which was ongoing and culled to provide CACC members with updates on issues most relevant and engaging to consumers via the bi-weekly E-newsletter. Quarterly reports were issued to the CACC Steering Committee to provide stats on the website, including social media mention stats, trends, and opportunities for further promoting the core messages of the CACC.

Key KACF.com website analytics being tracked include total visits, unique visitors, page views, average pages per visit, average time on website, visits from mobile devices, traffic sources, top keyword searches, top sections and content viewed, top authors and social mentions. The top line social media stats include more than 5,600 total social mentions (Twitter feeds, blogs, open social networks, mainstream media, video/photo sharing). Looking at the overall social media statistics from a monitoring system for the two years of the program, the results are good, but not great. Comments are regularly happening in a variety of social spaces, but farmer participation was not as much as the project team had hoped for in spreading the word about the Know A California Farmer effort. The positive news is that the project team has built relationships with several high profile California farmers that do have a large social reach; they actively promote content and the efforts of the CACC. Moving forward the project team will need to keep encouraging farmers to not only create content for the site, but to then share the content with their social graphs as well, and also spread the word about KACF.com via word of mouth.

Finally, the content in the Communications Toolbox was also reviewed and maintained. Materials from the "Ask a Farmer" social media training sessions and an archive of the E-newsletter were added and updated every week. As of September 30, 2012, the total number of Communication Toolbox pages viewed was 9,860, which demonstrates the value of the resource for specialty crop farmers desiring to learn more about social media and how to use the KACF.com website.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The performance goals established at the beginning of the project correlated with the approved tactics and communications plan, which was designed to engage both members of the California specialty crop industry and California consumers in the KACF.com website and related social media platforms (i.e. Facebook and Twitter). As such, the following project goals were established:

Goal #1: *Provide the specialty crop industry (farmers and affiliated organizations) with the training and tools they need to effectively use social media to engage consumers and improve public perceptions of agriculture as measured by 200 specialty crop farmers and affiliated organizations attendees at 9 total social media workshops.*
The project team was successful in achieving this goal as 337 industry members attended 10 social media workshops.

Goal #2: *Engage both specialty crop farmers (and affiliated organizations) and consumers in the KACF.com website and related social media platforms (i.e. Facebook and Twitter) as measured by the following metrics:*

CACC Members
- *Register 300 total contributors to the KACF.com website by September 30, 2012.*
- *Average at least two (2) new pieces of content (videos, photos or blogs) per day over the course of the October 1, 2010 to September 30, 2012 time period.*

California Consumers
- *2,500 Facebook likes.*
- *1,000 Twitter followers.*
- *1,000 unique visitors to the KACF.com website per month.*
- *250 (25%) repeat visitors to the KACF.com website per month.*
- *Maintain at least a three (3:00) minute average time spent per visit on the KACF.com website.*

- *Maintain an average of three (3) pages viewed per visit.*

For the time period October 1, 2010, to September 30, 2012 the following statistics were measured:

CACC Members
- A total of 620 registered contributors to the KACF.com website (well above the goal of 300 registered contributors).
- A total of 355 videos, more than 600 pictures, and over 500 blogs on the KACF.com website, for an average of almost exactly two pieces of content per day during the October 1, 2010 to September 30, 2012 time period (met target of two pieces of content per day).

California Consumers
- 3,080 Facebook likes (well above the target of 2,500 Facebook likes). More importantly, and not stated as a goal, the KACF.com Facebook page received 25,950 total visits and approximately 2,200 likes and comments on update statuses posted to the wall. This demonstrates that the KACF.com Facebook page established itself as a credible destination for conversations about California agriculture.
- 1,661 Twitter followers (well above the target of 1,000 Twitter followers).
- More than 30,000 unique visitors visited the KACF.com website, an average of 1,250 visits per month (well above the 1,000 visits per month target).
- A total of 16,000 repeat visitors visited the KACF.com website, an average of 665 per month or 53% of the unique visitors (well above the targets of 250/25% repeat visitors).
- An average of 2 minutes and 43 seconds spent on KACF.com per visit (slightly below the target of 3 minute per visit, but still within range).
- An average of 3.1 pages viewed per visit (slightly above the target of 3 pages viewed per visit).
- Collectively, more than 28,000 YouTube videos, 50,500 blog posts, and 8,900 photos were viewed by California consumers visiting the KACF.com website during October 1, 2010 – September 30, 2012.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The primary beneficiaries of this project were the 620 members of the specialty crop industry directly engaged in the KACF.com website and related CACC activities. These active contributors benefited from the social media training provided by the project, as well as the enhanced ability and opportunity to engage with consumers using various social media platforms, including the KACF.com website, Facebook, and Twitter. Indirectly, as the CACC core messages reached more than 30,000 unique Californian consumers, the broader specialty crop industry has benefited, and will continue to benefit, from better informed consumers and a more supportive general public. Furthermore, the 620 contributors to the KACF.com website have stood on the front lines of the social media revolution and have helped, and are continuing to help, put a face on California agriculture and reconnect consumers to the source of their food supply. Ultimately, the KACF.com website has helped to transform how specialty crop farmers communicate with, and relate to, California consumers. It enables the specialty crop industry to share their passion and livelihood with potentially more than 37 million Californians throughout the state, making what they do, and why they do it, much more meaningful and relevant to the general public.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

In order for a project such as this to be exceedingly successful, one geared around new technologies and methods of communication, it requires that a tipping point be reached, a point at which a critical mass of the industry becomes intimately engaged. Unfortunately, the project did not experience a tipping point scenario. Therefore, the primary lesson learned in this project is the fact that when dealing with new communications technologies like social media, the California agricultural industry is generally slow to adopt new approaches to connecting with consumers (if they are even interested in consumer outreach at all). While the project was successful in engaging the early adopters and allowing them to take the lead as the face of the industry, the project team hope is that over time the rest of the industry will see the value in connecting to consumers and reaching out to them using social media.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

KACF.com Website: http://www.knowacaliforniafarmer.com/
KACF.com Communications Toolbox: http://www.knowacaliforniafarmer.com/communications-toolbox/toolbox.php (password required, screen shot below)

KACF.com Facebook: http://www.facebook.com/?ref=home#!/knowacaliforniafarmer?fref=ts
KACF.com Twitter: https://twitter.com/KnowaCAFarmer
CACC YouTube Channel: http://www.youtube.com/caccmembers

California Department of Food & Agriculture
Specialty Crop Block Grant Program
FINAL PERFORMANCE REPORT

USDA Project No.: 36	**Project Title:** Spanish Strawberry Production Manual and Outreach	
Grant Recipient: Cachuma Resource Conservation District	**Grant Agreement No.:** SCB10036	**Date Submitted:** December 2013
Recipient Contact: Anne Coates	**Telephone:** (805) 455-2820	**Email:** acoates@rcdsantabarbara.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The Spanish Strawberry Production Manual and Outreach project was implemented to improve the long-term competitive position of the many Central Coast Spanish-speaking small/medium-acreage strawberry farmers. The main objective was to facilitate dissemination of accurate, local, up-to-date technical information on strawberry production, enabling Spanish-speaking farmers to improve adoption of best management practices (BMPs) within the framework of a sound business model and while achieving regulatory compliance. The broader goal was to enhance and sustain long-term competitiveness of California strawberry production, with an emphasis on the Central Coast, focusing on the Santa Maria Valley growing region.

The majority of the small-acreage Spanish-speaking strawberry farmers in the large Santa Maria Valley growing region have historically not had accessible information to make management decisions supportive of conservation, sustainability and competitiveness. The disconnect created by language and cultural barriers prevents access to agronomic education. Many resources are solely available in English, including a great deal of technical, regulatory and business management information. Additionally, Spanish-speaking farmers who speak very little English have had no way of connecting to the occasional resources that are available. For example, if translation is offered at a workshop, these farmers are probably are not on the mailing list to be informed. Even when translation is offered, the corresponding slides and handouts may not be in Spanish, intensifying uncertainty about the information.

To support the ability of Spanish-speaking farmers on the Central Coast to continue to do business while conserving resources, in order for strawberry production and land stewardship to be jointly achieved, the Cachuma Resource Conservation District (CRCD): 1) held 12 workshops to provide local research to farmers and connect farmers to local technical resources; 2) conducted over 50 one-on-one field visits; 3) produced two Spanish-language videos; and 4) developed and provided three-hundred farmers with an 80-page comprehensive field-ready Spanish Strawberry Production Manual (SSPM), entitled *Strawberry Production Manual for Central Coast Farmers*. The techniques and tools provided by workshops, on-farm consults, and the manual has allowed farmers to utilize and demonstrate use of BMPs to address food safety and water quality, to promote conservation and to improve their overall competitiveness.

The CRCD has been cultivating relationships and connecting local Spanish-speaking strawberry farmers with technical information and resources for over ten years. The CRCD has produced materials in Spanish for growers such as irrigation audit reports/recommendations and soil nitrate quick test (SNQT) fertilizer management tool instructions. The bilingual Technical Field Advisor and other bilingual staff have provided workshops held in Spanish, inviting partners such as local University of California (UC) Farm Advisors.

This project built on a 2008 Specialty Crop Block Grant Project 2, *Technical Assistance to Small-Acreage Farmers on the California Central Coast*. This 2008 project supported technical outreach to Spanish-speaking strawberry farmers in the form of workshops, field visits and demonstration sites of UC-led field experiments. Through this project, CRCD learned there was a need for a comprehensive strawberry production manual.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Spanish Strawberry Production Manual (SSPM)

To assure that the SSPM would best meet the needs of the target group, the bilingual Technical Field Advisor involved an active stakeholder advisory committee (SAC) of 32 local growers in each phase of manual development. For example, the fertilizer calculation section was added upon request of the SAC. The idea of using the dry eraser marker to write in the manual was developed in response to SAC members request to make calculations based on manual content. This idea was expanded to include nutrient budgeting and irrigation scheduling, evolving the manual into a unique, interactive tool as well as guide. The SAC was consulted on all draft versions of the manual, which proved to be instrumental in producing a useful final product. In addition, the Technical Field Advisor was a native Spanish speaker who had firsthand experience working on his family farm in strawberry production prior to working for CRCD, and thus, developed a great rapport with local farmers. Cultivation of this relationship produced a vocal SAC.

Two UC Strawberry Advisors from the other two Central Coast strawberry productions areas assisted with the manual content as well. The manual was further expanded under the direction of UC Strawberry Advisors as additional technical information was provided, which was relevant to the other two large Central Coast strawberry production areas. In addition, the business management section of the manual was greatly improved by contributions by the UC Farm Management Advisor. Once the project was expanded to cover the entire Central Coast, the bilingual Natural Resources Conservation Service (NRCS) Area Agronomist, NRCS Engineers and Soil Conservationists and Resource Conservation District (RCD) staff in other U.S. Department of Agriculture (USDA) Service Centers provided generous contributions as well.

The SSPM was initially to be 20 pages; however, the overwhelming interest in the manual resulted in an 80-page comprehensive, region-wide manual produced in Spanish to address complex aspects of strawberry production. Practical topics covered in the manual included: components of a business plan; assessing business costs; complying with regulations; understanding the strawberry plant and water cycle; variety and transplant selection; microclimates; soil considerations; bed design and preparation; mulch selection;

erosion control; irrigation system design, scheduling, and maintenance; macro- and micro- nutrients; nutrient budgeting and scheduling; fertilizer calculations; specific pest and disease cycles and Integrated Pest Management (IPM); fruit management and quality; a production planning calendar; and local free technical service providers. Each page was laminated and a dry erase marker and eraser was provided in order for farmers to follow the guide to write in nutrient budgeting, fertilizer, and irrigation scheduling calculations plus relevant notes.

The SSPM has been overwhelmingly well-received. The 300 copies were placed with growers immediately and CRCD is continuing to receive additional request for copies. The UC Strawberry Advisor in Monterey claimed 50 within a single day and has requested additional copies. The Agriculture Land-Based Learning Association (ALBA) in Salinas found immediate placement for 70 manuals for past and present students of their program. The manual was featured at the Farm Food Safety and Conservation Network's 6th annual Co-management Forum as an example of technical information that can be created through multi-agency collaboration. The Agricultural Commissioner's Offices have requested copies for farmers waiting in their lobbies. An English-language version has been requested and is currently under development using NRCS funding.

Field Visits
One-on-one on-farm Spanish-language technical assistance was provided to farmers. The sixty-four field visit consults provided by the project consisted of soil sampling, soil mapping, salinity management, irrigation management, nutrient management and IPM. To address irrigation management, irrigation evaluations were conducted to test the farmer's distribution uniformity, analyze scheduling, test irrigation water for salinity and provide specific recommendations. Hands on training was also provided by way of the Soil-Moisture-by-Feel test allowing farmers to actively participate in making a cursory determination of the moisture content of the soil for irrigation scheduling. In addition, training for in-season nutrient management was conducted using the SNQT. The SNQT kits were provided to farmers with instructions in Spanish. Additionally, soil samples were collected and sent to a lab for a detailed soil analysis report. CRCD translated the reports for follow-up farmer consultations on nutrient budgeting. Farmers were provided assistance with plant pathology by facilitating access to UC Cooperative Extension Pest Management Guidelines. Farmers were also assisted in the release of beneficial mites for non-chemical mite control. Farmers were aided in understanding regulatory requirements and in developing their Farm Water Quality Plans, a Central Coast Regional Water Quality Control Board Agriculture Order requirement.

Workshops related to SSPM
This project provided 12 effective workshops in business management, nutrient management, integrated pest and disease management (IPM), irrigation management, food safety, and erosion control and plant production. The workshops were scheduled to proceed periods of critical decision-making and deadlines associated with specific workshop topics. For instance, the workshop on diagnosing diseases was held in November 2012 while the field day on whiteflies and mites was held in March 2013. Upcoming Farm Service Agency (FSA) loans and NRCS cost-share opportunities and deadlines were announced at workshops by FSA and NRCS bilingual partners. The California Strawberry Commission (CSC) shared information and updates on food safety. Production costs and annual market trends and recent local field trial results were shared by the bilingual UC Small Farms Advisor.

Workshop topics and dates:

- Business Management for the New Season (July 19, 2011)
- Preparing the Field for the New Season (August 25, 2011)
- Nutrients in Plants (September 22, 2011)
- Nutrient and Pest Management (August 22, 2012)
- Pest Management Field Day (October 16, 2012)
- Irrigation Management (October 24, 2012)
- Pathogen and Disease Management (November 6, 2012)
- Business Management (December 4, 2012)
- Nutrient Management (February 4, 2013)
- Pest and Disease Management in SSPM (February 22, 2013)
- Control of Whiteflies and Mites Field Day (March 21, 2013)
- Strawberry Production Manual Field Day (June 27, 2013)

Video Outreach related to the SSPM

The SNQT is a useful tool in reducing in-season fertilizer use that proved popular with producers. During the course of the project, several site visits were conducted to demonstrate this tool. Additionally, staff from other Central Coast RCD and NRCS offices inquired about the tool. A supplies list and instructions were shared with regional partners, but more questions remained about how to perform the test. It was recognized that a video would be the best way to demonstrate the test to both producers and other technical service providers. Therefore, the project was expanded to include instructional videos based on content within the manual. As a result of review by the NRCS Area Agronomist and a UC video producer, simple instructions in Spanish were placed on the screen for each step of the process, in addition to verbal instruction. The videos were a beneficial addition to the project as easily-referenced information sources for farmers who cannot read well and/or are auditory as well as visual learners.

Project Partners

The CRCD could not have accomplished this project without the technical expertise and generous contributions of 23 editors and presenters from offices in 5 counties of the UC, NRCS and FSA. Additionally, the SAC of 32 local farmers shaped, reviewed and contributed to manual content.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

1) Produce a Spanish Strawberry Production Manual and distribute to 300 growers.

A 20-page production manual for Spanish-speaking farmers in the Santa Maria Valley growing region of the Central Coast, California was expanded to 80-pages to cover the entire Central Coast region. The manual received overwhelmingly positive feedback. Three hundred copies of the manual were to be printed and distributed. This goal was achieved with 80 copies for farmers in the Watsonville area, 90 copies for farmers in the Salinas area, 5 copies for farmers in the Templeton area, 97 copies for farmers in the Santa Maria production area and 28 copies for the Oxnard/Ventura production area.

One hundred more manuals will be produced with NRCS funding. Also using NRCS funding, an English-language version is in development.

A favorable development to the Scope of Work was production of a SNQT video and video of services for Spanish-speaking farmers. As with printed materials, beneficial BMPs, "how to" videos, are not readily available in Spanish. "How to" videos are easy to use references that can be viewed in the field on smart phones. These videos can reinforce concepts, inspire confidence, and are useful tools for visual and auditory learners as well as people with low reading comprehension. For this same reason, many diagrams were created and photos collected to pictorially explain information in the manual.

2) *Conduct 12 workshops over 3 years with an estimated 100 growers attending.*

Twelve workshops were to be conducted with a total of 100 attendees. This goal was achieved and exceeded with 15 additional farmers in attendance. Workshops received favorable reviews. Evaluations indicate that farmers are learning key concepts, appreciate receiving both crop and business management information and most farmers reported making improvements as a result of receiving information.

3) *Conduct 50 field visits as requested by growers.*

Sixty-four field visit consults (both initial and follow-up) were provided by the bilingual Technical Field Advisor who was sometimes accompanied by other CRCD staff and/or NRCS Soils Conservationists and Engineers. Field visits allowed CRCD to respond to individual farmer needs in a timely manner that encouraged implementation of BMPs as well as regulatory compliance. Field visits focused on grower needs related to soil sampling, soil mapping, salinity management, irrigation management, nutrient management, IPM and development of farm water quality plans. Field visits often promoted hands-on learning. SNQTs, Soil-Moisture-by-Feel test, pest scouting and releases of beneficial insects were conducted with farmers actively participating and learning the procedures. Farmers responded well to the assistance. On the program evaluation survey, 9 of 10 farmers indicated that RCD technical services were "very useful" (highest ranking).

4) *The CRCD anticipates that 70-90% of growers impacted by the project will implement one or more new and/or improved best management practice.*

In addition to evaluations for each workshop, a survey of 10 farmers was conducted at the end of the project to assess project effectiveness. This represents 8.7% of workshop attendees and 15.6% of field consults. Of farmers surveyed, 100% responded to agronomic education by incorporating BMPs. Changes as a result of working with CRCD included: 80% used the SNQT in-season monthly; 70% reduced the seasonal amount of fertilizer applied; 40% learned how to recognize life stages of pests; 60% rotated different chemical products; 60% used beneficial controls; 50% tested soil moisture as a tool for irrigation scheduling; 30% better managed for salinity; and 60% improved their irrigation system design.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

In 2009, Santa Maria represented 29% of all fall-planted and 14% of summer-planted strawberry acreage in California. The total value of strawberry crops in Santa Barbara County in 2009 was over $344 million. Given their lack of agronomic education, target farmers are at higher risk for making pesticide, fertilizer, and irrigation decisions that could potentially negatively impact the environment, as well as public and regulatory perceptions of the strawberry industry. Target farmers are also at a higher risk to use pesticides in a manner that increases general pest resistance, which limits the effectiveness for use in strawberries and other specialty crops.

Project beneficiaries were small/medium-acreage farmers and native Spanish-speakers who have minimal agronomic training or access to agricultural education opportunities due to language barriers. The target production area was the Central Coast, focusing on the Santa Maria Valley growing region. Although the project focused primarily on strawberry production, all local specialty crops benefit from a healthy local agricultural industry. The entire strawberry industry in California benefits greatly from a positive image with the public and regulatory agencies. Although difficult to quantify, the potential economic impact of this project is far-reaching and significant.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The Spanish-language *Strawberry Production Manual for Central Coast Farmers* was initially only to be 20 pages and only for farmers within the Santa Maria Valley. Two significant setbacks ended up monumentally strengthening and expanding this deliverable. First, the local, bilingual UC Small Farms Advisor who was initially a primary partner received extended sabbatical out of the country shortly after project inception. In addition to a new local UC Strawberry Advisor stepping in, two UC Strawberry Advisors from the other two Central Coast strawberry production areas stepped in to assist with technical content. Under their guidance, the manual was able to expand to provide technical information relevant to the other two large Central Coast strawberry production areas. Lastly, the Technical Field Advisors role was expanded, which developed a rapport with local growers that ultimately allowed the manual development to better meet the needs of the target group. For example, CRCD learned the growers appreciated pictorial representations of concepts. Therefore, a Spanish-speaking graphic artist who had assisted in the production of Spanish-language guides for raspberries, peaches and grapes was secured.

In working with the SAC, it became apparent that a balance had to be accomplished between the technical level of writing needed to convey complex concepts and the level at which a non-scientist or non-engineer could easily comprehend. A professional translator was secured who had experience in writing the Farm Water Quality Plan and other materials produced for this specific demographic. Her writing style tested well both with the SAC and with project partners. As a result of the collective abilities of the graphic artist to provide abundant information on a page in a manner that is pleasing to the eye and of the translator to convey high-level concepts in a straightforward manner, the level of the manual was raised well beyond the initial scope. SAC feedback was essential and instrumental in this development.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

The SSPM is available at www.rcdsantabarbara.org

See Attachments

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 37	**Project Title:** Spinosad Resistance in California Olive Fruit Fly *(Bactrocera oleae*) Populations	
Grant Recipient: Regents of the University of California, Davis	**Grant Agreement No:** SCB10037	**Date Submitted:** December 2013
Recipient Contact: Frank G. Zalom	**Telephone:** 530-752-3687	**Email:** fgzalom@ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Olive fly (OLF) is the most serious insect pest of cultivated olives worldwide. First detected in 1998, it is now found throughout California and it has caused significant damage to olive fruit production in many areas. Prior to the OLF introduction insecticide applications on California olives were rare, and few insecticides were registered on the crop. Approved for organic as well as conventional production, the insecticide spinosad (GF-120 Naturalyte Bait) gained emergency registration in 2003 and has been the only insecticide used for OLF control in California, so selection pressure for resistance was intensive. The main purpose of this project was to develop a molecular-based method for monitoring spinosad resistance. Resistance monitoring is valuable in justifying the need for alternative pesticides, managing resistance genes in populations, and studying gene flow (OLF movement) between populations. The motivation for pursuing this work was the identification of localized California populations that expressed as much as a 13-fold increase in resistance ratios compared with untreated European populations.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

There were four major activities stated in the initial proposal that can be summarized as follows:

1. Determine spread of resistance
2. Establish a spinosad resistant laboratory strain from California to isolate resistance-related mutations
3. Clone the nicotinic acetylcholine receptor (nAChR) subunits
4. Identify mutations in the acetylcholine receptor subunits linked to spinosad resistance

Survey of spinosad resistance. Olive flies infest fruit as they size and ripen during very late Summer and Fall (September - December). It is only during this period that infested fruit are available for collection and pupae can be obtained for rearing adults for resistance bioassays. During Fall 2010 (October through December), olive fruit were collected from a number of sites in Sonoma, Napa, Yolo, Butte, Alameda, Tulare and Kern counties, including six sites where increased resistance ratios were previously detected. In excess of 2000 olives were collected from each site which at infestation levels of at least 10% would be expected to yield at minimum 200 OLF pupae, enough to conduct a dose response bioassay. Historically low infestation levels were reported statewide in Fall 2010, so in spite of gathering thousands of olives, sufficient pupae to directly bioassay adult flies from these sites were not obtained. As an alternative, the few flies that emerged from pupae collected at 5 of the sites were placed in cages with unstung, uninfested olives to increase numbers and resulting pupae were collected, but there were never sufficient flies produced from any of these colonies to conduct bioassays. In 2011, made more intensive and directed olive collections were made at fewer sites where greater OLF populations were found (Sonoma and Alameda counties) and also from a previously untested area where spinosad had been most intensively used as part of a pest management district (Glenn and Tehama counties) and specifically from locations where Pest Control Advisers in the area said that they believe that spinosad 'wasn't working as well as before'. Sufficient flies were obtained from the Sonoma and Alameda county sites and resistance ratios at these sites indicated resistance levels of between 4.6 and 14.8 fold relative to the susceptible lab colony. Infestation was very low (less than 1%) in olives collected from within the Glenn and Tehama county pest management district, so the yield of pupae was not sufficient to enable bioassays. However, flies from these collections have been saved in 95% alcohol so that they can be tested should a molecular method of resistance analysis become possible requiring fewer flies needed to determine the frequency of resistance alleles present.

Development and maintenance of a spinosad resistant OLF colony. Development of a spinosad resistant colony was considered essential as a source of resistant flies throughout the year rather than limited to Fall field collections, and because with continuous selection greater levels of resistance could be achieved than is presently observed in the field. In Fall 2010, colonization of an OLF strain was initiated at UC Davis that would survive on artificial diet instead of olives, an important step in maintaining a resistant laboratory line since olive fruit are not available throughout the year that could be used to maintain a colony for multiple years. The University of Thessaly also initiated selection of a spinosad resistant OLF strain using an established strain as starting material. This strain was enriched in 2010 and 2011 by adding males obtained from field-collected flies from resistant sites in California. In addition to increasing colony vigor, the newly introduced flies from California also served to increase the colony's spinosad resistance by introducing resistance alleles.

The attempt to establish an OLF colony on diet at UC Davis was not successful, and the only other OLF colony maintained on diet in North America was also lost so that there was no other source of laboratory-established flies available in the U.S. A request for regulatory approval to bring a laboratory colony to UC Davis from Europe was not successful. Fortunately, the resistant colony at the University of Thessaly was selected and maintained. The colony was under constant selection through exposure to 0.04 g/ml of spinosad in the feeding water. This amount of spinosad is approximately 2 times the recommended amount for field application and also corresponded to 125 times the concentration that would kill 50% (LC50) of the susceptible OLF colony that has been maintained at the University of Thessaly. Bioassays showed that the resistance level eventually reached 35 times that of the susceptible colony. However, during Fall 2012, entirely unexpectedly and without any obvious changes in the insectary environment, the spinosad resistant colony collapsed. Because the spinosad resistant colony was unique, its loss inevitably compromised the molecular studies of resistance that were underway. These experiences demonstrate the difficulty in rearing OLF in the laboratory. Fortunately, specimens from the resistant colony have been saved and kept frozen at -80°C for future molecular studies.

Cloning of the nicotinic acetylcholine receptor (nAChR) subunits. In several instances, the nicotinic acetylcholine receptor (nAChR) has been shown to be the main target site of spinosad detoxification. In that regard, resistance to spinosad is assumed to develop because of alterations (i.e., mutations) in the nAChR. Cloning the nAChR from wild type (susceptible) and resistant OLF and searching for mutations that might have occurred in the nAChR of resistant flies would logically be expected to provide the marker for spinosad resistance in the olive fly. Obtaining the unpublished genomic sequence of the related species *Bactrocera dorsalis* (the oriental fruit fly) nAChR-α6, facilitated the process of designing primers that amplified the entire nAChR-α6 of OLF. mRNA was isolated from OLF adults from both the susceptible and resistant laboratory colonies, reverse-transcribed to cDNA and amplified with the heterologous nAChR-α6 primers. The ~2kb amplification product that was obtained was confirmed as the nAChR-α6 subunit by Southern hybridization. Subsequently, the PCR product was gel-purified, cloned into vector pBS and sequenced. Sequence analysis showed the 2020 bp insert had 94%, 84% and 82% similarity to the nAChR-α6 sequence found in oriental fruit fly, the house fly and *Drosophila melanogaster*. However, subsequent bioinformatic analysis of the two sequences did not reveal any differences that could be responsible for resistance indicating that there must be a different and novel molecular mechanism responsible for spinosad resistance in OLF. In order to identify additional target sites for spinosad resistance in OLF, an analysis of the entire transcriptome (i.e., all the expressed genes) of both the susceptible and resistant populations was undertaken to detect any differentially expressed genes. Unlike the previous approach, this one does not rely on any preconceived idea about the possible target of resistance, but rather assays the entire set of expressed genes. This approach, once considered prohibitively expensive, is more affordable now with the availability of New Generation Sequencing. The first round of analysis identified eight gene loci that are up-regulated (i.e., with higher expression) in the resistant population. None of these genes had been previously linked to spinosad resistance. Interestingly, three of these genes are involved in energy metabolism. It could be that resistant flies are capable of utilizing energy resources in turning on their detoxification mechanisms. Obviously, more research is needed in order to confirm these findings and further elucidate the mechanism of spinosad resistance in OLF.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

All four activities stated in the initial proposal were addressed. The activity related to establishing a spinosad resistant laboratory strain from California was terminated prematurely, as the spinosad resistant colony collapsed during the final year of the project. However, because it was a vigorous colony prior to its collapse, the molecular studies were able to proceed as originally proposed. Before the colony was lost, an attempt was made to restore the colony with additional wild flies. Thousands of olives were collected from California olive groves where spinosad resistance had previously been identified, and larvae within these fruit were held until they became pupae. The pupae were then shipped to Greece as a source of new wild flies with the intent of enriching the laboratory colony at the University of Thessaly. Over 500 adult flies emerged from these shipments, and an additional generation was reared on olives to obtain as many male flies as possible to mix with the resistant colony females. The female flies from the shipment were used to try to establish a new colony on diet, however wild females do not normally oviposit in artificial substrates (the waxed cones used for the colony females) and this attempt proved unsuccessful much as did the earlier attempt to establish an OLF colony on diet at UC Davis. The remaining flies were put in a separate cage where they were provided with preserved fresh olives. Although these flies oviposited heavily in the olives, they could only be maintained while suitable olives were available. After about 3 months of continuous efforts the last adult flies died. As many live adult flies as possible were harvested from both the resistant colony and the field collected flies remaining from those sent from California, and are preserved in a freezer at -80°C for future molecular studies.

The activity related to identifying mutations in the acetylcholine receptor subunits linked to spinosad resistance could not be completed in the timeframe of this project since no mutations in the nAChR-α6 subunit were found. Instead, a whole transcriptome differential expression analysis of resistant and susceptible flies was pursued that lays a foundation for future research in this area. The results of this analysis turned out to be groundbreaking as the work revealed eight gene loci with higher expression in the resistant population that may be responsible for a previously unknown mechanism of spinosad resistance and these were confirmed as well in the field-collected OLF. For example, the genes for ATP synthase or the cationic amino acid transporter II are up-regulated in the spinosad resistant laboratory populations as well as in individuals from California sites with high resistance levels, while they are down-regulated in the susceptible laboratory population and in flies from areas of low spinosad resistance. Therefore, results from studies of the laboratory flies appear to be relevant to field populations as well. Interestingly, both the ATP synthase and the cationic amino acid transporter II genes are involved in production of metabolic energy in resistant insects which might indicate that insects under insecticide stress require increased energy metabolism in order to compensate for the costs of energy-consuming detoxification processes.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Identifying the existence of a novel mechanism for spinosad resistance in OLF and possible genes related to the expression of the resistance are necessary steps in the development of a molecular tool for monitoring resistance in the field. If that goal is ultimately achieved due to these pioneering efforts, the project will have benefited all producers of California olives and their Pest Control Advisers since forewarning of resistance development will hasten the search for alternatives that can be used in a resistance management program to preserve the use of spinosad. The economic impact of losing a valuable tool like spinosad would be great as OLF damage can exceed 80% when not properly managed. To put this risk in perspective, about 10% fruit damage can be tolerated for oil olives when they are harvested and crushed immediately, but there is no tolerance for OLF infestation by table olive canners so any level of infestation represents a total loss to a grower.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The most important lesson learned is the difficulty of establishing and maintaining OLF colonies in the laboratory on artificial diet. A spinosad resistant OLF colony could not be successfully established at UC Davis, and the only remaining North American OLF colony maintained on diet was also lost during the course of this project. The resistant colony selected by introducing male OLF from California to colony females of the strain at the University of Thessaly was suddenly lost following many generations of successful rearing. These experiences emphasize the importance of maintaining redundant colonies at multiple sites for future research. The loss of the resistant colony compromised future research on spinosad resistance, but fortunately before losing the colony an analysis of the differences in gene expression obtained from transcriptome sequencing was performed. The modification of the initial plan of research to incorporate new molecular techniques and approaches that were not available or practical when the initial proposal was written is another lesson learned. This became important since one initial goal was to clone the nAChR-α6 subunit from both resistant and susceptible flies. Although this objective was achieved, no differences were noted. By analyzing differential gene expression of the entire transcriptome, not thought practical when the proposal was written, additional genes such as ATP synthase and cationic amino acid transporter II were found that may also be responsible for spinosad resistance.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

See attachments.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 38	Project Title: California Specialty Crops to Europe	
Grant Recipient: California Agricultural Export Council	**Grant Agreement No.:** SCB10038	**Date Submitted:** December 2013
Recipient Contact: Frederick W. Klose	**Telephone:** (916) 863-0311	**Email:** fklose@caec.net

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The European Union as a whole is the second largest export market for California specialty crops, ranked only after Canada. Inside the European Union, Germany is the largest single country destination for California specialty crops – and, as a market in its own right, would be California's fourth ranked export market – after Canada, China, and Japan. While Germany might be considered a "mature market", its importance cannot be disputed, and competitors from around the globe recognize the potential of increasing their market share by "chipping away" at California's prominence in the market.

This project was designed to directly influence German consumers by promoting California specialty crops as an integral part of the "California Lifestyle". Past research had shown that "California" evokes very positive images in the minds of German consumers – images of sunshine, beaches, Hollywood movie stars, healthy and active people, etc. By jointly promoting California specialty crops under the "California Banner", the project's goal was to support sales of California specialty crops by connecting the "Image" of California together with the products from California.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

The approach to this project was loosely based on the successful "California On-Board" promotion conducted by CAEC in 2002 – where California products and "California Cuisine" were served to travelers in German Railway dining cars. As the German Railway system is widespread, efficient, and a common form of transportation for most German citizens, it is an ideal vehicle for reaching literally millions of German consumers.

For this project, CAEC once again tied the "Taste California" promotion to the German Railway system (Deutsche Bahn – DB). In this case, however, promotions occurred in selected railway stations, rather than directly aboard the train. This change of venue allowed for reaching many more German consumers: since many rail travelers do not eat in the dining cars, but they all pass through the Railway Station on boarding or exiting the train.

The project incorporated two major elements: Tasting booths in the German railway stations and extensive retail promotion in associated convenience stores inside the train stations and at motorway service areas. To reach a large target audience, three high-traffic railway stations of supranational significance in Germany were selected. For five days each, specialty crop samples and information brochures were handed out to travelers in Berlin, Dresden and Frankfurt.

To provide a consistent overall impression, a new promotional theme and logo was developed for this activity, and promotional materials based on the new theme were created. The walls of the tasting booth for all three events were created with special light panels and decorated with images of Californian landscapes and mood pictures as well as pictures of the promoted specialty crops. The two counters were designed correspondingly. Two flat screen monitors were placed at the booth, looping the "Taste California" film http://www.youtube.com/watch?v=YqyuwBh4l74. Additionally, the promotional staff was equipped with shirts, caps and buttons which also displayed the "Taste California" logo and the website address. For the event in Frankfurt, an Airstream trailer was also decorated with respective logos and pictures.

An informational brochure (circulation: 100,000) as well as the homepage www.taste-california.de were created with the pictures from the promotion walls and contained information about tourist destinations as well as about CA specialty crop items. During the promotion, participants could win a trip to California – which was donated by the California Division of Tourism. This raffle was announced in the brochure as well as on the homepage and was also accessible via QR-Code. The brochure contained a voucher for 15% discount on CA specialty crop items which could be redeemed during May in all participating retail stores. Links to social media were included on the website to give visitors the opportunity to share the website with friends. The website was supported by advertisements via Google Adwords.

The activities were promoted by a press mailing to local media in Berlin, Dresden and Frankfurt as well as the online publication of the press release. A seven-page article on California food was also published in the DB customer magazine "mobil".

The retail promotion took place in 92 Point Stores, a nationwide supermarket chain by the distributor & provider SSP. For this cooperation, various California specialty crop food items were placed prominently in shops all over Germany. The products were advertised by special labels on shelves, advertisement posters and ceiling hangers. In nine stores, a "Taste California" film was shown. Also, two new walnut products by Farmer's Snack were listed, one being mono shelled CA walnuts.

This project would have been impossible to conduct without the contributions of the various partners. The California Division of Tourism provided major assistance in the task of "joining" California specialty crops to the "California Lifestyle" – their contributions of staff time, resources and materials provided a framework from which this "California Image" campaign could be based. California Specialty Crop industry Partners were: the California Walnut Commission, California Dried Plum Board, the Wine Institute / E&J Gallo Wines, and the California Olive Oil Council / California Olive Ranch. Each provided valuable contributions of samples for distribution through the booths. In addition, the contribution of E&J Gallo's representative in Germany with assisting in the coordination of this involved project was immense, and the Walnut Commission's PR efforts directly resulted in a 7-page feature on California specialty crops in "DB Mobil" the "in-flight magazine" of the German railway system (with a readership of 1.4 million, and an "advertising value" of $138,000).

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The first key goal was to achieve a total exposure through all media of 2,675,000 impressions. This includes exposure of passengers moving through the station and shoppers in retail stores as well as media and web exposure.

Passengers moving through station	3,550,000
Shoppers	1,660,000
Media and internet exposure	5,034,700
Total impressions:	10,244,700

As the retail promotion is one major element of the project, a direct exposure to more than 860,000 customers in all associated retail stores was expected. During the promotion period, a total of 1,660,000 shoppers could see the promotional material including the in-store video.

The third key goal of the promotional activities was to achieve at least 270,000 tastings of CA specialty crops. As only prune samples were available at all three locations and the small amount of olive oil samples were just distributed in Frankfurt, only 142,800 tastings could be achieved.

During the promotion period more than 4,600 California specialty crop items with a total value of more than € 9,000 were sold. Thus, the expected sales value of € 1.8 million could not be reached. One reason for this divergent result was that, contrary to original plans, no CA specialty crop items were sold at the respective booths. This was due to various regulations of the Train Stations, as well as the logistical difficulties involved in handling cash payments at the booths. Furthermore, the retail stores were not close to the booth, which reduced the number of impulse buyers and redemption of vouchers after visiting the booth. Finally, some items were not available in every store but only in Berlin, Dresden and Frankfurt. Therefore, the total sales increase of more than 13% during the promotion period can be considered as a quite positive outcome.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The primary purpose of this project was "image building" to influence German consumer attitudes and create a positive impression for California specialty crops in Germany. Quantitatively, described above are the numbers of Germans who witnessed the promotional activities. However, in order to measure the level of consumer "affinity" toward California specialty crops as a result of this promotional activity would require a budget nearly equal to the entire project budget. However, it is certain that some number of German consumers were positively influenced – and will thus be more inclined to buy California specialty crops vs. competing products. In this manner, this project benefited farmers and marketers of any California specialty crop that is sold in Germany.

A more direct benefit accrued to specific "partners" in this venture – most notably, the California Wine Institute / E&J Gallo wines – which logged direct sales increases of 25.7% in Berlin; 5.1% in Dresden; and 7.7% in Frankfurt during the promotional period. The California Walnut Industry also achieved a major success, as reported in the following "success story".

As a result of the Taste California promotion, the German distributor "Farmer's Snack" launched two new products at the SSP stores (POINT Convenience Stores). One of these products was a 100g bag of California walnut kernels.

Farmer's Snack Marketing Director reported that the cooperation with SSP was very successful and contributed to selling 1.9 million 100g bags last year. This year they anticipate selling 2.5 million 100g bags.

In addition to the SSP advertising and prominent placement they received during the Taste California promotion, they printed the "California Walnuts" rosette on the front of their packaging during the Taste California promotion to inform consumers of the product's origin. That was such a successful marketing tool, that they decided to print this rosette on their packaging in 2013 as well to show their commitment to California product. Additionally, they will be adding the California walnuts rosette to the front of another product in their portfolio (350g bag of walnut kernels). They anticipate sales of this product to increase five-fold from € 50,000 to € 250,000 (euros) in 2013.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

This project was very complicated, involving numerous sub-contractors, partners, and activities, as compared to the 2002 "California On-Board" promotion, where CAEC worked with only a single German partner for implementation. In this project, there were 4 major elements: 1. Securing space inside the German Railroad Station; 2. Booth Construction; 3. Booth logistics and staffing; and 4. Corresponding retail promotions. Each one of these required a separate sub-contractor and coordination issues. In addition, securing Specialty Crop partners and product samples required additional resources in coordination. Overall, the number of individual elements in this project was prohibitive to obtaining excellent results during the limited timeframe. A primary reason for the shortened timeframe was the "project shift" that took place in September, 2011 due to an unforeseen event -- staff changes at the German Railway that required re-focusing the promotion into the Train Stations. With a projected start date of March 2012, and only 5 months of lead time to complete all arrangements, the "Taste California" month was postponed to May 2012 to provide an additional two months of lead time. CAEC's recommendation for a project of this size and scope is to allow, at minimum, a full year from final project approval to the actual implementation. With a full year of lead time, many of the problems encountered with reaching stated goals could have been solved: 1. Shortfall in the expected number of samples (CAEC was only able to secure product samples of California prunes, and a very small number of California olive oil, and with additional advance notice, CAEC could have obtained many more samples); 2. Shortfall in sales figures: A major impediment was the process for "listing" a product for sale in the POINT convenience stores, but this somewhat complicated process, combined with the short lead time, resulted in only a few products actually being "listed" in the convenience stores during the promotional period. This low number of California specialty crops actually being sold as part of the promotion resulted in the sales figures being much lower than projected.

On the other hand, the partnership / cooperation of the California Division of Tourism proved invaluable to the success of the program. The elements of California that appeal to German consumers are the "Cool" visions of California places. CAEC utilized this imagery to "connect the dots" in the consumer's mind, that California is "awesome", and California specialty crops are "awesome" too.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Attachment: Taste of California Report

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 39	Project Title: Ecology Center Nutrition Food and Farming Programs	
Grant Recipient: Ecology Center	**Grant Agreement No.:** SCB10039	**Date Submitted:** December 2012
Recipient Contact: Martin Bourque	**Telephone:** (510) 526-1131	**Email:** martin@ecologycenter.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The purpose of the project was to increase the community health and consumer base for California specialty crops (CSCs). CSC farmers struggle with high production costs and losses due to perishability that increase the further CSCs are shipped. Simultaneously, in California (CA) low-income populations are suffering disproportionately from diet-related diseases while receiving over $5.7 billion yearly in food benefits. In order to expand the local market for CSCs while addressing CA's epidemic of diet-related diseases, the Ecology Center's (EC) proposed CDFA work was to address these issues using: city-wide planning focused on increasing CSC availability; 150 Berkeley Farmers' Markets; assistance getting and using wireless Electronic Balance Transfer (EBT) devices and Market scrip for 20 more Farmers' Markets statewide; and by increasing CSC farm-to-facility sales by researching existing barriers with representatives from all groups, developing replicable solutions, and creating/sharing a report on findings.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

EC's approach is to make the availability of California Specialty Crops ubiquitous, and the use and taste of those crops culturally familiar to consumers who are not traditional CSC purchasers. EC's Nutrition, Food, and Farming Policy (NFFP) programs work together to create infrastructure and market expansion, providing benefits to CSC farmers and residents in perpetuity.

The EC's Farmers' Markets (ECFM) increase consumption and sales of CSCs by bringing together CSC growers and Alameda County shoppers for well over $3 million in direct farm-to-consumer CSC sales. EC's Statewide Farmers' Market EBT Program provides assistance in setting up, using, and promoting EBT systems and market scrip at Farmers' Markets throughout CA. The Berkeley Food Policy Council (BFPC) benefits Berkeley and beyond by connecting nonprofits, health service providers, schools, and government agencies through a network of health & food programs and coordinated citywide planning. EC's 2011 Farm-to-Facility Expansion project sought to research how to directly connect local CSC farmers to Berkeley's $6-million-plus in institutional purchasing.

The Ecology Center's 4 Farmers' Markets:
As planned, the EC produced 150 Farmers' Markets in Berkeley and served 47 CSC growers total. Several growers attended more than one of the EC Markets weekly, but are only counted once. EC also opened the new Albany Farmers' Market on May 4, 2011 and produced 24 markets in Albany with the support of the Albany City Council and staff, and numerous community organizations and businesses. Total year-one sales for Albany were $750,000. The Saturday Market in Berkeley is EC's largest and has an average of 3,000-5,000 shoppers per week. Annual Market sales for Saturdays are estimated at $3.1 million total (range of $2.6 – 3.6 million). Based on previously measured customer counts, EC's Thursday and Tuesday Market sales are estimated to each be $1.7 million annually ($3.4 million total). All together, the direct sales for the Ecology Center's 4 Farmers' Markets total $7.24 million. When multiplied by 67% (to ensure that non CSC sales were claimed), this brings us to an estimated $4.85 million – 162% above EC's CDFA goal.

Farm to Facility (F2F) Project:
The Research. EC's Market staff worked closely with the UC Berkeley Haas School of Business' Bay Area Environmentally Aware Consulting Network (BEACN) to perform market research on the development of F2F efforts at EC's Markets. Surveying and key interviews were completed and the initial report was drafted. F2F turned up numerous helpful results for Berkeley/Albany and the farmers that utilize EC's four Markets. However, the study also made it clear that EC's region is somewhat unique within the state. Services like Veritable Vegetable are already making it very easy for local facilities to buy in bulk from local growers. These distributors, of course, take a sizable fee to manage, ship and deliver the produce. EC is looking for ways to remove that loss of revenue for the growers.

The Report. While the F2F project gained very useful information that EC can now use to increase F2F direct sales for its local growers (resulting in an upcoming pilot of *Veggie Valet*, described below), the F2F project didn't find a "universal solution" that would work throughout the state. For this reason, EC concluded it was premature to distribute its local report statewide to other markets in 2011. Prior to sharing results with colleagues, EC will field test the F2F conclusions and continue to identify the aspects of the project that are widely replicable/applicable. In 2012 EC will: 1) speak with markets statewide to learn more about their perceived F2F barriers, and then 2) significantly re-work its survey tools to be general enough to work outside of Berkeley/Albany. To achieve this next step, EC will be working with Roots of Change and their Consortium; EC hopes to then work with the Consortium in an advisory capacity to help them develop their ensuing F2F programs.

Veggie Valet: The 2011 an F2F project resulted in the launch of EC's 2012 pilot Veggie Valet program. This program will facilitate farmers selling in bulk to wholesale buyers from EC's Tuesday Market by removing three of the key barriers that buyers referenced in their surveys: parking, easy access to sellers/elimination of crowds, and easy transportation/loading of purchases. The Veggie Valet program will include opening the Tuesday Market one hour earlier for bulk-buyers only; special on-site parking to facilitate access; and assistance moving and loading purchases. EC will also continue to explore online ordering via third party providers.

Statewide Farmers' Market EBT Program:
This has been another highly productive year for the EC's EBT program. In 2011 EC surpassed its goal of 20 net markets by 235% and assisted 47 markets that will now provide EBT access to shoppers for the first time.

In addition, EC helped another 107 markets to fully integrate their existing EBT systems or to promote its use. In total, EC helped 154 Certified Farmers' Markets (CFMs) throughout the State.

Berkeley Food Policy Council (BFPC):
The full BFPC met quarterly as planned in 2011. The BFPC now has 85 registered members that represent 54 member organizations. When the BFPC completed its strategic plan, it was the consensus of members that the Council would consider four or five macro level goals/objectives to help guide work from 2011 into the future. With the ultimate goal of creating a service, education, and policy infrastructure in the region, the following objectives/factors emerged:

a. Make it not only possible but easy for all residents to grow and share a portion of their food
b. Eliminate economic and geographical barriers to purchasing *Real Good Food* for all Berkeley residents
c. Effectively support all residents in acquiring basic *Real Good Food* knowledge, including how to shop for and prepare *Real Good Food*
d. Eliminate diet related illness in the long run, and diet related health disparities in the short run (focus on the core problem areas first)
e. End hunger in Berkeley in the long term by eliminating the root causes of hunger, and in the short term by assuring that all in need have additional assistance
f. Foster a broad based understanding of the injustice and inequity pervasive in the industrial food system and promotes tools and mechanisms to create viable alternatives.

To achieve these objectives, the BFPC focuses on the following practices: 1) Information sharing; 2) Programmatic collaboration; and 3) Public education. Work completed in each of these categories in 2011 is as follows:

<u>Information sharing.</u> At each of the four quarterly meetings, the BFPC steering committee dedicated one hour to information sharing. Participants in the Council gave updates on their work and opportunities for collaboration/ participation. Results from EC's Farmers' Market surveys were presented and the BFPC received a presentation of the Youth Food Bill of Rights. EC hosted the BFPC list serve, which is an email forum in which participants share information and speak to the broader BFPC community. Information sharing is consistently reported as one of the most important reasons for participation in the Council.

At the December 2011 meeting of the BFPC there was a presentation by the Berkeley Unified School District (BUSD) staff on changes in funding that may eliminate a major portion of the food and nutrition efforts in Berkeley. A subcommittee has been formed to explore both short term and long-term solutions to this problem. The programs educate public school students on the importance of eating fresh, locally grown fruits and vegetables, and how to shop for and prepare these healthy foods.

<u>Programmatic collaboration.</u> Programmatic collaboration developed both structurally through working groups and informally through networking opportunities at meetings and events. In 2011, many programmatic collaborations were developed, including a joint effort to save a local food production employment and training program, a free CSC distribution program at a free clinic, co-hosting the 2011 Community Food Security Coalition Annual Conference and conference tour, and most deeply through a series of Food Day events coordinated by the BFPC. In addition, projects for 2012 were developed, including relocating the Farm

Fresh Choice urban produce stand to the Spiral Gardens Community Nursery to increase sales of CSCs, and the development of the Fruit and Vegetable Prescription program which is a partnership of the Ecology Center and Lifelong Medical. At the state and national level, the BFPC is working to create a statewide federation of Food Policy Councils to better coordinate collective work.

Public education. The BFPC focused its shared public education efforts on creating a city-wide awareness of the importance of eating CSCs from local, sustainable sources. Together, the BFPC members hosted over 23 events and activities in October 2011 as part of the national Food Day. Events ranged from a tour of local farms, to community outreach with health screenings, and a youth-led (and powered) smoothie bike; all focused on increasing the consumption of CSCs.

SCBGP funding to EC is spent solely to enhance sales of eligible California Specialty Crops. While Certified Farmers' Markets (CFMs) offer some ineligible crops/foods, this is a small fraction of their offerings. However, to ensure that no SC funds support ineligible crops/foods, EC invoices no more than 67% of the NFFP expenses for reimbursement; the other 33% of expenses are being covered by matching funds and amply cover any unintended contact with ineligible crops or producers, or other activities that are not part of this project. For example, specialty crop block grant funding only supports 67% of the cost of the EBT tokens. In this way, other funding will cover the small number of tokens used for non-CSC purchases. No SCBGP funds were used for lobbying activities.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The table below indicates a comparison of the project's goals and outcomes achieved:

Ecology Center Performance Measures Table

Activities	Performance Indicator	Status
BFPC: A full list of participants will be noted in the minutes of each quarterly meeting. Productivity of activities will also be noted in minutes.	Implementation of the programs laid out in the 2010 CDFA-funded BFPC strategic plan; coordination of existing health and nutrition programs	**Completed** Held 4 Quarterly Meetings 3/10, 6/10 and 9/16, 12/16. Advances were made on a number of programmatic collaborations and the formation of a new working group on school food and nutrition programs
ALL: Oversight meetings with Executive Director to review workplans and report	All	**Completed** Meetings were held regularly. EBT Meetings moved to every other Thursday.

Activities	Performance Indicator	Status
EBT: Check the number of authorizations from CA Department of Social Services for CFM wireless Point of Service devices and EBT sales/usage reports.	Increasing the number of Farmers' Markets in CA that accept EBT benefits from 138 to 158; measuring the sales volume at those Markets.	**Exceeded Goal:** Assisted 47 new markets getting EBT running. Additional 17 in process. Assisted 154 total. Ongoing efforts with CDSS and CDFA in tracking EBT accessible markets.
BFPC: Create and administer a feedback survey of BFPC members	Implementation of the programs laid out in the 2010 CDFA-funded BFPC strategic plan; coordination of existing health and nutrition programs	**In Process:** Waited for one full year of BFCP activities to administer survey. Survey under review by steering committee. 85% Complete.
BFM: a) CSC Farmer Survey; b) Customer Survey	Facilitation of over $3 million in direct BFM CSC sales; measures sales, environment for Growers, and customer totals	**Exceeded Goal.** Surveys competed for 2 markets. Sales measured based on purchases of shoppers surveyed.
Farm-To-Facility: A full list of participants will be noted for each meeting and for each survey.	Programs to increase farm- to-facility sales of CSCs starting in 2012 with a findings report disseminated statewide	**Adjusted Approach:** Facilitated meetings changed to individual interviews, per farmer requests.
Farm-To-Facility: a) completion of mutually designed direct-sales solutions and plan to launch new programs in 2012; b) completion and dissemination of findings	Programs to increase farm- to-facility sales of CSCs starting in 2012 with a findings report disseminated statewide	**Completed** Surveys completed, report produced with recommendations. Results viewed as too specific to local conditions for statewide distribution, will be shared with other local CFMs.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Through the Farmers' Market EBT Program EC served an estimated 24,000 EBT shoppers and an estimated 3,080 CSC vendors at 154 markets by helping the market associations move forward in accepting and promoting EBT. While there is still a long way to go, EBT sales at Farmers' Markets have increased dramatically over the past 4 years. According to the USDA Food and Nutrition Service (FNS), from January 1, 2011 to December 31, 2011 there were $2,163,847 in EBT redemptions at CA CFMs and 101,723 transactions. Using the month of October as a snapshot for comparison, in October 2007 EBT redemptions at CA Certified Farmers' Markets were only $34,179 for the month. In October 2010, that number was up to $147,835, and in October 2011 the redemptions were $252,351. That is an increase of 70.69% in the last year alone. EC is proud to play a crucial role by helping all of California's CFMs to fully integrate EBT shoppers.

At the Farmers' Markets, EC directly served 47 CSC growers with $4.85 million in direct farm-to-consumer sales by increasing the number and frequency of shoppers through events, promotions, and EC's new Albany Market. The BFPC is benefiting both CSC growers and the thousands of at-risk residents that the Council's members serve.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

- During the F2F research, EC learned that it is much better to do in one-on-one interviews, phone calls, and emails with farmers rather than trying to organize focus groups or facilitate meetings. Their time constraints do not easily allow for the meeting format.

- EC anticipated that the Farm to Facilities efforts would produce best practices and recommendations that would be useful across the state. EC learned that each situation is so unique and dependent on local relationships, demand, and service providers that each market/town may have to customize their Farm to Facilities efforts significantly.

- EC did not see the need to work deeply on school-based programs in the BFPC when it submitted its proposal for 2011. However, as a result of changes in demographics and changes to the SNAP ED funding structure, it has become clear that school-based programs will need to be a focus going forward. A Working Group has been formed and will become more active as the BFPC explores sustainable sources of funding to support this important and trend-setting work.

- In developing the BFPC in-depth survey (a short survey is distributed at the end of every meeting), EC found that there were a number of very different approaches to surveying that were not easily reconciled. These ranged from simply getting a pulse check on how the process is working for participants to doing a full blown community food assessment. EC has honed this down and expects to survey participants in the first quarter of CY 2012.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

The following are publications related to this project, and are provided as attachments to this report:

- Berkeley Food Policy Council Strategic Plan 2011
- Ecology Center Farmers Markets – Farm to Facilities Report
- Albany Farmers' Market Consumer Study, June 8, 2011
- Berkeley (Derby) Farmers' Market Consumer Study, March 29, 2011

USDA Project No.: 40	Project Title: California's Specialty Commodity Opportunity Outlook	
Grant Recipient: Center for International Trade Development, State Center Community College District	**Grant Agreement No:** SCB10040	**Date Submitted:** December 2012
Recipient Contact: Alicia Rios	**Telephone:** (559) 324-6401	**Email:** alicia.rios@scccd.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The USDA Foreign Agricultural Service (FAS) provides over 3,000 reports each year pertaining to export markets and export opportunities through its Global Access Information Network (GAIN). However, specialty commodities remain largely overlooked by GAIN reporting. To offset this, Export Market Development (EMD) reports have been created utilizing Market Access Program (MAP) funds to help fill this gap. EMD reports, however, examine opportunities on a market-by-market basis and are focused on buyers, varietals, population, distribution channels, commodity trends and developments on a country-by-country basis. EMD reports do not compare, contrast, and prioritize opportunities across export markets, and do not research certain key specialty commodities that play an important role in California's exports. There is no centralized information resource or reporting that prioritizes export market opportunities for California's specialty commodities. This has left a large information gap when it comes to evaluating and prioritizing export markets around the globe for California's specialty commodities. As such, opportunities can easily get missed and the best markets for development may go under developed.

California's specialty commodity groups, growers, packagers, shippers and the state's trade agencies need a centralized and uniformly researched export opportunity platform that will overcome these market intelligence constraints, and clearly map and prioritize California's specialty commodity opportunities, while also clearly identifying shifts in demand and emerging opportunities. This project would provide that platform - a reporting and information distribution system, prioritizing 52 countries for development on a commodity-by-commodity basis. The project will ensure that California's leading specialty commodities have a standardized resource to more quickly and effectively increase exports of California's specialty commodities, and address market analysis shortfalls in a consistent and comprehensive fashion.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Year 1 Activities and Tasks Performed:

- Formed an association/advisory board of specialty crop commodity groups and commissions to outline project, and review developed work product.
- Preliminary research was developed on the needs previously identified and template development.
- Conducted research and surveys to identify top 20 specialty crops.
- Data was collected for targeted 20 specialty crop products from Euromonitor's extensive database and resources.
- Performed data gap analysis, design and integration of multiple datasets to ensure complete coverage of 20 specialty crops.
- Reviewed initial agricultural commodity export values and rankings for top 20 specialty crops by advisory board and other represented commodity groups, and collected feedback.
- Incorporated reviewed feedback into research and data collection to prepare for finalization.
- Finalized clearly defined templates and charts that describe final outputs in a standardized fashion. The CITD completed the production of an electronic opportunity guidebook that supports increased trade of California's top twenty exported specialty commodities.
- Uploaded final product to website. CITD decided on venues for outreach and final product dissemination.

Year 2 Activities and Tasks Performed:

- Advisory group reviewed and approved the final Global Outlook Report for dissemination.
- Sponsored a booth at the Dried Fruit Associations (DFA) annual conference in San Diego on April 25-27, 2012 to disseminate the Global Outlook Report to Specialty Crop exporters.
- Organized and coordinated an international seminar that took place during the DFA conference's general sessions. During this seminar, Matt Tripodi of Euromonitor spoke on CITD's Global Outlook Report.
- Coordinated site visits with Commodity Boards that took take place in June 2012 as well as three statewide seminars where Euromonitor spoke on CITD's Global Outlook Report. The three seminars were facilitated on May 22nd (San Diego), May 23rd (Fresno), and May 24th (Napa).
- Developed a page on CITD's website to track downloads of the Global Outlook Report. The system track company info as well as the individual reports each downloads.

Contribution/Role:

- **Development:** Project partner Euromonitor contributed to much of the information gathering, analysis, and development of templates and final product. Commodity boards and other industry partners contributed to reviewing and evaluating a preliminary report and methodology, and provided useful feedback to proceed with final product development and dissemination.

- **Dissemination:** Project partner Euromonitor contributed to the dissemination of the final report by presenting on the Outlook Reports at CITD sponsored events and hosted activities. Additionally, commodity partners participated in one-on-one meetings to discuss Outlook Reports as well as distributed information to their membership on how to access these reports from the CITD website.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Activities completed in order to achieve performance goals and measurable outcomes for the project are summarized under the Project Approach section. Baseline for all Goals was 0.

The project goals were divided into 4 stages, have been completed, and are as follows:
- *Stage 1 – Information Gathering:* Project began by conducting a brief, but in-depth, review of its internal data systems, including Fresh Foods and Countries & Consumers, and leveraged the Global Export Analysis Reporting System (GEARS).
- *Stage 2 – Data Review and Analysis:* Analyzed collected data and uncovered opportunities for California specialty commodity exports across the target geographies and 20 product categories.
- *Stage 3 – Production & Delivery:* Final analysis was incorporated into a detailed PowerPoint presentation that provides a complete picture of the key opportunities for California exports.
- *Stage 4 – Dissemination & Evaluation:* Presentation of finished product, and compilation of data for final evaluation and report. Target was 75-100 downloads of the Outlook Report. The report has already been distributed to over 75 companies just from the CITD exhibit booth at the Dried Fruit Association Conference in April 2012, and meetings with commodity boards and companies from May-June 2012. The CITD is continuously tracking downloads of these reports from its website and anticipated to far exceed is initial projection in long-term distribution.

Due to a shift in the project from an analysis of the top 20 specialty crop exports to the top 20 with highest growth potential, CITD was unable to complete the follow-up surveys to measure the average value growth being that the dissemination of the Outlook Report took place during the first 6 months of 2012.

Hot Market Report Dissemination (16,284):
- Exhibit Booth at Dried Fruit Association Annual Conference, April 25-27, 2012:
  - 148 companies pick up hard copies of the 1 or more Hot Market Reports
- www.fresnocitd.org website views/downloads of Hot Market Report from April 2012 to present:
  - 989 individuals - Full Specialty Crop Commodity Opportunity Outlook (all 20 combined)
  - 596 individuals – Hot Market Report for Almonds
  - 843 individuals – Hot Market Report for Apples
  - 1,153 individuals – Hot Market Report for Cauliflower & Broccoli
  - 776 individuals – Hot Market Report for Cherries

- 756 individuals – Hot Market Report for Citrus
- 744 individuals – Hot Market Report for Figs
- 732 individuals – Hot Market Report for Grapes
- 731 individuals – Hot Market Report for Leafy Greens
- 715 individuals – Hot Market Report for Mandarins & Tangerines
- 742 individuals – Hot Market Report for Melons
- 696 individuals – Hot Market Report for Onions
- 746 individuals – Hot Market Report for Other Berries
- 730 individuals – Hot Market Report for Peaches & Nectarines
- 710 individuals – Hot Market Report for Pistachios
- 738 individuals – Hot Market Report for Plums
- 741 individuals – Hot Market Report for Processed Tomatoes
- 753 individuals – Hot Market Report for Prunes
- 739 individuals – Hot Market Report for Raisins
- 790 individuals – Hot Market Report for Strawberries
- 716 individuals – Hot Market Report for Walnuts

Survey Results:

Hot Market Reports – Choose from 1 (the low satisfaction) to 5 (the high satisfaction); 3 is neutral or "does not apply."

Survey Responses	Average Rating
How relevant was the information provided in the Hot Market Report(s) to your business	4.1
The amount of information provided in the report was sufficient to make marketing decisions	3.6
My company incorporated all or part of the information provided in the Hot Market Report(s) into its Business Plan	2.9
Marketing decisions based off the Hot Market Report(s) help expand my global market sales	3.2
The Hot Market Report(s) were easy to understand and access	4.2

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

California is the largest producer of agricultural products and the top exporting state. In 2008, the state's cash farm receipts totaled $36.1 billion. California ranked 1st among all 50 states in 2008 with agricultural exports estimated at $13.6 billion. In both cases, the majority comes from specialty commodities. Specialty crops represent 90% of California's total farm gate agricultural production and more than 90% of farm employment. Agricultural exports help boost farm prices and income, while supporting about 157,528 jobs both on and off the farm in food processing, storage, and transportation. Exports are important to California's agriculture and economy. Measured as exports divided by farm cash receipts, the state's reliance on agricultural exports was 38 percent in 2008. According to the Agricultural Issues Center at the University of California, for every $1 billion in farm sales, there are 18,000 jobs created in the state, about 11,000 in the farm sector itself plus about 7,000 in other industries.

This project supported the jobs of over 140,000 people involved with specialty commodity trade growth. It provided 3,000 farms, trade organizations, trade service business (transportation, storage, et al) and state trade agencies a clear road map of prioritized global export opportunities across key geographies and categories, and a guide that standardizes macro-economic, consumption and trade flow statistics into a user-friendly deliverable that allows for immediate action. It allowed organizations to move more quickly and successfully in market opportunity assessment and development, securing greater levels of specialty commodity exports and saving time and money across these groups in the development of such analysis on an independent, one commodity / one project at a time basis. Long-term, this project will increase export revenues and job growth both on the farm and in supporting industries.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

CITD's intent was to develop a Global Outlook Report of the top 20 specialty crop commodities, but during the review phase, it was suggest by several of the California Commodity Boards that it would be more beneficial to California specialty crop producers if the focus shifted to the top 20 specialty crop products with the highest growth in emerging markets. Upon discussing this shift with a sample of CITD existing specialty crop exporters, this was confirmed.

The full Global Outlook Report is more than 200 pages long, so to better capture the attention of the end user, CITD broke the report up into 20 specific reports, each focusing on 1 of the 20 top specialty crop commodities. Individuals still have access to the full report from CITD's website at (http://fresnocitd.org/resources/hot-market-reports/). Once individual report access was added, there has been a significant increase in interest and downloads of these reports.

However, the CITD will need a more specific tracking system incorporated into its website. One drawback to the views/download monitoring is that the system doesn't track multiple views for a single user or IP address. This may affect the total number the downloads, but with over 16,000 totals views/downloads, the CITD far exceeded its original dissemination goals.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

- Attachment A – Global Outlook Report (and individual Hot Market Reports for the top 20 specialty crop commodities with the highest growth in emerging markets can be downloaded at: http://fresnocitd.org/resources/hot-market-reports/
- Attachment B – Explore Exporting – The World is Waiting Seminar flyer.
- Attachment C – DFA Conference Brochure and attendance list.

Project 41 – Sustainable Agriculture Education (SAGE)

Final Performance Report

Project Title
Launching a California Agricultural Almanac (CAA): Putting California Specialty Crops on the Map

Project Summary
The purpose of the CAA is to enhance the market for the state's extraordinary bounty of specialty crops by providing real-time, accessible crop information to the public thereby deepening appreciation for what these crops are, where they are grown, when they are in season, and how they are affected by weather. There is increasing focus on eating healthy, local, and seasonal food. Though much of what is eaten is grown within the state, many Californians know little about California crops and even less about the geography of California agriculture or the seasonality of its diverse crops. Californians who want to eat local food need readily and regularly available information about California grown specialty crops, including seasonality, production places, and special attributes. The goal of the CAA is to encourage public interest and support of California specialty crops by developing a collaborative online application to facilitate the collection and distribution of crop production information. Distribution will occur through a syndicated web feed of current crop production information including crop icons showing the general locations of crop production throughout California during any given week. The integration of geographic locations will permit the feed to be used in maps, both online and in print, and will foster a better understanding of the relationship between geography and the seasonality of California specialty crops. In effect, the project creates a simple, self-sustaining link between two interested parties for their mutual benefit.

Project Approach
SAGE created the website: www.calagalmanac.com, the most comprehensive repository of information about California specialty crops currently available. However, fulfilling the entire original goal of the CAA, which is to showcase "what's in season where" for specialty crops in a straightforward, lightweight manner for presentation through existing media, proved to be challenging. As investigation began into the available sets of crop data (by place and by seasonality), a number of challenges became apparent. Most of these had to do with the lack of data, and/or the inaccessibility of data, and to date, the infeasibility of a system for real-time updates. As a result of these unforeseen challenges, the CAA has been developed to Beta stage and does not yet provide all of the data sharing functions originally outlined in the goals for the project. The CAA website was soft launched in September 2011 through distribution on the SAGE website as well as on partner websites and newsletters. The Work Plan table below summarizes activities performed and work accomplished during the grant period:

Work Plan Summary

Project Activity	Summary
Project initiation meeting for project staff, consultants, content providers and distribution partners; refine work plan and timeline; identify key additional partners	In November 2010, SAGE hired a CAA project manager and convened a project initiation meeting. Participants included a mapping and database partner GreenInfo Network, and the *San Francisco Chronicle*, a potential distribution partner. Following the meeting, SAGE refined the work plan and timeline, identified target audiences, and identified key distribution partners, including newspapers and commodity commissions.
Draft and prioritize scenarios for sustaining the project over the long term; position project to line up with preferred strategy/scenario	SAGE met with potential partners, including the Community Alliance with Family Farmers and commodity commissions, to discuss how to sustain the project over the long term.
Invite participation of all specialty crop associations to ensure comprehensive representation of all crops	SAGE invited the participation of the 13 Buy California commodity commission members in December 2010. The commissions expressed interest in having their commodity represented. Some commissions shared commodity data including location and seasonality information.
Compile crop list and baseline data for production locations, seasons, and related attributes	In December 2010, SAGE began compiling a comprehensive crop list using available crop and seasonality data. To date, crop and seasonality information has been inputted for 13 counties (Bay Area and San Joaquin Valley counties) and baseline crop data (pesticide use report - PUR) has been inputted for all counties in the state.
Overall site design and technical coordination of the data collection application and crop database; seed database with baseline data	GreenInfo Network began developing a user friendly online editor in January 2011 to allow SAGE and other users to input crop, location, seasonality and event information into a database.
Develop data collection application to allow for data input and review of the crop locations/attributions database	In February 2011, GreenInfo Network finished designing the online database and editor. The crop list was uploaded to the database and SAGE continued to input new crop and seasonality information as it became available.
BETA testing of data collection application and review process	BETA testing of the online editor was completed in February 2011, though tweaks continue to be made to the overall design based on continued user input.
Develop website for promotion of the California Specialty Crops database	GreenInfo Network, with direction from SAGE and input from partners, developed the CAA website, www.calagalmanac.com.
Official launch of the website	In September 2011, the website was launched with the help of the CAA partners. Partners announced the website launch in their electronic newsletters and on their websites.
Refine/improve all project elements (data collection, interface, and feed) as needed	Before and after the website launch, GreenInfo Network refined and improved the website based on feedback from SAGE, partners and user input.
Solicit and engage additional distribution partners; refine output products as needed	In the business assessment conducted at the conclusion of the project, it was determined that educators were likely to be an important new distribution partner and target audience. Refining the products needed by this audience will continue in Phase 2 if funding is obtained.

Complete business plan for a self-sustaining service and activate key strategies	Business consultant Paul Sytsma joined the team in October 2011 and completed a full business evaluation and plan.
Conduct detailed project evaluation and submit final report	With the help of the business consultant, SAGE conducted a full project evaluation and presents it here as part of the final report.

In summary, the CAA represents the first-ever comprehensive effort to assemble crop-place, crop-seasonality, farm, market, and agricultural event data in a single interactive environment. The CAA succeeds at providing interactive data that graphically displays where 170 uniquely defined specialty crops are grown in the state. Crop information is available at the county level for the entire state, and at the more specific agricultural place level (108 defined agricultural places) for counties in the greater Bay Area. Primary project partners (the Center for Urban Education about Sustainable Agriculture (CUESA), Community Alliance with Family Farmers (CAFF), Marin Agricultural Land Trust (MALT), Om Organic, and University of California Small Farm Program (SFP)) provided farm, crop, seasonality and event data, and met regularly with the CAA project team to discuss project direction and provide feedback.

Goals and Outcomes Achieved

The overall goal of this project was to encourage public interest in and support for California specialty crops by developing a collaborative online application to facilitate the collection and distribution of crop production information. Specifically, the project goals were to 1) create a clean, lightweight interface for the input of crop production locations and related attributes, and 2) design an easy-to-use and impactful way for the public to view and interact with crop production data.

Outcome achieved for Goal 1: GreenInfo Network developed an online editor for SAGE and other users to input specialty crop, location, seasonality and event information into the CAA database.

Outcome achieved for Goal 2: SAGE and GreenInfo Network developed a public website, www.calagalmanac.com, a comprehensive central hub for California specialty crops information.

The original intent of the CAA was to automate the data sharing process among three types of data partners. These partners included

1. Registered Users : individuals who would register on the CAA website to provide crop, farm and agricultural event information,
2. Content Providers: organizations (e.g., Buy Cal, commodity commissions, etc.) that would provide updated data on a regular basis, and
3. Distribution Partners: (e.g., *San Francisco Chronicle*, CAFF, etc.) who would consume and redistribute the data provided on the CAA in packaged and/or customized formats.

During the development of the CAA, the data sharing process changed due to the unanticipated challenges of obtaining data described above. As a result, the CAA now relies upon Project Partners: (CUESA, MALT, etc.) that have a reciprocal relationship with the CAA. These organizations both provide data for the site and consume and redistribute the information the CAA provides. The CAA has established Memorandums of Understanding (MOU) with six data partners including CAFF, SFP, OmOrganics, MALT, CUESA and Johnny's Seeds. Two data sets, Pesticide Use Report (PUR) data and County Crop Reports data, are sources for regularly updated and published data sets inputted into the CAA. The annotated Performance Monitoring Plan below explains the evolution of the CAA data sharing process and provides a comparison of actual accomplishment with the goals established for the reporting period.

Performance Monitoring Plan Summary

Activities	Explanation	Performance Indicator
Use analytics software to measure number of visitors to website	Analytics available for CAA Beta site soft launch (September 2011 to January 2012)	1,042 visits, 830 unique visits
Measure number of registered users with access to the data collection application	The CAA does not yet have a registration function for individual registered users. Data is provided by Project Partners and is entered from Data Sets.	CAA successfully aggregates and makes available 18 Data Sets and has MOU agreements with six Project Partners.
Measure number of data commits	Acquiring data sources for the CAA is challenging. Many (identified valuable data providers) expressed interest but were unable to provide compatible data. For example, County Crop Report data is not related to specific areas within counties, there are some limitations in the crop list (e.g. general crop categories such as "miscellaneous" vegetables); Certified Producers Certificates provide place specific complete lists of crops, but little of this data is digitized; Commodity Commission and the Buy California Campaign could not provide crop-by-place-by-season data because data was sensitive and proprietary and/or not in geo-codable form.	Significant data enhancement is a result of recent development of a method to input PUR data into the CAA on a county-wide basis.
Establish registration for users who wish to include crop data on their websites	This was an achievable goal for the CAA, but time was a limiting factor.	
Estimate size of total audience by collecting usage statistics from Distribution Partners	As described above, CAA data sharing process developed differently than initially anticipated. Distribution Partners, now falling within the category of Project Partners, could potentially provide usage statistics given further development of partnerships with the CAA.	Not complete at this time.
Data evaluation	It was presumed that hundreds of Registered Users would be inputting data into the CAA. As this is not a current function of the CAA, ongoing data evaluation is not a necessary activity.	Data is provided by established Project Partners and Data Sets, and are reviewed for accuracy before being added to the CAA.

Project management	Ongoing	Efficient work flow management of strong communication between all project team members is a strong success of the CAA project.

In summary, the CAA succeeded in identifying, aggregating, and making accessible for the first time the following data sets: 1) SAGE-defined agricultural places, 2) SAGE-defined crop taxonomy, 3) United States Department of Agriculture, National Agricultural Statistics Service crop data tied to defined agricultural places, 4) Farmland Mapping and Monitoring Program agricultural growing area data, 5) PUR crop data on a county-wide basis, 6) County Crop Reports crop data, 7) Certified Producer Certificate crop data tied to agricultural places, 8) expert-identified data for particular agricultural places, 9) farm data from CAFF which had limited crop information, 10) farm data from CUESA, 11) farm data from the SFP, with a focus on agriculture tourism offerings, 12) farm data from Monterey County, 13) Farmers Market data from the California Farmers Market Federation, and 14) event data from the MALT, CUESA and the University of California, Davis Small Farms Center.

The CAA represents the first-ever comprehensive synthesis of all of this data in one interactive environment. This achievement provides a unique, valuable baseline tool on which to build a more robust data repository and grow a broader audience of users.

Beneficiaries

The CAA provides direct benefit to specialty crop farmers by increasing their online presence, identifying new markets, and participating in the creation of more robust farming data by region (yields, crops that are grown, effects of weather, etc). Currently, the CAA highlights 1,326 farms throughout the state. Another group directly benefitted by the CAA is the AgTourist (Agricultural Tourist) audience interested in understanding more about sustainable agricultural in California, with the specific desire to participate in events that encourage connection between rural and urban lifestyles. The CAA partners with the CalAgTour program, a project of the SFP, to map agricultural events and educational opportunities throughout the state. Since the soft launch of CAA in September 2011, there have been 336 visits to the events page on the CAA website.

Additionally, the CAA benefits County Agricultural Commissions and the numerous researchers who access the County Agricultural Reports, by providing visualization as well as ready access to crop and place data. Additional beneficiaries include the project partners to date (SFP, CAFF, MALT, CUESA, etc.) whose own public education and outreach efforts are enhanced by CAA. Finally, the general public benefits from having an accessible, comprehensive go-to site that answers the questions – what is local, what grows where and when?

Lessons Learned

There were three additional aims to the goals outlined above which the project did not completely meet. The aim to populate the website with complete and regularly updated information proved to be problematic due to the lack of data, and/or the inaccessibility of data, and to date, the infeasibility of a system for real-time updates. The website does however reflect the best optimized aggregation and presentation of accessible specialty crop production information in the state at this point.

In turn, the lack of dynamic data meant that the aim of regularly and widely distributed data feeds proved unfeasible. Distribution partners and audiences using the website directly need dynamic data to encourage regular uptake and use, respectively.

The project also aimed to complete a business plan for a self-sustaining service. The initial concept had been that opportunities for monetizing the site would come from wide-spread utilization, which is not yet feasible due to some of the challenges outlined above. The project produced a Business Assessment (attached) which outlines the project's history, addresses the market and competitive landscape, identifies strengths and weaknesses based on a general site review, reveals insights from dozens of user interviews, and makes recommendations for Phase 2 operations. Although the project is not yet self-sustaining, it currently stands as a useful static resource and a plan outline is in place to take the CAA to the next level.

The trend in California toward purchase and consumption of locally grown produce has created the need for tools and data sets that educate consumers about their food choices, and that connect them with the rich agricultural landscapes of California. There are several applications, in addition to the CAA's attempt to do this. Similar to the CAA, these tools attempt to showcase information about the "what, where, and when" of local food production. However, among these tools there is no dominant application that brings data together in a simple and unified way, and the market for online tools in this space is fragmented. More specifically, there is no site that presents crop and seasonality detail in a visually appealing way. This set of circumstances creates a unique opportunity for the CAA - with refinements - to address the deficiencies in the current market for online tools.

All grant funds were expended on project.

Contact Person

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Additional Information

Please see: www.calagalmanac.com

A Business Assessment is attached.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 42	**Project Title:** Heat-tolerant Lettuce and Spinach Varieties for Adaptation to Global Warming and Low Land Cost Areas of California		
Grant Recipient: USDA-ARS, Salinas, CA		**Grant Agreement No:** SCB10042	**Date Submitted:** December 2013
Recipient Contact: Beiquan Mou		**Telephone:** 831-755-2893	**Email:** Beiquan.mou@ars.usda.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Global warming and climate change pose serious challenges to California agriculture and place unprecedented pressures on the sustainability of horticulture industry. Former U.S. Energy Secretary and Nobel Prize winner Steven Chu warned that California's "Salad Bowl" – Salinas Valley, could turn into a dust bowl by the end of the century, as global warming takes its toll. Adapting the leafy greens industry to future conditions is essential to meet the needs of a growing population and increasing demand for leafy vegetable products. Forecasts show that global warming over the next several decades will take place irrespective of any action taken today. Thus, the development of crops that can cope with heat, drought and other climate extremes may well be the single most important step that can be taken to adapt to the changing environment. However, breeding a new variety takes time, often about 10 years. The USDA-ARS' ability to breed these new varieties is undermined by the rapid loss of the genetic diversity of plants, which is in turn accelerated by climate changes. Therefore, there is an urgent need to mitigate the abiotic stresses through improvement of leafy vegetables for future environments. In addition, leafy vegetables are losing acreage to housing and industrial development as well as competition from other crops such as strawberry, and land cost in the major production areas of coastal California is very high. The USDA-ARS proposes to screen lettuce and spinach germplasm collections to find heat-tolerant varieties that can thrive in hot weather. This project seeks to help California leafy vegetable growers mitigate the adverse effects brought by a warming planet, and expand the growing seasons of lettuce and spinach in hot but low land cost areas such as the Central Valley or Imperial Valley. Successful completion of the project will help ensure the long-term future of these crops, reduce production costs, and enhance the competitiveness of California lettuce and spinach.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

In order to identify heat tolerant genotypes, more than 3,500 lettuce and 400 spinach varieties and germplasm accessions were screened in growth chambers. The USDA-ARS searched the available references regarding the effect of high temperature on plant growth and development in order to find and develop suitable methods that can be used in the screening of lettuce and spinach varieties for heat tolerance. The USDA-ARS developed methods of screening for heat tolerance such as thermotolerance, seedling growth, cell membrane thermotolerance (electrolyte leakage), and chlorophyll fluorescence (MINI-PAM). Seeds were placed in Petri dishes to test their ability to germinate at high temperature (29 and 34°C) as compared to controls at 24°C. Three week-old seedlings were exposed to heat stress (43/35°C day/night) for a week before being assessed for leaf and plant damages as well as growth reduction. By using these methods the USDA-ARS was able to identify different types (crisphead, butterhead, green leaf, red leaf, romaine, wild or primitive forms) of lettuce and spinach varieties that can tolerate heat stress and/or germinate under high temperature conditions. The heat-tolerant lettuce and spinach varieties were then tested in field trials at the University of California West Side Research and Extension Center (WSREC, Five Points, CA) in the San Joaquin Valley and at the University of California Desert Research and Extension Center (DREC, El Centro, CA) in Imperial Valley for two years. Seed germination percent, plant height, diameter, head compactness, plant weight, tipburn, heat damage, and core length were recorded for multiple plants in each plot. Data collected were subjected to statistical analyses.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The USDA-ARS performed statistical analysis of data from seed thermo-dormancy and heat-tolerance experiments conducted in growth chambers and fields for lettuce and spinach. Inhibition of lettuce seed germination at high temperatures is a common problem associated with lettuce production. Depending on lettuce cultivars, seed germination may be inhibited when temperatures exceed 28°C. The delay or inhibition of seed germination at high temperatures may reduce seedling emergence and stand establishment of lettuce in the field, leading to a reduction in economic yield. In order to identify heat tolerant lettuce genotypes, lettuce varieties and germplasm accessions were screened for thermotolerance. By using this method the USDA-ARS was able to identify lettuce cultivars and germplasm that can germinate under high temperature conditions. Some of the lettuce cultivars and germplasm exhibited thermo-inhibition at 29°C, while others exhibited thermo-tolerance at higher temperature (34°C). Lettuce seed germination in the field was positively correlated with seed germination at 29 and 34°C. The results indicated that lettuce genotypes differ greatly in their ability to germinate at high temperatures as determined by the percentages and the rates of germination. The analysis also found that some spinach varieties were resistant to thermo-dormancy at 36°C as compared to controls at 22°C. They were able to germinate under high temperatures when planted in the fields in the San Joaquin Valley and Imperial Valley in July and August.

When planted in hot environments in March and May in the Central Valley and Imperial Valley, some lettuce and spinach varieties were heat-tolerant, with little yield reduction, early bolting, and tipburn, as compared to control plants grown in cool climate in the Salinas Valley. These heat-tolerant varieties identified include crisphead, butterhead, green and red leaf, romaine, and wild species. The thermo-tolerant varieties could be used to expand lettuce production seasons in warm and low land cost areas and reduce the need for seed priming, lowering the production costs. The results from this study may help growers choose lettuce varieties to be grown in a warm environment. The information may also help lettuce breeders to improve the crop for adaptation to global warming and climate changes.

The USDA-ARS demonstrated part of the results to about 40 people including board members of the California Leafy Greens Research Program representing major lettuce/spinach growers/producers, seed company personnel, researchers, and media at field trials conducted in Salinas, San Joaquin, and Imperial Valleys in the second and third years of the project. A manuscript titled "Evaluation of lettuce genotypes for seed thermotolerance" was published in the HortScience journal (attached). Other manuscripts for heat-tolerance in lettuce and spinach will be submitted to professional journals. These achievements meet the goals and the expected measurable outcomes of identification of heat-tolerant lettuce and spinach varieties, evaluation and demonstration of these varieties in major production regions in the San Joaquin Valley, Imperial Valley, and Salinas Valley for the leafy greens industry, and the publication of research results in professional journals.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

California produces about 80% of the lettuce and 70% of the spinach in the U.S., occupying 202,800 and 28,500 acres and valued at $1.5 billion and $153 million in 2012, respectively. Most lettuce and spinach crops are produced in the coastal areas of California. Being cool-season crops, lettuce and spinach are vulnerable to global warming. Heat-tolerant lettuce and spinach identified from this project should reduce crop loss due to warmer weather, and ensure long-term viability of growing these crops in the region. This project will benefit 107 lettuce, 67 spinach, and 25 spring mix producing companies and more than 30 seed companies with thousands of personnel involved in growing, shipping, processing, distribution and retail of lettuce and spinach products and seeds in California. In addition, heat-tolerant varieties from the project would be adapted to hotter conditions in inland areas of California. It may expand lettuce and spinach production seasons from current four months to nine months in San Joaquin Valley and year-round in Imperial Valley. Land rents in coastal Monterey County average $1,600 per acre, while it costs only $300 per acre in Fresno County of San Joaquin Valley. Lettuce and spinach growers can potentially save $339 million a year on land rent alone if most production is shifted to inland valleys. Since heat-tolerant varieties tend to be drought-resistant as well, these cultivars should not require more irrigation water. As the costs of land, labor, fuel, fertilizer, packing material, and transportation continue to rise, it is essential to reduce production costs of leafy vegetables. This project helps reduce land costs and improve the sustainability and profitability of California lettuce and spinach crops.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

USDA-ARS achieved more goals than what was originally proposed by adding the testing of lettuce/spinach seeds for high-temperature germination (thermodormancy), an aspect is important to the leafy greens industry.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Attachment A - The following publication has resulted from this research project:

Lafta, A. and Mou, B. 2013. Evaluation of lettuce genotypes for seed thermotolerance. HortScience 48: 708-714.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 43	**Project Title:** California Strawberries and insulin resistance (IR) in humans: Combating a major risk factor for diabetes and cardiovascular disease through diet	
Grant Recipient: The Regents of the University of California, Davis	**Grant Agreement No.:** SB10043	**Date Submitted:** December 2013
Recipient Contact: Britt Burton-Freeman	**Telephone:** (780) 341-7078	**Email:** bbfreeman@ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The initial purpose of the proposal was: 1) to assess the ability of California strawberries to improve insulin responsiveness in people with insulin resistance and, 2) to assess mechanisms of action in order to understand and explain the benefit of strawberry consumption in this context. Insulin resistance is a precursor to diabetes, and both are risk factors for cardiovascular disease (CVD). In America and in various parts of the world, the prevalence of diabetes is substantial and on a trajectory to increase over the coming decades if current lifestyle trends continue. The research from this grant will provide the type of science-based evidence needed for developing preventative health, food-based strategies using strawberries.

Insulin resistance (IR) is a critical metabolic abnormality with roots in many chronic diseases such as type 2 diabetes mellitus, CVD and even Alzheimer's disease. In westernized countries, 25-35% of the population has some degree of IR impacting quality of life. While food is not medicine, in recent years research has uncovered bioactivity of certain fruits and vegetables beyond that provided from the essential nutrients. Strawberries have a unique phytochemical profile that along with the essential nutrients and fiber they provide could serve to slow or impede onset and progression of some diseases. Work in cell culture and preliminary work in humans suggests that strawberries may have specific benefits relative to the action of insulin. The work performed by this grant is timely because it provides new data and knowledge about strawberry intake and bioactivity to support health in a population that is "at risk" for the most apparent non-communicable diseases of the 21st century (diabetes, CVD, Alzheimer's).

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Human clinical Trial 1 (acute phase) - This study tested the hypothesis that strawberry improves insulin responses in insulin resistant individuals under conditions of acute oxidative- and inflammation- stress: the result of Western meal consumption. All of the components of Trial 1 have been completed as listed in the performance monitoring plan. Plasma insulin concentrations as measured by the least significant mean (LSM) were significantly lower when strawberry (provided in a beverage) accompanied the Western (style) high carbohydrate/fat meal (HCFM) compared to when the meal was consumed with the control/non-strawberry fruit containing beverage ($p<0.01$). However, staff did not observe significant differences in glucose concentrations after the meal, suggesting that the presence of strawberry reduced the insulin requirement (i.e. improved insulin efficiency) to achieve glucose homeostasis. Although staff observed a reduction in inflammatory markers (IL-6) and oxidative stress markers (Oxidized LDL) in the group that consumed strawberry beverages with HCFM meal compared to the control group, the data were not statistically different. Staff also analyzed plasma samples after consumption of different doses of strawberry with the HCFM using Q-TOF LC/MS and LC-MS/MS. The data showed detection of 33 compounds/metabolites in the plasma after consuming the strawberry beverages; 7 were new discoveries and not reported previously. The data also showed that as the amount or dose of strawberry increased, so did the concentration of the major metabolites. Pelargonidin- O-glucuronide (PG) was the most abundant metabolite and a signature metabolite of strawberry consumption. Maximum concentrations (Cmax) of PG were achieved at ~150 minutes and were significantly different among the beverages (maximum concentrations were 0, 94.3 ± 21.4, 166.5 ± 16.2 and 226.7 ± 36.7 nmol/L after consuming 0, 10, 20, 40 g freeze-dried strawberry powder in beverages, respectively ($P < 0.05$). Area under the concentration curve (AUC), a measure of exposure during the 6 h also increased with increasing amounts of strawberry ($P < 0.05$); however, pharmacokinetic evaluation indicated that while higher concentrations of key strawberry compounds/metabolites were achieved with eating more strawberry; the absorptive capacity of pelargonidin-based anthocyanins may have been saturated resulting in decreased efficiency of absorption when greater amounts were ingested. For example, the percent bioavailability pelargonidin-3-glucoside ranged from 1.8% to 1.3% (10 g vs 40 g, respectively of freeze-dried strawberry powder containing beverages). A prelude to these data has been published in the Journal of Berry Research 3 (2013) 113–126, DOI: 10.3233/JBR-130048.

Human Clinical Trial 2 (chronic phase) - The objective of the study 2 (chronic study) was to test the hypothesis that strawberries included in the diet regularly would improve insulin sensitivity and hence, glucose tolerance in insulin resistant individuals. This was a 6-week, parallel design study with a 4-week follow-up to evaluate strawberry-associated improvements in insulin action after daily intake. To maintain the study blinded, the strawberry was delivered in a beverage similar to what was used in the acute phase of the project. All of the study-related procedures of Trial 2 have been completed according to the performance monitoring plan. The data indicated that chronic consumption of strawberry (40 g/day) significantly improved glucose metabolism as measured by oral glucose tolerance test in the insulin resistance individuals characterized by HOMA values. However, inflammatory markers (IL-6, IL-1b, hs-CRP) and oxidative stress markers (Oxidized LDL) were not changed in response to chronic consumption of strawberry beverages, suggesting that alternative mechanisms must be involved.

In-vitro cell culture studies: The effect of a strawberry on insulin signaling pathways was studied in a cell culture model using skeletal muscle and fat cells. The study was designed to understand the actions of insulin within cells by measuring different proteins that get turned on or off during different stress conditions with and without strawberry. Cells were exposed to high glucose, free fatty acid (FFA) and a combination of both to mimic what the body would be exposed to during a diabetic, pre-diabetic or post-meal (fed) state: this regimen served as the “stress condition”. Using this paradigm, various concentrations of strawberry were tested. The results of this work indicated that a water extract of Strawberry (1 mg/mL) attenuates high glucose (15 mM – diabetic concentrations of glucose), free fatty acid (2 mM-FFA–fasted, obese, diabetic concentrations) and Glucose +FFA–mediated impaired insulin activity as measured by insulin-mediated activation of p-Akt in muscle cells. Strawberry water extracts also improved deficits in insulin signaling incurred by lower glucose and FFA treatment mimicking pre-diabetic concentrations or after meal concentrations. These data suggest that the water soluble components of strawberry have biological activity and when utilized in a stress condition, similar to what is observed in real life (diabetes, pre-diabetes or fed states), strawberry may minimize the high nutrient-induced impaired insulin signaling observed in skeletal muscle tissue. Similar experiments as those above were also carried out with fat cells (adipocytes). However, no significant impairments of insulin signaling pathway as measured by p-Akt in response to relatively high glucose, FFA and combination of both within 6 h were observed. Additional experiments are required to understand the nutrient-sensitive pathways that are modulated in adipocytes.

All project partners have been involved with the project as intended. Co-PIs, support scientists and the clinical team from IIT significantly contributed to the meeting and achieving the tasks outlined in the project workplan.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

1. Establish cell culture, perform mechanism of action studies- the main propose of this performance goal was to perform dose response assays and mechanism of action studies to support clinical trials. The outcome of the studies is important for explaining/interpreting data obtained from the clinical trials. The initial cell culture studies were performed to understand the bioactivity of different strawberry extract concentrations/doses in an insulin signaling model (dose-response). Thereafter, mechanistic studies were performed using the lowest effective dose to understand the mechanism of action of strawberry in the presence of glucose and/or FFA. Proteins involved in insulin signaling pathways (activation) were measured after the different treatments.

2. Trial #1: Critical to any clinical trial is the recruitment of eligible participants. Advertising, database query and various screening methodology developed by the clinical team contributed to meeting this performance goal. Approximately 500 people were contacted, 64 passed the initial screening to come to the lab for follow up screening, 39 were eligible and 27 subjects were enrolled. Subjects were scheduled on four different occasions to complete the protocol specified tasks. Out of the 27 subjects enrolled, 22 completed the study (5 people dropped out early). Subjects provided blood samples at protocol specified time points over 6 h that were subsequently analyzed for glucose, insulin, triglycerides, cholesterol, IL-6, Oxidized LDL and plasma metabolites (strawberry derived).

3. Trial #2: Similar to the acute trial (#1), subjects were recruited and screened to meet the enrollment performance goal. Approximately 1,100 people were contacted or contacted the team, 79 were eligible for screening at the clinic and 56 subjects passed the eligibility criteria. 46 subjects enrolled in the study and 38 subjects completed with 8 dropouts. Subjects were required to drink strawberry or control beverages at home for 6 weeks with frequent visits back to the lab for assessment and replenishment of test beverages. All completers performed an extended oral glucose tolerance test, which included blood collection at weeks 0, 6 and 10 (no beverages were consumed between weeks 6-10). Blood samples were analyzed for glucose, insulin, triglycerides, cholesterol, IL-6, IL-1 beta, hs-CRP, Oxidized LDL.

4. Data analysis and statistical analyses are complete. Data interpretation/manuscript writing is ongoing. One manuscript is published and another three manuscripts are in preparation and planned for submission in February 2014. Abstracts and presentations at scientific and health professional meetings occurred as planned during the course of the project period. These communications allow for ongoing messaging and knowledge sharing among scientists and health professionals that are ultimately conveyed to the general public resulting in enhanced strawberry interest, demand and sales. Communication has been at the Experimental Biology Meetings, American Chemical Society meetings, Berry Health Benefits Symposium, American Aging Association, Dietetic Association Meetings, University invited talks (Rush University, BYU) and functional food programs (Supply side, Nutracon), among others.

5. The final Performance Monitoring assessment is based on industry sales and annual California strawberry production/ acreage trends. This is a long term monitoring goal and the California Strawberry Commission will be monitoring the progress yearly. It is expected that household purchases by heavy buyers to increase 11.5 times by/in 2017, with an increase of ~5% measured in April 2013. Production goals were 4-6% increase per year. Results from the April 2013 assessment indicated a 9.1% increase in fresh strawberry production and 4.9% in frozen from 2009 to 2012 (data source USDA). From 2011 to 2012, production in fresh strawberry increased approximately 6.8%. Consumer sales tracked by AC Nielson indicated that purchase frequency increased 16.9% from 2009 to 2012. Volume and buying rate increased 25.1% and 20%, respectively. Performance metrics associated with this project are on course or exceeding expectations.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The outcome of this project will benefit the strawberry industry and consumers. There are approximately 400 farmers and 70 shippers/processors of strawberries in California. It will contribute to the growth of the strawberry industry by providing health-specific knowledge about strawberries when choosing/purchasing fruit. The data derived from this study provides the type of science-based evidence needed to establish the role of strawberries in health and disease risk reduction. This research provides the type of data needed by health care professionals to establish specific recommendations and dietary guidance about strawberry consumption.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

This project has served as a model of how coordinated research involving food scientist, nutritionists, health care providers and industry can work toward goals to improve industry metrics and informed choice and quality of life of the general public.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Four students undertaking masters degrees were involved in the project and various components of the research are included in their theses. Two students have graduated (one student is pursuing a PhD at Washington State University and the other student is working as a research assistant at North Carolina State University). Two students are in the process of compiling their theses; one of which who has already secured a job at an analytical chemistry lab in New York.

Publications:

- Tulio et al, Berry Fruits Modulated Endothelial Cell Migration and Angiogenesis via Phosphoinositide-3 Kinase/Protein Kinase B Pathway in Vitro in Endothelial Cells. J Agric Food Chem. 2012,PubMed PMID: 22448669.
- Tadapaneni et al, Effect of High-Pressure Processing and Milk on the Anthocyanin Composition and Antioxidant Capacity of Strawberry-Based Beverages. J Agric Food Chem. 2012. PubMed PMID: 22224588.

- Banaszewski et al, A pilot study to investigate bioavailability of strawberry anthocyanins and characterize postprandial plasma polyphenols by Q-TOF LC/MS in humans. J Berry Res, 113–126, DOI: 10.3233/JBR-130048.

Presentations:

- Banaszewski et al, Detection and Quantitation of Polyphenolic Compounds in Strawberry Powder Using LC-MS/MS, 58th ASMS Conference on Mass Spectrometry and Applied Topics, Salt Lake City, Utah, May 23 - 27, 2011
- Banaszewski et al, Detection and Identification of Anthocyanins in Human Plasma Following Ingestion of a Strawberry Beverage FASEB J March 17, 2011 25:771.1
- Chang et al, Polyphenol-rich fruit modulate endothelial cell function via PI3 Kinase/Akt Pathway in Vitro in Human Umbilical Vein Endothelial Cell (HUVEC) FASEB J March 17, 2011 25:772.6
- Chang et al, Polyphenols-rich fruits attenuate cell migration in vitro in human umbilical vein endothelial cells (HUVEC) exposed to glucose and free fatty acids FASEB J March 29, 2012 26:lb432
- Kangath et al, Strawberry extract attenuates glucose and free fatty acid-mediated impaired insulin signaling in vitro in skeletal muscle cells FASEB J March 29, 2012 26:821.15
- Chang et al, Polyphenol-rich fruits attenuate cell migration in vitro in human umbilical vein endothelial cells (HUVEC) exposed to glucose and free fatty acid, Berry Health Benefits Symposium, 2013.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 44	**Project Title:** Fresh Fruits and Vegetables: A Centerpiece for a Healthy School Environment	
Grant Recipient: The Regents of the University of California, Santa Cruz	**Grant Agreement No.:** SCB10044	**Date Submitted:** December 2013
Recipient Contact: Tim Galarneau	**Telephone:** (831) 459-3248	**Email:** tgalarne@ucsc.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

California children eat less than the suggested amount of fruits and vegetables, and thus, show increases in diet-related health problems. Because children eat a significant portion of their diet at school, the U.S. Department of Agriculture (USDA) established the Fresh Fruit and Vegetable Program (FFVP) to improve childhood nutrition. School personnel and others who implement the FFVP need professional training and technical assistance. This project supported professional development and technical assistance for school administrators, staff and partner organizations who work in public schools to incorporate more fresh fruits and vegetables into school menus. California's State Nutrition Action Plan goal is to promote consumption of fruits and vegetables through partnerships with nutrition assistance programs and groups. With 95% of the state's children receiving up to one half of their dietary intake in school, school menus provide an opportunity to offer a variety of fresh fruit and vegetable choices to their students.

This project provided 24 trainings to school administrators, staff, and partner organizations on how to incorporate more fresh fruits and vegetables in school menus and increase student's awareness and consumption of fresh fruits and vegetables through nutrition and garden-based education. These trainings were conducted in underserved regions statewide. In addition, a specialized Fresh Fruit and Vegetables: A Centerpiece for a Healthy School Environment (FFVCHSE) training was provided to food service personnel, focusing on incorporating more fresh fruits and vegetables into school menus, and incorporating fruit and vegetable growers and distributors to further advance insights on how to access and supply these school markets. The project team titled these specialized trainings “Culinary Camps” and hosted the training in summer 2012 and 2013. Finally, the project team conducted formative and summative assessments of the trainings and workshops to inform future efforts.

This project solely benefitted eligible specialty crop producers due to its focus on nurturing the incorporation of more fresh fruits and vegetables in California schools. Schools that increase fruits and vegetables in meals and snacks will become an available market for California growers. The project team conducted training and delivered information to school administrators, school staff, organizations, and volunteers working in schools about how to incorporate more specialty crops in school food. Also, these trainings provided growers with information and tools to support access to school markets. Since the goal for this project was to promote consumption of fruits and vegetables in schools, there was an increase in favorable market conditions for California fruit and vegetable growers to use to their competitive advantage.

This project supports an expansion of the existing FFVCHSE trainings, which have been provided since 2006. The project team, which includes experts in nutrition, agriculture and garden-based learning, has continued to provide critical training and technical assistance to school personnel and their partners. Thus, the project team utilized a proven and successful training program to train school personnel and their partners in educational and administrative activities that support the incorporation of more fresh fruits and vegetables in school meals and snacks.

The FFVCHSE was developed and piloted in early 2009 through a USDA Team Nutrition Training Grant and continued support came from work funded by the 2008 Specialty Crop Block Grant Program (SCBGP) Project 6 for FFVCHSE trainings conducted in 2010 and 2011. This project carried on the successful FFVCHSE trainings to underserved regions of the state.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Fresh Fruit and Vegetables: A Centerpiece for a Healthy School Environment Training (FFVCHSE)
Twenty four trainings in total were completed consisting of eight trainings being provided in each project region: Southern California, North and Central Coast, and Central Valley. Trainings were assessed with regard to increases in participants' knowledge about healthy school food and ideas for healthy school food action plans.

- ***Southern California: San Diego Resource Conservation District***
  Bakersfield (November 1-2, 2011): 34 registered; 29 attended
  *Los Angeles (December 6-7, 2011)***:** 87 registered; 52 attended
  *Los Angeles (February 7-8, 2012):*77 registered; 46 attended
  Bakersfield (March 1-2, 2012): 39 registered; 32 attended
  Pomona (December 12-13, 2012): 70 registered; 38 attended
  Pomona (March 12-13, 2013): 87 registered; 52 attended
  San Diego (November 6-7, 2012): 53 registered; 32 attended
  San Diego (February 26-27, 2013): 30 registered; 18 attended.

- ***North and Central Coast: University of California, Santa Cruz (UCSC)***
  Ukiah (November 17-18, 2011): 50 registered; 42 attended
  San Francisco (November 30-Dec 1, 2011): 55 registered; 28 attended
  East Palo Alto (February 22-23, 2012): 38 registered; 26 attended
  Ukiah (March 15-16, 2012): 62 registered; 40 attended
  Salinas (October 16-17, 2012): 38 registered; 26 attended
  Thousand Oaks/Simi Valley (November 14-15, 2012): 34 registered; 22 attended

Sonoma (March 7-8, 2013): 38 registered; 27 attended
Thousand Oaks/Simi Valley (April 11-12, 2013): 26 registered; 18 attended

- ***Central Valley: University of California, Davis (UCD)***
  Fresno (November 15-16, 2011): 61 registered; 34 attended
  Hayward (December 8-9, 2011): 56 registered; 33 attended
  Fresno (March 28-29, 2012): 49 registered; 32 attended
  Hayward (March 20-21, 2012): 63 registered; 42 attended
  Modesto (October 23-24, 2012): 48 registered; 32 attended
  Chico (November 27-28, 2012): 52 registered; 31 attended
  Modesto (March 5-6, 2013): 49 registered; 32 attended
  Chico (February 25-26, 2013): 63 registered; 42 attended

The regional trainings covered a variety of topic areas, some of which include the following areas: National Movement on School Food; Preparing and Serving Fruits and Vegetables; Serving School Garden Grown Produce in the Cafeteria; Promoting Fruits and Vegetables in the Classroom; Community and Cafeteria Connections; Sourcing Local California Produce; Models that Work; School Wellness Policies; Gardening Skills and Resources; Greening Schools; Farm to School; and Teaching Garden Enhanced Nutrition Education.

Guest presenters attended trainings to cover some or all of the topic areas listed above based on their area(s) of expertise. These presenters included school food services directors and personnel, representatives from non-profit organizations that promote farm-to-school activities and representatives from the California Department of Education (CDE).

All lessons/trainings covered methods of introducing, promoting, and encouraging the consumption of specialty crops in fostering a healthier school food environment. However, the training partners decided to emphasize a certain topic based on the season. Thus, in the fall there was more focus on nutrition education and in the spring gardening became a key focus topic.

Also, training partners and Food Service Consultants (FSC) presented a range of school food menu options that various schools utilize. The FSC's shared their meal menus and planning tips, which highlighted ways to incorporate more fresh fruit and vegetables into school menus. In addition, the FSC gave cooking demonstrations, provided recipes and shared information resources including the on-line "Recipe Challenge". "Scratch Cooking", creating meals from basic on-hand ingredients, generated a great deal of interest among school food service personnel, as has the topic of "Salad Bars" in schools. School regulations were reviewed to foster increases in specialty crops and healthy food consumption through school rules and guidelines. Finally, options for serving fresh fruit and vegetables at different times of the day were discussed along with examples of how different school districts approach serving fresh fruit and vegetables.

As the project progressed, training partners realized a website to house all materials that project partners shared at each workshop would be valuable resource for participants. Therefore, a website was created at no cost to the project, which included agenda items for all workshops and information about associated training resources. The website, http://www.healthyschoolenvironment.org/training-resources, has proven to be a successful tool for the project. Project partners created a successful model for facilitated discussions, brainstorming, and troubleshooting about healthy school food issues as well. For example, the "Greening Schools" topic was specifically created by the project partners to highlight opportunities for increasing efficiency and reducing waste, which can lead to cost savings that can be then reinvested in specialty crop sourcing and promotion efforts.

Statewide Culinary Camps

In addition to the 24 regional trainings, two statewide Culinary Camps were completed in June 2012 and June 2013. These trainings focused on increasing innovative efforts to source and prepare more specialty crops in school food services. Outreach for the Culinary Camps was conducted through an internal e-newsletter list serve base of 2,000 affiliates consisting of attendees from regional trainings. The CDE and training partners sent promotional announcements to thousands of additional target stakeholders such as food service and nutrition staff from around the state. Also, large and small scale producers and distributors were invited to participate. Currently, some of these companies provide school districts with fresh preparation equipment to demonstrate the latest innovations of easing the increased use of California specialty crops in their kitchens. Thus, these industry professionals could provide insights to advance districts efforts for increasing the sourcing and consumption of specialty crops.

Training partners introduced three panels and interactive sessions covering topics ranging from Production and Distribution, Fresh Preparation with Specialty Crops, and Finding Cost Savings to Cultivating Advances in Behavioral Economics to Increase Consumption of Fresh Fruits and Vegetables. During lunch, the Camps encouraged further collaboration by providing "curbside consulting" or one-on-one advising between presenters and attendees as well as round table discussions focusing on panel themes. Interactive activities zones were established to showcase examples of fresh preparation oriented district kitchens, demonstrations of menu preparations for items featuring only specialty crops and a fresh preparation equipment demonstrations zone. The agenda and materials from these trainings were made available online at www.healthyschoolenvironment.org.

Due to the interest generated by these two trainings, project partners hosted on June 19, 2013 a forum following the Culinary Camp. Although outside the scope of the project, this meeting followed the content and purpose of the Culinary Camps on advancing specialty crops offerings in districts across California. The success of these trainings led to additional discussions with USDA, CDE and the California School Board Association that built on and focused on ways to improve offerings and consumption of fresh fruits and vegetables in schools.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Due to the budget amounts available, staffing time constraints and changes in project staff during the last year of the project, measurable outcomes for this project were not tracked as written in the original Scope of Work. However, to measure whether performance goals and outcomes were achieved, the project team conducted extensive surveys of training/workshop participants to identify changes in student consumption of fruits and vegetables, increases in schools knowledge of purchasing fresh fruit and vegetables, and increases in market opportunities from California growers.

1) *Increase (at least 5%) in the current consumption of fresh fruits and vegetables by students in the project's elementary schools.*

Although baseline measures were not collected for this measurable outcome, the project team evaluated changes in fresh fruit and vegetables over the project period through surveys of food service directors and purchasers. To assess the change, if at all, in student consumption, a follow-up survey was provided to food service directors participating in the program. More specifically, the survey evaluated their perceptions of change in student food consumption. In the first year of the project, survey results revealed that 81% of respondents perceived students to be eating more fruits and vegetables as a result of implementing knowledge gained by school personnel to incorporate more specialty crops into school menus. According to the 2011-2012 survey results, 65% of respondents reported students consumed more fruits, while 58% reported students ate more vegetables. Therefore, the project was successful in increasing students' consumption of fresh fruits and vegetables.

2) *Increase in knowledge by school personnel about how to incorporate fresh fruit and vegetables into school lunches as in changes in, or plans to change, school lunch and snack menus.*

To assess whether the program had achieved this outcome, data was gathered in two ways. First, the project team analyzed if training participants had obtained new skills and knowledge, which are prerequisites or intermediate steps to purchasing more fresh fruits and vegetables in the future. Data from the workshop surveys suggested participants learned new ways to serve fresh fruits and vegetables.

In the first year of the program, participants were surveyed to measure the extent of learning by attending program training. Participants responded to a point scale where 5 represented "learned several new ideas" and 1 represented "did not learn anything new." Upon completion of the first year training, participants' average response was a 4.2. In fall 2012, the average extent of learning how to incorporate fresh fruits and vegetables into school menus increased to 4.8. However, in spring 2013, the evaluation form was revised to adjust the response scale where 5 represented "a great extent" and 1 represented "not at all." The average score during this time period was 4.1. The above survey results convey that one avenue for increasing fresh fruits and vegetable procurement was increased, as participants increased their knowledge in increasing specialty crop in school lunch and snack menus.

The second method used to assess an increase in knowledge by school personnel was by conducting a survey of food service directors and other food service personnel responsible for purchasing food. This survey measured the extent to which behavior changed after participating in the program. The first survey was conducted in late October and November 2012 to assess changes for participants from the 2011-2012 school year workshops. The project team contacted 114 people who appeared to procure food from the previous year's trainings. There was a 32% response rate. Attendees were asked if they purchased more fresh fruits and vegetables after attending the training, 41% said yes. The second survey was conducted in June 2013 for those who attended trainings in the 2012-2013 school year. This survey differed from the previous survey as it was designed to focus on training food service personnel. This end-of-workshop evaluation included several additional questions in order for the project team to have a better understanding of intentions to incorporate more specialty crops into school menus. The project team contacted 36 food service directors and received a 32% response rate. Results were similar for the 2012-2013 attendees, where 42% said yes, they would purchase more fresh fruits and vegetables after attending the training. Furthermore, when participants were asked how the training helped them, attendees responded by saying it provided opportunities to network, it helped with salad bars and food preparation ideas, creating lesson plans and it helped with connecting to local farmers and their operations.

Based on surveys conducted, the project team met their goal of increasing school personnel's knowledge, as in changes in, or plans to change, school menus by incorporating fresh fruit and vegetables into school lunches as a result of attending the program trainings.

3) *Increase in interest in and knowledge of school market opportunities by California fruit and vegetable growers whose farms are in the project locality or region as reflected in sales to project's elementary schools by California growers.*

The first measure the project team analyzed was participants learning of farm-to-school during trainings. The project team reasoned, the more people know about implementing farm-to-school, the more likely they will be able to implement it, and thus, this will have an impact on increasing consumption of California specialty crops. In 2011-2012 school year, a survey was conducted that asked attendees how well they understood farm-to-school programs or how well their knowledge increased. The survey point scale was between 5 representing "much better or very good understanding" to 1 representing "no better understanding." During the 2011-2012 survey, the average response was around 4.1. Furthermore, in spring 2013, attendees were asked to what extent did they learn new ways to implement farm-to-school, where 5 represented "a great extent" and 1 represented "not at all", the average was 4.1. Overall, the attendees acquired knowledge that will facilitate bringing in more California fresh fruit and vegetables into school menus.

The second measure the project team looked at was the intention to purchase local, California specialty crops. In school year 2012-2013, 92% of the respondents indicated they intended to purchase more local fresh fruits and vegetables. In the final food service directors training, 100% of survey respondents agreed that they too intended to purchase more local specialty crop as a result of attending the training. Thus, the project met its goal in creating more favorable market conditions for California's fruit and vegetable growers.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Specialty crop growers, as well as distributors of specialty crops, gained new markets in which to sell their products. Since school food service staff identified purchasing more specialty crops after training, and that they have purchased these fruit and vegetables from local, regional or other California sources, a direct connection can be made that growers gained new markets as a result of this project. Furthermore, farmers and distributors participating in the statewide Culinary Camps benefited from the training sessions as they expressed the training discussions and feedback was valuable in better determining market interests and scales of need in schools. For example, farmers and distributors had the opportunity to meet directly with existing and new clients.

Based on attendance to 24 trainings and two Culinary Camps, other beneficiaries of this project include food service professionals, nutrition educators, garden educators, farm-to-school professionals, school children and administrators of schools or districts. While the project had approximately 1,400 individuals register, 926 individuals involved in farm-to-school programming benefited by attending project trainings. Based on survey evaluations, students consumed more fruits and vegetable for lunch and snacks, which will improve their chances for better health in the future. Administrators and food service personnel benefited professionally from this project by increasing their knowledge of how to incorporate more specialty crops into their schools.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

Project staff learned an incredible amount about how to convene diverse staff and stakeholders working on a systems approach to cultivating a healthy school environment. Methods to impact increased preparation and consumption of California specialty crops entail working with food and nutrition staff, school garden and nutrition educators, school district officials, growers and community partners. Also, the project team even learned school nurses have a teaching credit component that can allow them to partner for nutrition education in schools, and thus, be another ally for school food personal in promoting their healthy offerings. For example, Los Angeles Unified School District is currently developing curriculum for nurses and their association.

The project team and training partners realized the importance of having an online web-tool and e-newsletter promotion tool for keeping participants connected and helping them access project resources to share more broadly with their peers and colleagues. Since the website was not a part of the original project, the project team did not track activity related to the web-tool. This would have been helpful in determining how many additional food and nutrition directors and staff benefitted from the materials and content beyond those who attended the trainings. Furthermore, the project team also learned that the day to day demands of school food service staff made it difficult for them to follow-up with evaluation responses, which resulted in lower than expected response rates.

The project team learned a more substantial budget was needed to measure changes in student food consumption and menus as this type of data was found to be time intensive to collect. Similarly, it was difficult to measure changes in grower knowledge. However, the project team realized in the future it would be much easier to obtain grower feedback if they participated more actively as an advisor or cohort member committed to the outcomes in advance of implementing the project.

The project team built a strong base of partners reaching thousands across California. Based on the feedback gained, the project team was informed of the need for a greater technical specificity with trainings targeting a reduced scope of participants (i.e. focusing one day trainings for food and nutrition services and other day trainings targeting school garden and nutrition educators). This would more greatly benefit the current needs and issues that have arisen in school food.

Above all, what really made this project's regional trainings and statewide Culinary Camps unique is the diversity of people involved in school food who come together to learn about what others were doing; people who otherwise would not discuss these issues and may not have worked together to increase offerings of specialty crops.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Project materials and additional content is available online at www.healthyschoolenvironment.org including powerpoint presentations, training hand out materials, menu and specialty crop promotion materials, evaluation tools, as well as related research and publications highlighting FFVCHSE project efforts.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 45	Project Title: Unified Production Nursery Systems Approach for Integrated Pest Management (IPM) and Best Management Practices (BMPs).	
Grant Recipient: California Association of Nurseries and Garden Centers	**Grant Agreement No.:** SCB10045	**Date Submitted:** December 2013
Recipient Contact: Chris Zanobini Dr. David Fujino, UC Davis	**Telephone:** (916) 448-3900 (530) 754-7739	**Email:** chris@agamsi.com dwfujino@ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The California nursery and floriculture industry is challenged every day with exposure to invasive pests and pathogens of concern or covered under quarantine regulations that exist in various regions of the state. The risk of finding Light Brown Apple Moth (LBAM), Red Imported Fire Ant (RIFA), *Phytophthora ramorum*, causal agent of Sudden Oak Death (SOD), European Grapevine Moth (EGMV), Asian Citrus Psyllid (ACP), Glassy-Winged Sharpshooter (GWSS), Diaprepes, or European Brown Garden Snail (EBGS) on nursery growing grounds, operational facilities, or in nursery transportation trucks is a constant worry for growers and regulators alike. Such risk has the potential to halt intra-state and inter-state shipping until a delimitation survey is conducted and/or the nursery is found to be free from the pest. Also at stake is the possibility of customers refusing to accept nursery products which, in spring, can equate to millions of dollars of lost sales.

As the introduction of invasive insects and diseases has impaired the ability of California's nursery industry to do business, growers have used best management practices (BMPs) in combination with Integrated Pest Management (IPM) approaches to exclude and prevent the spread of several major pests. Stand-alone sets of BMPs exist for particular pests and diseases such as *P. ramorum* and LBAM. Unifying these pest-specific systems approaches into a methodology applicable to a range of insects and diseases will prevent the spread of existing pests and exclude future invaders allowing nurseries to conduct business in a more efficient and sustainable manner while safeguarding California's crop agriculture and the environment.

SCBGP 2007 projects "Control Tactics for Larvae of *Diaprepes abbreviatus* in Ornamental Nurseries in Southern California" (Project 9) and "Tomato Yellow Leaf Curl Virus: Detection and Management of a New Exotic Disease in California Tomatoes" (Project 10) both focused on specific pests impacting nursery specialty crops; this project evaluated these and other practices and systems approaches across multiple pests for benefit in exclusion, prevention, and control of both present and potential pests. SCBGP 2009 project 10 "Multi-Commodity Sustainable Practices Program" focused on more than one crop; this project evaluated only application of those programmatic practices specific to nursery specialty crops.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Develop project team to conduct literature search of existing best management practices and develop into multi-pest matrix and technical summary. California Association of Nurseries and Garden Centers (CANGC) charged representatives from UC Davis and the UC Nursery and Floriculture Alliance to complete the project work plan. A graduate student in the Department of Entomology and Nematology completed the BMPs literature search producing a technical summary and a matrix of BMP activities across 11 insect and disease species of concern identifying activities applicable to multiple pests. (Attachments 1&1A)

Assemble a Science Advisory Committee composed of researchers, regulators, and nursery industry stakeholders charged with reviewing the BMP matrix and technical summary. The Science Advisory Committee met once after individually reviewing the matrix and summary and recommended changes to the documents as well as confirmed plans for future activities. A subcommittee was formed to solicit and fund research projects needed to fill information gaps found in the BMPs matrix/technical summary. A second subcommittee was formed to deliver education and outreach pertaining to the creation of the comprehensive BMPs publication and subsequent training workshops to facilitate adoption of the BMPs. (Attachment 2)

Solicit and fund research sub-projects needed to fill information gaps found in the BMPs matrix/technical summary. Four sub-projects were identified and funded: Nursery case studies to assess the economic impact of scouting or monitoring for pests and diseases within the nursery, Habitat manipulation to enhance biological control of soil pests in nurseries, Compilation of historical regulatory statistics on insect and disease finds in California to establish baseline data, and Economic report on the current diversity and value of the nursery industry in California to determine the importance of BMPs.

Use of Scouting as a Pest Management Practice by California Nurseries. University of California Agricultural Issues Center project scientist used surveys to conduct personal interviews at four California nurseries differing in size to assess the economic impact of scouting (monitoring) for detecting insect pests and diseases in nurseries. The conclusions are: 1) Not all nurseries keep track of how much of their annual production and/or market scrap is due to pest and disease. Without a measure of the damage and loss that comes from pest and disease it is difficult to assess the effectiveness of scouting or the overall pest management strategy. 2) The objective of scouting programs is similar across nurseries: Early detection of pest related issues which lead to isolation and rapid treatment to reduce infestation risk to the rest of the nursery. 3) It is uncommon for a nursery to have employees who are full-time scouts. Targeted scouting is conducted as part of the duties of specific employees. 4)

Nurseries try to include general labor in forms of non-targeted or passive scouting, which is conducted while performing other production tasks. 5) Targeted scouting in nurseries is centered on some form of implicit or explicit production calendar. 6) Scouting labor costs are far less than chemical treatment labor costs. 7) Nursery scouts, unlike chemical applicators, are not seen as skilled labor that deserves a higher level of compensation. 8) Nurseries identify the advantage of increased targeted scouting is to reduce pest risk and lower chemical treatment costs. BUT 9) There is a lack of talented employees with the ability and knowledge to be effective scouts. To be an effective scout an employee must have a passion for the nursery profession. AND 10) Nurseries currently invest very little in training their employees to be effective scouts. (Attachment 3)

Habitat manipulation to enhance biological control of soil pests in nurseries. UC Davis, Department of Entomology and Nematology used fungus gnats as a model insect species having a soil infesting life stage to examine the efficacy of using single or multiple biological control agents and differing soil media (habitat manipulation) on fungus gnat control. Experiments are still ongoing and it is too early to detect treatment differences. (Attachment 4)

Compilation of historical regulatory statistics on insect and disease finds in California to establish baseline data. A Senior Environmental Scientist at the California Department of Food and Agriculture (CDFA) ran searches in their database of insect/disease nursery finds in California for seven of the 11 species in the BMP matrix over the years from 2008 – 2012 and tabulated them by county. This work will establish a baseline of data to compare with future statistics after widespread adoption of multiple pests BMPs. (Attachment 5)

Economic report on the current diversity and value of the nursery industry in California to determine the importance of BMPs. UC Davis, Department of Agricultural and Resource Economics conducted an economic analysis of the nursery industry to determine baseline data that will be used in the future to understand the impact of invasive pests and quarantines and the effect of implementing BMPs.

Communication to the nursery/floriculture industry on progress of the multiple pest BMPs development and to provide educational workshops and conferences utilizing BMPs to mitigate pest & disease risk for the nursery industry. Between July 2011 and June 2013, University of California Nursery and Floriculture Alliance (UCNFA) presented material pertinent to the BMPs project at 16 workshops or conferences in CA to a combined audience of 929 growers, regulators, state and county officials and allied industry vendors. These events are archived online at: http://ucanr.edu/sites/UCNFA/ (Attachment 6)

Creation of the comprehensive BMPs publication. The project's original plan called for the development of a printed manual of multiple-pest BMPs. Groups in the food safety arena have recently offered web-based tools for generating BMPs based on criteria input by the user. This platform was seen as more dynamic and expandable than the traditional manual format. With the help of a research consultant and the web development group at the UC Davis, Division of Agriculture and Natural Resources (ANR), the BMPs matrix, technical summary, historical regulatory statistics on pest finds in California, and current list of quarantine counties (Attachment 7) were compiled into a web-based selection tool that growers can use to develop sets of BMPs tailored to their location and shipping requirements. This is a small-scale effort meant to introduce California growers to the concepts of

BMPs and will be expanded as BMPs are developed for other invasive and endemic pests and diseases. This tool can be found online at: www.cangc.org and http://ucanr.edu/sites/UCNFA/CANGC_Unified_BMPs_Project/Pests/

In-person training workshops for facilitating use of the online tool for generating customized BMPs. Although it was not possible to do within the time frame of the grant, five in-person workshops have been scheduled throughout California between September and October 2013 to demonstrate the BMPs online tool to growers and allow them to try out the tool on their own laptop computers with help available from the workshop presenters. These free workshops will take place in Watsonville, Parlier, Ventura, Irvine and San Marcos before June 30, 2013. The events web page can be found here: http://ucanr.edu/sites/UCNFA/2013_Educational_Programs/BMPs_Online_Tool_Demonstration/

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The project's primary goal was the creation of a set of BMPs that could be used by CA's nursery and floriculture industry for early detection and exclusion of multiple pests and diseases of concern or under quarantine from their operations. The initial vision for this goal was in the form of a printed BMPs manual available in hard copy or for download from the web. The actual accomplishment was in the form of a more cost effective, dynamic and expandable online selection tool that can be customized to a grower's location and shipping requirements.

Originally, a research consultant was tasked with the literature search and compilation of multiple pest BMPs. Because the grant was delegated to UC Davis for management, experts from the Entomology and Nematology Department selected a qualified graduate student to do the work with the added outcome of contributing valuable experience to the student's academic career.

The assembly of the Science Advisory Committee composed of researchers, regulators, and nursery industry stakeholders charged with reviewing the BMP matrix and technical summary provided a rare opportunity for these groups to meet and discuss the importance of Best Management Practices to the future of CA agriculture. Increasing occurrences of invasive pest and disease species within the state and decreasing funding for regulatory activities makes it imperative to develop a systems approach for early pest detection. This important dialog will continue and result in a process acceptable to regulators and sustainable for growers.

One of the most important aspects of a multiple pest BMPs program is regular scouting or monitoring for pests and diseases within the nursery. One of the roadblocks to large scale implementation of scouting programs is the perceived high labor costs. The case study "Use of Scouting as a Pest Management Practice by California Nurseries" funded by this project begins the data collection that compares the costs of a traditional pesticide-dependent pest management program with those of an integrated pest management program that includes scouting.

The measurable outcome that will define the success of a multiple pest BMPs program is decreased incidents of insect and disease finds in nurseries by regulatory agencies. The CDFA database search conducted as a part of this project establishes baseline data for finds of seven species of interest in the time frame of 2008-2012. These data can be compared in the future with nursery finds when multiple pest BMPs programs are more widely implemented in CA nurseries.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The main beneficiaries of this project are California's 2800+ nursery and floriculture producers who can incorporate multiple pest BMPs programs into their nurseries by using the online BMPs tool. They will be able to review, select and document their efforts for early detection and exclusion of pests and for maintaining "free from" operations. The economic benefits can be large when early detection of quarantine pests allows shipping to proceed. California regulators will also benefit by operating in an environment of increased documentation and allowing them to assess the feasibility of a voluntary systems approach to a nursery certification program.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The original activities and expected measurable outcomes were not achieved due to a major restructuring; the original measurable outcomes were not realistic in light of the reorganization. One of the challenges of developing and then executing a grant is the changes that occur from when the concept is developed and when the grant is actually awarded. It is important that the objective and purpose of the grant, as well as the activities and outcomes, remain viable and relevant. A lesson learned is to be realistic in the activities and outcomes proposed, and to re-evaluate before, during and after the grant.

The original project called for production of the multiple pests BMPs in Spanish. Because it was decided to change from a print publication to an online BMP-s selection tool, there wasn't sufficient time to utilize the translation services available at UC Davis.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 46	**Project Title:** On-Farm Practices to Manage Water Supply and Reliability Risks	
Grant Recipient: The Ecological Farming Association (EFA)	**Grant Agreement No:** SCB10046	**Date Submitted:** December 2013
Recipient Contacts: Ken Dickerson	**Telephone:** 831-763-2111	**Email:** ken@eco-farm.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Water supply insecurity for agriculture is a long-term challenge for economic viability of specialty crop production in California. Climate change, legal decisions limiting the supply of water for agriculture, increased competition and other factors have intensified this insecurity. Producers' awareness of on-farm management options to improve water security, as well as access to technical support and cost share opportunities, is limited. For example, fewer than 5% of growers implement cover cropping and/or minimum tillage, important practices for increasing water storage and reducing the need for applied water. The recent drought, estimated to have caused losses of up to $3 billion and 80,000 jobs, has elevated the importance of this issue for growers, providing a timely opportunity to leverage heightened interest to help growers develop longer-term stability. A stable specialty crop industry depends on grower knowledge of information and access to trainings on the full range of management and cost-share options available to mitigate water supply risks. While substantial headway has been made on irrigation efficiency technologies, awareness and adoption of cultural practices that enhance water security are limited and are typically overlooked. In particular, improvements in irrigation management, soil management to enhance water capture and storage, dry farming, off-stream storage ponds, and water recycling can multiply benefits of technology, improve Ag Waiver compliance, increase productivity, save water and energy costs, and increase profitability. This project exceeded its original scope, and provided over 1,000 specialty crop growers with information and training to implement scientifically proven water management best practices to improve water security, also connecting growers with and seeking to expand financial and technical support resources.

The project was directed at eligible specialty crop producers and producer groups as outlined in the USDA detailed definition of specialty crops and the Agricultural Marketing Service list of eligible crops. Outreach for all events targeted specialty crop producers by specifying target audiences in outreach materials and circulating notices through specialty crop associations, periodicals, and advertising. Prospective participants were screened to ensure eligibility.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Regional Ag Water Solutions Forums and Ecological Farming Conference Water Stewardship Project (WSP) Workshops

In 2011, the Ecological Farming Association (EFA) conducted preliminary research to identify geographic regions of greatest need for water stewardship education. Regional Forum interviews allowed EFA to hear from farmers about the practices they were interested in and how they wanted to access the information. Regional planning committees convened—engaging a statewide network for producers, government agencies, non-profit organizations, and industry representatives to produce the forums and the workshop sessions at the annual Ecological Farming Conference over the three year period of the grant. EFA agendas included farmer-to-farmer presentations, technical expert presentations, farm tours, resource agents, discussion components, and speakers and co-hosts. The Community Alliance with Family Farmers (CAFF) collaborated and presented two regional forums on dry farming in vineyards on the Central Coast. Collaborator, California Agricultural Water Stewardship Initiative (CAWSI), presented two EcoFarm workshops covering water metrics and soil on-farm for water storage. The USDA Natural Resource Conservation Service (NRCS) presented at the Ecological Farming Conference on compliance with the Ag Order requiring management plans for irrigation and farm run-off.

Water Stewardship Multimedia Education Program

EFA's peer review of curriculum materials included CAWSI and their advisory council, The California Roundtable on Water and Food Supply, as well as the Santa Cruz Resource Conservation District (Santa Cruz RCD). EFA developed curriculum materials: on-farm water stewardship case study videos and a companion guide. Along with these case study videos, resources for general on-farm water stewardship, funding and technical assistance, and streaming audio files from ten EcoFarm workshops were posted online, where they continue to be a resource for specialty crop growers, promoted through EFA's continuing programs.
EFA designed and carried out a Water Stewardship Project (WSP) of educational presentations to farmers and agency personnel on the Central Coast and in the Central Valley. EFA publicized web materials to farm groups and individuals and promoted the resources through a wide network of partner organizations including the California RCD network, UC Cooperative Extension (UCCE), NRCS, and California Certified Organic Farmers (CCOF). EFA coordinated an outreach campaign with the CA-RCD Executive Director, the NRCS, and UCCE agents. EFA conducted an email campaign to 20 CA-RCD agents, and 18 UCCE agents who had water or specialty crops as their specialty. Thus, 38 total personalized connections were made with CA-RCDs and UCCE. Finally, EFA evaluated the online multimedia curriculum using surveys and online feedback tools.

Increased Technical Support and Cost-share Funding

Throughout the three year term of the grant EFA promoted and worked to assist growers in applying for cost share funding through NRCS to implement agricultural water enhancement practices, through EFA's website, E-News, social media, fliers at events and on the water stewardship project site. EFA made a special appeal to its network to promote the NRCS cost-share and technical programs available to specialty crop farmers. EFA reposted the Santa Cruz County NRCS articles from Between the Furrows, the Santa Cruz County Farm Bureau through the EFA Water Stewardship Recharge Blog. EFA participated on the NRCS State Technical Advisory Committee to work to increase support mechanisms promoting on-farm cultural and irrigation management practices and connecting farmers.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Through EFA's events, 6,004 people received WSP presentations, workshops, and curriculum. (See Appendix A.) EFA provided farmers technical trainings and the WSP resource website—an online multimedia curriculum. Farmer feedback came through forum, workshop and online surveys, (see Appendix B).

The WSP was strong in performance on goals for education and outreach, providing farmers with support and resources to adopt water risk management practices. EFA did experience challenges in collecting survey information from specialty crop growers following the educational events regarding their quantifiable data. What EFA concluded with this project was that this level of tracking called for an alternative design of the relationship with the farmers including pre-existing commitment of the NRCS, RCD and UCCE for collecting this data. However, EFA was able to assess farmer needs and interest in adopting practices through surveys at the events and follow up surveys online.

In a broader view of NRCS water risk management programs, Environmental Quality Incentives Program (EQIP) and Agricultural Water Enhancement Program (AWEP) funded projects in CA in Fiscal Year (FY) 2010 totaled 2,409. FY 2011 totaled 2,036. FY 2012 totaled 2,504. EFA and its partner organizations were part of an overall effort to educate and connect farmers with these cost share and technical programs. Another measure of the project's effectiveness is in the average ratings of knowledge before and after exploring the WSP curriculum. Using the 82 respondents to these questions, EFA found that there is an impressive increase in average user knowledge after exploring the materials. The scale used in the question was 1 = Not well-informed to 5 = Well-informed. When examining the responses, EFA was very encouraged to see that the average before exploring WSP was 2.3 out of 5 and after WSP jumped to 3.7 out of 5. See Appendix C for graph.

EFA's WSP website links to and from EFA's home site and the CAWSI site and has a fully functional and free multimedia curriculum. EFA promoted this site through its E-News, Social Media (Facebook, Twitter), and Recharge Blog. Outreach included CA-RCD, NRCS, UCCE, EFA News lists, EcoFarm Conference mailing list and attendees, and many partner groups including Pajaro Valley Community Water Dialogues (PVCWD), CCOF, FarmLink, Wild Farm Alliance, and more.

The WSP curriculum was promoted in EFA's E-News and water-related topics were in the E-News nine times. EFA produced 21 WSP blog posts. The WSP reached over 6,500 people through the online network. EFA promoted WSP in the advanced EcoFarm Conference agenda, which is distributed to 12,000 individuals, for all three years of the grant 2011, 2012, and 2013. In December 2012, EFA's E-News included an article about Dry Farming, and in May 2013 EFA did a stand-alone WSP Announcement. The highest hits in a month to date was in May 2013, which had over 1300 hits. See Appendix D for monthly page views. The WSP was also featured in CCOF's blog: http://www.ccof.org/blog/farm-resources-business-sustainability-ecological-farming-association-water-stewardship-project, reaching 10,000 with additional promotion in their E-Newsletter. CCOF's Facebook has 2,123 fans, and the post was on the feed for both Facebook and Twitter, thus having the potential to reach 2,705 more. In summary, EFA was able to reach an audience of 6,004 farmers and agriculture industry people directly with conferences, forums and events focused on water stewardship for specialty crop growers. EFA reached 6,500 farmers and ag industry people with the WSP curriculum and website. Extrapolating from the specialty crop grower surveys, of which 100% indicated interest in expanding current water stewardship practices or adopting new water stewardship practices, EFA was able to reach the goal of effecting change on over 800 specialty crop farms to date. EFA's continued emphasis on the WSP after this grant, including maintenance and promotion of the WSP, ensures that EFA will remain engaged with and relevant to California specialty crop growers and support them in implementing water stewardship and supply risk management practices. For examples of curriculum and promotion materials, see Appendix E, F, and G.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Impact: The curriculum and outreach materials developed by this project were marketed to specialty crop growers throughout California, and EFA primarily targeted growers in the Central Valley and Central Coast. The research phase of this project helped target program activities where the need and potential impact were identified as the greatest. EFA directly benefited over 1,000 specialty crop growers who participated in workshops, field days, technical seminars, grower conferences, and on-line education. Beneficiaries included specialty crop growers affiliated with partnering specialty crop organizations, such as the strawberry growers reached through the PVCWD process; Farm Bureau chapters; California Certified Organic Farmers (CCOF) chapters; Community Alliance with Family Farmers (CAFF) chapters, and California Water Stewardship Initiative (CAWSI); as well as individual growers and organizations reached through EFA's website, the WSP, and through the CA-RCDs, UCCE and NRCS. Growers learned technical and cultural practices that improve management of water risks, heard from peers about their experiences with implementation and the agronomics, and gained improved access to technical support and cost-share funding and assistance in navigating these systems and connection with a network of other farmers pursuing similar approaches. The economic impact of adopting the water risk management strategies EFA promoted varied according to practice, crop, water source, and other factors. For example, Gleick et al. (2009) found that irrigation scheduling reduced the water use by 11-20% while also reducing energy, fertilizer, and labor cost.

California specialty crop growers were supported and continue to be supported in making a range of improvements for water stewardship and supply risk management through access to the information presented in EFA's WSP's online curriculum, forums and workshops at the Ecological Farming Conference. While these improvements vary by operation, all improvements to water management on the farm offer either economic savings or potential for expansion of operations by overcoming water supply risks or both, all of which mean more efficient and effective use of water and opportunities for improved energy efficiency resulting in a combination of economic gains and water conservation for California specialty crop growers.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

EFA learned that specialty crop growers benefit from learning about a full range of water stewardship and water conservation techniques, from the basics of innovations in drip irrigation to the more advanced techniques such as wireless network monitoring. Throughout the WSP presentations and surveys, growers indicated interest in accessing information about irrigation and water supply risk management practices such as irrigation scheduling, high efficiency pumping, and the current technology for low emitter/drip irrigation technology. This indicates a significant need for continued emphasis on specialty crop grower education and resources for water stewardship on the farm. There is continuing need to make improvements in water stewardship and irrigation management throughout California specialty grower operations as the adoption of these techniques is of great interest to growers for cost control and due to supply limitations these growers face and now and in the future.

The challenge EFA experienced in collecting the quantifiable agronomic specifics from this project is a lesson learned for the design of future projects. Growers need greater incentive to participate in sharing proprietary business-specific information as a follow up to a water stewardship forum or workshop at EcoFarm Conference. Future projects that EFA will design to gather such financial and operational statistics will be done with prior commitment of the NRCS, CA-RCD, UCCE and specialty crop associations to these types of reporting goals. Farmer incentives will also be considered in the design of the project for specialty crop growers. EFA also found it necessary to offer the forums for no charge, and did not raise the $1,600 in program income in order to attract a greater number of specialty crop growers to the forums. One of the positive unexpected outcomes of the WSP was that EFA, in collaboration with the farmers who participated in the video case studies, was able to help create an instructional water stewardship video series that also showcased the stewardship values of the featured farms as a marketing and promotional tool. EFA was able to adjust the production of the case study videos to highlight the farmer-to-farmer education model in a way that also worked for marketing the values of the farms. This provided those farms with the incentive to be open to sharing all of the agronomic information about water stewardship and their farming operation. The farmer-to-farmer education model and the interactive, web-based resource for technical information and access to financial resources ensure that EFA can continue to promote this WSP curriculum to an ever-widening circle of California specialty crop growers in a way that is relevant and readily accessible.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

See EFA's Water Stewardship Project website at www.efawaterstewardship.org as well as the following appendices: Appendix A, Event List and Participants; Appendix B, Survey Highlights; Appendix C, Participant Knowledge Increase; Appendix D, Website Statistics and Structure; Appendix E, Water Stewardship Project Companion; Appendix F, Water Stewardship Flyer – Santa Cruz; Appendix G, WSP Flyer General.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 47	Project Title: Carbon dynamics of orchard floor applied, chipped almond prunings as influen cover crop management and farm practices	
Grant Recipient: California Almond Board	**Grant Agreement No.:** SCB10047	**Date Submitted:** December 2013
Recipient Contact: Debye Hunter Gabriele Ludwig	**Telephone:** (209) 343-3230 (209) 765-0578	**Email:** dhunter@almondboard.com gludwig@almondboard.com

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The overall objective of this project was to improve the industry understanding of how pruning management and tree removal techniques impact soil carbon stocks, air quality and greenhouse gas (GHG) emissions. To serve this purpose, the project developed various input data sets to incorporate into the DeNitrification-DeComposition (DNDC) model. The DNDC model is a soil biogeochemical model used to estimate GHG flux from natural systems. The model results were used to quantify how pruning management, tree removal and other factors influence soil Carbon (C) and Nitrogen (N) cycling, soil C stocks and production of nitrous oxide (N_2O).

This project does not build on a previous SCBGP project but does build on non-grant funded work that has been and is being conducted, focusing on the effects of applying chipped prunings and whole-tree residues in the San Joaquin Valley. Employing a statewide approach, the project will take into account the significant regional and sub-regional differences among orchards including soil types, irrigation methods, between-row vegetative covers, and orchard-management practices. These rank as the key factors that bear on the carbon dynamics of applied prunings—and the effective management of the process. Given the statewide scale of annual prunings disposal (about 400,000 tons), the intent of this project was not only to enhance the state's production of almonds, but also have practical application for other kinds of annually pruned tree crops.

The recent industry trend of shifting away from the traditional method of burning annual prunings in favor of chipping and leaving them to decompose on the orchard floor could mean increasing organic matter stored in orchard soils. Burning has become problematic owing chiefly to the implementation of more stringent air-quality regulations. The end result is an assessment of C sequestration opportunities and losses associated with application of chipped prunings to the orchard floor versus traditional burning practices across a full range of California orchard conditions. Thus, this project was timely as it provided information to almond and other tree crop producers to address AB32 GHG reduction targets in 2020 for agriculture.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

The approach to this project was through six main tasks. These tasks represent steps in achieving the most accurate and regionally-specific results possible through the DNDC model, and included the following:

Preparation for Field Survey
The most recent Land Use Surveys from the California Department of Water Resources (DWR) (1994-2007) were compiled for counties of interest between Red Bluff and Bakersfield, California. These surveys were merged into a single Geographic Information System (GIS) database for analysis, and the data was summarized into acreages by county and crop type so that total almond acreage could be determined for each county. County Crop Reports for each survey area and year were also reviewed, in addition to the most recent year available, for the purpose of verifying almond acreage and location by county. (The most recent County Crop Reports that were available during this effort were from 2009; the 2010 Crop Reports will also be reviewed.) The almond acres in these reports were documented for comparison with the DWR survey data.

Literature review
The literature review was conducted by reviewing and summarizing information from peer-reviewed scientific journal articles, ABC annual reports, and University of California Cooperative Extension (UCCE) publications. Topics in the literature review include the role of agricultural soils in climate change, C and N dynamics in orchard soils, the effect of different management practices on C sequestration and flux, and the potential for C sequestration (capacity and longevity) specifically in California almond orchard soils. The literature review was directed and informed by the field survey, described below, to provide region-specific background information that guided the model development.

Field Survey
The field survey was conducted by interviewing UCCE extension agents, researchers and growers in key almond-growing regions. The survey included information from multiple respondents in all dominant almond growing areas of the state. Survey topics included preferred pruning practices, preferred agronomic and cultural practices (such as planting density and duration of orchard life), current pruning disposal practices, level of interest in alternative pruning disposal practices, costs of various pruning and pruning disposal practices, orchard removal techniques, and innovations in almond production.

GIS Database Development for DNDC Model
DWR Land Use data were used as the mapping unit for GIS modeling database development. The US Department of Agriculture, Natural Resource Conservation Service (USDA, NRCS) Soil Survey Geographic Database (SSURGO) was used to estimate watershed-wide soil properties. For each map unit the top soil horizon was extracted along with the soil attributes of organic matter, clay, pH and bulk density, which are the minimum soil attributes required by the DNDC model. SSURGO data were downloaded for each county in California. For each Almond orchard polygon, a spatially weighted mean value for each soil

attribute was calculated by converting map unit data to raster format and performing a zonal mean using ArcGIS Spatial Analyst.

N-deposition data were downloaded for each station in and around California from the National Atmospheric Deposition Program, National Trends Network (NTN) website. Mean total N-deposition for the 2008-2009 period (2010 data are not yet available) were calculated for each monitoring station in the NTN. A total N-deposition value was assigned to each almond orchard polygon based on the value of the nearest NTN station.

Daily meteorological data were downloaded for each California Irrigation Management Information System (CIMIS) station active from 2008 to 2010. Each of the polygons was assigned to the nearest CIMIS station to compile daily weather data required for DNDC modeling. DNDC requires daily maximum and minimum temperature and precipitation. While daily solar radiation and wind speed are optional, these data are important and will be extracted from the CIMIS databases.

DNDC Model Calibration and Validation
This task focused on collecting existing field data, led by the collaborating University of California, Davis (UC Davis) scientist. Field data include yield, pruning, irrigation, fertigation, below-ground biomass, nutrient percent, climate, general soil properties, soil initial N, and soil initial C.

Web-GIS Version of DNDC
Applied Geosolutions developed a system (GeoSolution) for integrating geospatial data analysis and biogeochemical system modeling into a web-based framework. The geospatial web framework is based on a custom implementation of a number of well-tested and widely used open source components. The framework has a service-oriented architecture that will support applications associated with this project, leveraging functionality, tools, and data with other projects.

The goal was to provide services in several ways, through multiple types of clients, including web browsers, mobile applications (Android and iPhone), and directly using standards-compliant protocols, such as Open Geospatial Consortium (OGC) and web map/feature/content/processing services (WMS, WFS, WCS, and WPS). The core of the program used Django, a Python-based web framework for the development of the website. The GIS portion utilized GeoNode, a collection of open-source GIS open-source technologies including GeoNetwork and GeoServer. Applied Geosolutions used this architecture to develop the prototype Django application to run DNDC, generate reports, and display visualizations of the output.

Two of the main project partners, Applied Geosolutions and Land IQ (formerly NewFields), led efforts (Literature Review, Field Surveys, GIS development) as described previously. In addition to the above, researchers at UC Davis, Department of Viticulture and Enology have begun the process of accumulating and formatting various research data sets at UC Davis to develop the almond DNDC modeling data sets.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Describe current practices – specifically prunings management.
This goal was accomplished through the field survey. It became evident through the field survey that pruning practices have changed dramatically in recent years. In general, growers prune almond trees much less than what was previously conventional. For this reason, determining biomass of removed orchards becomes a significant factor in determining potential to increase organic matter in orchards. This problem was addressed in additional work aimed at using remote sensing to determine biomass from removed orchards. Though this approach needs further development, a preliminary investigation shows that it has promise in determining biomass. In addition, pruning and pruning disposal practices are linked to orchard location as a result of climate and air quality regulation differences.

Summarize existing research on pruning management impacts of soil carbon and net GHG emissions.
This goal was accomplished by the literature review. Studies compiled for the comprehensive literature review point to many aspects that must be considered if orchard floor application of chipped prunings shows potential as a practice for increasing soil organic matter and sequestering C. First, out of all the factors that affect soil C reserves in agricultural systems, management is the most important because it most dominantly influences soil organic C. While certain management practices (e.g. cover crops, irrigation management) can promote significant increases in soil C and potentially decrease GHG, discontinuation or significant modification of these practices can convert soils from a C sink to a C source. Therefore, any management practice that is designed to sequester C must be considered in the long-term.

It is unknown specifically how great the gains in organic C would be if chipped prunings were applied, and if these gains would justify a long-term change in management practices. Second, every soil has a finite capacity to sequester C; the increase in C resulting from a new management practice would eventually level off. However, it is unknown how long that would take in almond orchards in various parts of the state. Thirdly, because of the depletion of C in cropland soils in general, these soils are recognized to have great potential in sequestering C. It is unknown, however, specifically what that potential is in almond orchards in California. Research conducted in California to date indicates that C sequestration and several other ancillary benefits of management designed to augment soil C reserves are evident in some but not all scenarios. The uncertainties evident in the literature review emphasize the need for spatially-specific modeling to help answer some of these questions.

Provide input parameters to the DNDC GHG soil biogeochemical model using GIS data and management information.
This goal was achieved by using information from the field survey, literature review and GIS database. County wide input data for 16 almond growing counties within the Central Valley of California was used. A database with integral, irreplaceable and one-of-a-kind data was utilized from ABC surveys. Additional

irrigation type (flood, drip, micro, sprinkler) data has been determined by county as well. Concurrently, the DNDC model has been continued to be refined and prepared for these inputs.

Build GIS databases on soils, climate and orchard management.
This goal was accomplished by compiling spatial data in the GIS database compiled and developed for the DNDC model. It consists of 16,349 land use polygons designated as almond orchards. Each of these polygons is associated with discrete soil, meteorological, and N-deposition data, and were therefore modeled as separate units to determine GHG flux.

Run model to quantify soil carbon impacts of various pruning management strategies across a range of existing soil and climate conditions in California.
Applied Geosolutions modified the crop model in DNDC to better serve almond systems. Previously, the crop model partitioned biomass to roots, stems/leaves and a yield component. The new version partitions biomass into four separate components: roots, stems (woody structural materials), leaves and yield component. This new crop model requires the following inputs:

(1) Maximum almond yield in kg dry matter/ha;
(2) Annual biomass production partitioned to nuts, leaves, stems, and roots;
(3) C/N ratios for nuts, leaves, stems, and roots;
(4) Accumulative degree days from leaf shooting till nut maturity in degree C;
(5) Water requirement in kg water/kg dry matter of produced biomass;
(6) N fixation capacity (plant N taken from the atmosphere/total plant N content).

Applied Geosolutions calibrated and validated DNDC based on field data collected at Belridge and Arbuckle almond orchards. Data were provided by UC Davis collaborators. Tests included assessment of emissions from tractor rows versus tree rows, fertilizer type, and irrigation system (sprinkler versus drip). DNDC captured the general magnitudes and peaks of N_2O emissions. Applied Geosolutions applied the validated DNDC model to estimate GHG emissions across California almond orchards. The model was used to simulate GHG emissions from a range of almond orchard management practices common in California. Information on fertilizer and irrigation water use, and GHG emissions for the 10-year period was derived from 2001 to 2010.

Numerous input datasets was assembled for the simulation:

- Maps of almond orchards based on data from the DWR Land Use Survey data and the USGS National Land Cover Dataset (NLCD)
- Weather data from the DAYMET meteorological model
- Atmospheric N-deposition data from the National Atmospheric Deposition Program (NADP) NTN
- Soils data from the USDA,NRCS SSURGO Database

Baseline management, yield, and water use was estimated based on the information in the Cost and Return Studies provided by the UC, Davis Agricultural and Resource Economics Department and field surveys from NewFields/Land IQ. Based on baseline management, GHG emissions was created and modeled from over 70 alternative management scenarios that theoretically influence GHG emissions. All combinations of the following alternative management scenarios were looked at:

- Alternative fertilizer rates: each region had 4 rates based on the survey results: no fertilizer, mean, 50% of the mean and twice the mean to assess the impact of a wide variability in N application rates.
- Irrigation: drip, micro-sprinklers, or flood
- Orchard flood management (no vegetation, resident vegetation)
- Prunings management (incorporation versus removal)
- Pruning intensity (none, low, medium, high: based on NewFields/Land IQ surveys)

Provide a user friendly web-GIS system to access model results and modeling system.
The results of these simulations were used to create a webGIS tool for querying and visualizing DNDC model results that enables users to evaluate changes in GHG emissions associated with a practice change at orchard, user defined region: orchard and county scales. The system is with designed with user authentication to allow different users access to data. This system was developed using primarily open source tools including Django, GeoNode, and OpenLayers.

Application of the full DNDC model for simulating GHG emissions from almond orchards requires significant inputs and expertise. To make the tool available to a wider range of end users, a new simplified model, which is referred to as the DNDC metamodel, was created in order for users to access via the web. This DNDC metamodel tool is a data mining approach that relies on a large database of several million pre-computed DNDC output records that represent a factorial set of scenarios, distributed over a range of climate inputs and soils characteristics.

The chosen prescribed model scenarios represent variations in key parameters that were identified as being dominant controls over GHG emissions in these specific cropping systems. All other parameters remained fixed based on general assumptions applied to all farm fields. Climate data, which is necessary for execution of DNDC, was drawn from a large gridded weather database called DayMet for the years 2003-2011. This web tool for running a simplified DNDC model has been deployed and validated previously for other systems, with typical worst-case accuracies of 90% or greater, and response times of less than 0.5 seconds.

User activity has yet to be monitored because Applied Geosolutions is still working on the webGIS component with matching funds from ABC. Since the full DNDC model was too complicated for users on the web, a simplified version of that model is being created, which will be the central part of the web tool. With that being said, the number of users was not tracked every six months, and therefore, the project team was unable to determine adoption of cooperators.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The 6,000 almond growers in California benefit from a greater understanding of N and C dynamics in their orchards. This information will influence fertilizer rates and practices, organic matter management, prunings management, and potentially other agricultural practices in orchards. The overall benefit is an increase in orchard nutrient and economic efficiency, which includes agronomic efficiency as well as resulting environmental benefit from nutrient conservation. Similarly, growers of other permanent crops, nut crops in particular will also benefit, for reasons stated above.

In addition, this project benefits researchers investigating the complex systems in which orchard trees, soil nutrients, and atmospheric elements interact. This project work builds on and contributes to the growing and evolving scientific literature, particularly that which is generated by UC researchers. Air quality regulators will gain understanding of the practicality and potential consequences of alternative to agricultural burning practices.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The project team learned a better understanding is needed of the variability of almond production systems, especially the C and N components of those systems throughout the state. For example, very different irrigation methods occur regionally throughout the state and significantly impact the C emissions and N management of these systems. In addition, more research is needed to more accurately determine true almond acreage in the state and where that acreage occurs – which impacts the modeling results.

At the onset of this project, the project team realized that due to the nearly 900,000 acres of almonds in the state this work would be preliminary in nature. Saying that, the results are compelling as related to understanding (in a regional sense) the C and N dynamics of these important agronomic systems of the state. This work will continue with the ABC in the future and additional funding will be sought.

A key lesson learned included the improvement of spatial mapping of almonds in the state with the use of remote sensing technologies. Overall, the lessons learned will significantly improve the ability for the almond industry to better manage GHG emissions and potentially provide offsets for others into the future.

DNDC is a soil biogeochemical model that is highly parameterized to capture and simulate the complex processes that drive carbon and nitrogen cycling, production and consumption of greenhouse gases in the soil and transport of the gas to the atmosphere. During this project an easy to use webGIS based tool was developed to make it easy to collect soils and daily weather data required for DNDC simulations. Nevertheless, the input requirements for running the full model was still too cumbersome for most users. So another web based tool was developed to enable users to run a simplified version of DNDC for almond orchards. The web based DNDC model requires general information on fertilizer application rates, orchard spacing, year, soils, irrigation system and pruning management. The simplified tool executes the model in less than 3 seconds. Testing indicates that the simplified model estimates GHG emissions within 10% of the full model 95% of the time. The take home message from this work is that detailed process models like DNDC can be used for the basis of multiple quantification approaches ranging from detailed Tier 3 methods (fully parameterized DNDC) to easy to use Tier 2 tools (simplified DNDC model). Selection of using either Tier 2 or 3 models will depend on the users' needs. Tier 2 models are well suited as an educational tool to understand general trends on how management impact GHG emissions. While Tier 3 models require model input data, their use can result in lower uncertainties which may be required for offset protocols.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 48	**Project Title:** California Cut Flower Industry Sustainability Study	
Grant Recipient: California Cut Flower CCFC	**Grant Agreement No.:** SCB10048	**Date Submitted:** December 2013
Recipient Contact: Kasey Cronquist	**Telephone:** 805-696-5000	**Email:** kcronquist@ccfc.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

California flower farmers use the latest best management practices for growing cut flowers and the state provides an ideal climate and workforce for flower production. Nevertheless, the low cost of flowers imported from South America is putting tremendous competitive pressure on the California cut flower community and capturing more and more market-share. Most consumers do not know where the flowers they purchase come from or are they aware of the sustainable practices being used by California flower farmers. There are several "sustainable" certification programs for California flower farmers to join but few do so because of the cost of joining these programs coupled with the uncertainty of the economic benefit for joining one of the programs.

The California Cut Flower Commission (CCFC) contracted with SureHarvest (SH) to meet some of the challenges outlined above. Working closely with the CCFC's management and grower members, SureHarvest's scope of work was to:
• Capture current cut flower growing practices through a survey tool and focused interviews and develop a practices benchmark.
• Identify the most relevant certification programs in consultation with CCFC and see how California cut flower practices align with existing certification programs.
• Assess the transportation footprint of flower transport from South American sources to US markets and compare this to the transportation footprint for California-grown flowers to the US market.
• Analyze the collective sustainability standards of existing certification programs in light of the California flower farmer benchmark and make recommendations for next steps for CCFC's sustainability program.

From the results of SureHarvest's study, the CCFC's task was to compare existing certification programs and their standards in reference to the California flower industry in order to:
• Establish a benchmark for the California flower farmers' sustainability practices including development of a model for measuring carbon footprint for flower production and a comparative analysis of the distribution footprint of off-shore and US-based industries.
•Align existing certification program key standards to California flower growers' sustainability benchmark and provide a recommendation regarding the appropriateness of a sustainability certification program for the CCFC.
• Execute a public relations campaign targeting industry, media and consumers with findings from the study.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

In November 2010, CCFC contracted with SureHarvest to conduct an analysis of the sustainability programs that exist for the cut flower industry world-wide.

In January 2011, SureHarvest accompanied CCFC staff to visit California's flower growing regions and explain the project and its goals. SureHarvest took information gleaned from those regional meetings and developed a survey that was sent to 202 cut flower farms in March 2011. Thirty-five surveys were completed and returned. (Forty percent of those surveys returned were from farms subject to the CCFC assessment on farms that have gross sales over $500,000.)

SureHarvest evaluated and compared nine certification programs available to cut flower famers. Additionally, SureHarvest calculated the amount of greenhouse gas emissions (expressed as CO_2 equivalents or CO2e) produced when shipping cut flowers from South American to US destinations by air and then ground, and compared calculations to the greenhouse gas emissions produced when shipping cut flowers by ground from California to US destinations.

To date, the self-certification is in development with the task force meeting on a regular basis to review the work and develop additional tools.

A "farmers toolbox" was developed as it was determined to be more beneficial than a public relations campaign.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

SureHarvest captured current cut flower growing practices through a survey tool and focused interviews, in order to develop a practices benchmark. They identified the most relevant certification programs in consultation with CCFC and determined how California cut flower practices align with existing certification programs. SureHarvest performed an assessment of the transportation footprint of flower transport from South American sources to US markets and compared this to the transportation footprint for California-grown flowers to the US market. Lastly, they analyzed the collective sustainability standards of existing certification programs in light of the California flower farmer benchmark and made recommendations for next steps for CCFC's sustainability program.

The findings of SureHarvest's study can be found in their report, "Member Grower Practices Survey, Alignment of Practices with Existing Certification programs, and Transportation Footprint of Shipping Flowers from South America to US Destinations" completed in May 2011 (see Attachment). Through the review of the certifications that exist in the industry, SureHarvest delved further into the "carbon footprint" of flowers grown outside of the U.S. compared with flowers grown in California and distributed to the same markets. Previously, there was anecdotal evidence that the environmental impact of imported flowers was higher than California Grown flowers, but that information had not been quantified in a formal fashion for this industry. It was unexpected that the footprint would be so significant. The research found a 3-16 times larger footprint for imported flowers compared to California grown flowers. SureHarvest's study was presented at the CCFC's annual meeting in January 2011 and distributed to cut flower growers in October 2011. SureHarvest's study can also be found on the CCFC's website.

After careful consideration, CCFC decided that a sustainability program together with a "farmers toolbox" of messages about the benefits of purchasing California grown cut flowers to share with customers would better serve California cut flower growers than a public relations campaign. Materials were developed for use by California's flower farms to share with potential and existing customers when discussing features and benefits of California Grown flowers.

It was determined that the "toolbox" would be distributed in a statewide webinar. In November 2012, the CCFC held a webinar wherein interested cut flower farms were presented with an overview of the results of the study and the message toolbox. Twenty people representing 15 farms participated in the toolbox webinar on November 7, 2012 (these participants represent more than half of the cut flower production in California). Forty-seven attendees were provided with the toolbox at the annual meeting. The toolbox is now shared upon request, and three farms have contacted CFCC to request the toolbox. Of the 60 farms assessed for sustainability practices, more than half have received the toolbox.

California flower farms overall have seen a year over year increase in sales from 2012 to 2013, and it appears the farms that obtained the sustainability research findings from the CCFC were able to use the new "Transportation Footprint" data and materials to drive additional sales and build on the reputation of California Grown Flowers. One grower used the toolbox to share the "Transportation Footprint" information to a group of wholesale customers from across the country that visited his farm.

Based on the information learned from the research conducted by SureHarvest, it was determined that there is a need for a sustainability certification that recognizes the regulatory environment in which California flower farms operate. A self-assessment workbook is being developed with a task force of flower farmers and University of floriculture researchers, led by SureHarvest. A diverse group of cut flower farmers representing different sizes, growing regions and crop varieties from throughout the state serve on the task force. Completion of the self-assessment workbook is anticipated in late summer/early fall 2013.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Beneficiaries of the California Cut Flower Industry Sustainability Study are the 225+ cut flower farms in California. Information from the study will enhance marketing efforts of the farms to their internal and external customer base.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

As proposed, this project was intended to gain further insights into the sustainability certification programs that are available for the international cut flower community. The CCFC and its partners have taken that information and developed programs that build upon the information gleaned from the study in terms of the sustainability certifications that are available, a program that would benefit California's cut flower farms, and the environmental impact of transporting flowers to destinations within the United States.

Through this project, CCFC learned that the original goals and objectives of a research project can be forced to change based on the results found in the research. In many ways, what CCFC's research found exceeded expectations to such a degree; the original goal to educate the industry with findings became secondary to the goal of developing a sustainability program exclusive to California's flower farmers. The positive was that the project took on a more meaningful long term investment; the negative was that it was not a time certain moment and opportunity. Rather than a "splash" of conclusions and information to share, the CCFC is now wading deeply into the development of a robust sustainability initiative that was inspired by the research and its conclusions.

It was unexpected that the research findings were going to be as powerful as they were. California's flower farmers found themselves facing a compelling case for developing a unique program that better promotes their efforts as California flower farmers, especially when compared to the claims of the flowers being imported from other countries. The conclusions of the "Transportation Footprint" section, alone, were unknown and very compelling.

The goal to message the results of this research more broadly were not achieved in the timeline that was originally set forth. However, a much larger opportunity was identified and California's flower farmers were willing to let go of a short term gain of publicity for the long term gain of a brand new program of sustainability for their California flowers.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

"Member Grower Practices Survey, Alignment of Practices with Existing Certification programs, and Transportation Footprint of Shipping Flowers from South America to US Destinations"
http://www.ccfc.org/files/2012/SureHarvest%20Final%20Report%20to%20CCFC%20edited%2010_20_11.pdf

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 49	**Project Title:** Buy California Marketing Agreement Consumer and Trade Public Relations Campaign in Canada	
Grant Recipient: Buy California Marketing Agreement BCMA)	**Grant Agreement No.:** SCB10049	**Date Submitted:** December 2012
Recipient Contact: Alicia M. Adler	**Telephone:** (916) 492-7062	**Email:** aliciaa@bryantchristie.com

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

In October 2010, the Buy California Marketing Agreement (BCMA) requested Specialty Crop Block Grant Program (SCBGP) funds to conduct a marketing and public relations campaign in Canada to increase exports of California specialty crops to this market. Activities focused on strengthening relationships with the media, retail sector, and building top-of-mind consumer awareness of California grown products, by emphasizing the important role they play when Canadian products are out-of-season.

BCMA began marketing and public relations efforts in Canada when it emerged as California's largest export market for agricultural products in 2007, surpassing the European Union and Mexico. California's market share was steadily increasing and Canadian consumers generally viewed California products favorably.

However, in recent years there had been a number of government and retail programs encouraging consumers to buy local Canadian produce. BCMA does not discourage consumers from purchasing local products, but overemphasis on this point was beginning to threaten California specialty crop sales in Canada. Given this, the proposed project would continue its marketing and public relations campaign that focuses on how California products can be complementary to local produce and are available when local products are not in season. These efforts would help increase exports of California specialty crops to Canada in the long-term.

The 2011/12 program year would mark the fourth year of BCMA's marketing program in Canada. The program had previously been funded through a grant from the United States Department of Agriculture (USDA)/Foreign Agricultural Service (FAS) Market Access Program (MAP) Global Broad-based Initiative (GBI) fund. However, the grant was limited to three years, and BCMA's funding was set to expire in June 2011. The SCBGP funds provided an opportunity to continue this valuable program, which supports California specialty crop exports to this vital market.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

During the grant period, BCMA implemented the fourth year of its consumer and trade relations campaign in Canada. BCMA continued to focus on the overall "Experience California" theme, and from a PR perspective, highlighted the fresh and original style of "California fusion cuisine."

BCMA's strategy was to communicate to consumers using select media relations tools at the point-of-sale, maintain individual contact with key retail, trade and foodservice contacts, and measure results to evaluate campaign effectiveness.

At the beginning of the grant period, in July 2011, regular meetings were held between project partners (Argyle Communications and R.E.P.S. Inc.) to discuss plans to maximize impact on targeted Canadian consumers. During these meetings, project partners developed a comprehensive public relations plan, including measureable goals, strategic focus, campaign themes, and tactical approach.

Between July and August 2011, project partners developed, and/or sourced from BCMA signatories, recipes and photography that feature select signatory products. Where possible, recipes featured two or more in-season signatory products used in combination. In addition, an up-to-date list of BCMA signatories, corresponding product availability and seasonality, and available collateral material were collected for presentation to the targeted retail trade and initial retail visits were conducted to solicit interest in and support for BCMA's merchandising and in-store promotional programs. BCMA's project partner, R.E.P.S. Inc., targeted Canada's major retailers through one-on-one "sell in" visits with key produce procurement and merchandising personnel.

In August 2011, BCMA's Canadian microsite content was updated to highlight new recipes and include current signatory information (www.californiagrown.org/Canada). Additionally, BCMA launched its media outreach campaigns, targeting grassroots communities through controlled matte stories featuring the campaign theme and recipes, with a link back to the Canadian microsite. Also, BCMA proactively reached out to mainstream media with information and stories about the benefits of California grown produce to correspond with signatory products being in-season. Currently, 16.6 million targeted consumers have been reached (also referred to as "impressions") through 269 media placements.

Meanwhile, through follow-up visits with key produce procurement and merchandising personnel, BCMA ensured ongoing support for its merchandising and in-store promotional programs among Canada's major retailers. R.E.P.S. Inc. crafted Merchandising Agreements (contracts) with retailers, planned and implemented all retail program activities across Canada, as well as managed all third parties performing retail duties on behalf of BCMA in Canada.

Throughout the grant period, BCMA extended the reach of the campaign by partnering with a targeted online community to directly supply key consumers with information about California grown produce. Currently, 521,711 targeted consumers have been reached through an online partnership. Additionally, a bilingual audio news release was developed that included content about in-season California grown produce, which was pushed out through radio stations across Canada. Currently, 2,232,900 million consumers have been reached through 57 radio stories.

To properly evaluate program performance, project partners oversaw in-field research activities to gauge campaign effectiveness. When completed, the research was compared to annual benchmark data. Campaign results and progress were reported to signatory partners and the BCMA. Project partners also reported on market conditions, retail flyer and in-store promotional activity, sales results, and trade feedback.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

To measure the California Grown campaign's effectiveness, project partners utilized the "Media Relations Rating Points" (MR^2P) system. This system is an industry-standard used to evaluate the impressions that were achieved by an activity (or the number of targeted consumers reached), the extent to which the pre-established key messages penetrated the media coverage, and the cost per impression for the overall campaign. BCMA's goal was to secure three to five million impressions through the campaign of media outreach, achieve a quality score of 75% or more in message penetration using the MR^2P system when evaluating results, and achieve a cost per 100 impressions of less than $3.00. The final program surpassed campaign goals, securing 16.6 million impressions through 269 media placements and 521,711 audience impressions through the online partnership.

To gauge consumer attitude toward California grown produce, and to evaluate the effectiveness of the overall campaign in Canada, BCMA conducted its annual Omnibus survey. In-field research was conducted and the results were compared to the annual benchmark data. A total of 1,006 people were surveyed at the end of the 2010-2011 program, and 1,002 people were surveyed at the end of the 2011-2012 program. While results indicate that consumer awareness of California grown products has risen (up from 30% in 2010-11 to 39% in 2011-12), purchase frequency and consumer preference for California grown products has remained fairly stable from year to year. Specifically, the percentage of target consumers buying California grown products in the past six months dropped slightly from 66% in 2010-11 to 64% in 2011-12, and the percentage of consumers associating California grown products with great taste, freshness, and high quality remained in the 70th percentile. Given these results, BCMA plans to reconsider the necessity of its online media presence and potentially shift funds to focus on in-store marketing and promotions where targeted consumers are more likely to make impulse purchasing decisions based on promotional materials.

To gauge retail support of the California Grown campaign in Canada, project partners tracked weekly flyer ad activity among targeted retailers and monitored in-store promotions. In 2011-12, BCMA aimed to secure a minimum of 25 California Grown branded signatory flyer ads across 8 retail banners in Canada, and execute a minimum of 8 California Grown signatory in-store promotions across 8 retail banners in Canada. As a result of R.E.P.S.' efforts, 9 retail banners were targeted, including: Thrifty British Columbia, Save-On, Overwaitea/PriceSmart British Columbia and Alberta, COOP Alberta, Metro and Basics Ontario, Sobeys and Freshco Ontario, and Longo's Ontario. Combined, BCMA was able to secure 21 qualifying flyer ads for five of the six participating signatories. All trade funding was allocated to flyer ads with in-store signage and displays to support them.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

This project originally intended to benefit 12 specialty crop industry members of BCMA, including asparagus, avocado, cherry, fig, kiwifruit, nectarine, olive, peach, pear, plum, raisin, and table grapes. However, by the time the project began in July 2011, BCMA membership had changed and the following industries withdrew their participation in BCMA programs: fig, kiwifruit, nectarine, olive, peach, plum, and raisin. These industries either dissolved their commodity board or withdrew their membership in BCMA. As a result, this project directly benefited the following specialty crop industries of BCMA: asparagus, avocado, cherry, pear, plum, and table grapes. The project also had residual benefits for all agricultural products from California that are sold in Canada.

These organizations benefited from the attention drawn to the quality and value offered by California agricultural producers. BCMA's marketing campaign presented California produce as a logical solution for consumers looking for premium produce when local produce was unavailable. Essentially, this project conveyed the message that California is a partner to Canada and provides a wide variety of quality products to Canadians.

As a result of BCMA's efforts in 2011/12, consumer awareness of the superior taste, freshness, and quality of California agricultural products remained high (in the 70^{th} percentile among surveyed consumers), and overall export value of BCMA member products increased from $395 million in 2010 to more than $438 million in 2011.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

While there were no unexpected delays, impediments, or outcomes in the implementation of the marketing program, BCMA continued to face the challenge of the "Buy Local" movement in Canada. To overcome this, the team successfully built on the "next best to local" messaging and consumer awareness of the superior taste, freshness, and quality of California products remained high. Total export value of BCMA member products increased.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Please refer to Attachment A for images of program components.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 50	Project Title: Field Testing a Carbon Offset and Greenhouse Gas Emissions Model for CA Winegrape Growers	
Grant Recipient: California Sustainable Winegrowing Alliance	**Grant Agreement No.:** SCB10050	**Date Submitted:** December 2013
Recipient Contact: Allison Jordan	**Telephone:** (415) 356-7535	**Email:** ajordan@wineinstitute.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The project purpose was to test emission reduction and carbon sequestration opportunities associated with California winegrape cultivation in the field, develop high standard quantification methodologies for greenhouse gas (GHG) baselines and reductions that will enable growers to access carbon markets, and provide a user friendly web-based interface to facilitate access to these technologies in order to drive conservation innovation and create incentives for adoption of sustainable practices by the state's winegrowers and other specialty crop producers. This project was timely and has enhanced the position of the CA wine industry in light of state and federal discussions about agriculture's role in cap and trade programs. It also addressed issues such as resource issues integration, regulatory challenges, water use efficiency, air and water quality, and climate change adaptation and mitigation.

The project built on two previously funded Specialty Crop Block Grant Program (SCBGP) projects and was a direct outgrowth of a 2007 SCBGP project, which highlighted the need for a model like the Decomposition-Denitrification (DNDC) model to quantify GHG emissions from vineyards and assessed scientifically sound options for reducing emissions. In Project 4 (2007), entitled "California Vineyards Climate Protection Initiative", California Sustainable Winegrowing Alliance (CSWA) worked with university and industry partners to examined knowledge and research on vineyard GHG emissions and offsets. University of California, Davis (UC Davis) scientists conducted a literature review and produced an in-depth report on the current understandings, project partners developed a grower-friendly educational hand-out, and conducted outreach and workshops on the project findings. Calibrating the DNDC crop model for California wine grapes was part of the 2007 project, which was field trialed and validated in this SCBGP project. In addition, Project 42 (2009) entitled "Reducing Our Footprint: Minimizing GHG Emissions and Nitrogen Leaching in Vineyards, and Enhancing Landscape Carbon Stocks" developed a web tool for assessing GHG emissions through a collaboration with CSWA and the U.S. Department of Agriculture, Agricultural Research Service (USDA, ARS). The USDA, ARS contributed data on vineyard GHG emissions with various soil types and management practices in Napa and Lodi, and life cycle analysis of vineyard carbon food prints.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Over the course of the grant, the CSWA worked with Applied Geosolutions (AGS), SureHarvest, the Environmental Defense Fund (EDF), scientists from UC Davis, and other project partners to advance project goals to field test, evaluate and implement a climate protection incentive system, incorporating the DNDC model and practices that improve air quality, reduce GHG emissions, improve carbon sequestration potential, and promote other environmental benefits.

The CSWA conducted five California Vineyard field assessments – two in Napa Valley, one in Sonoma, and three in Lodi – in order for AGS to better understand California vineyard systems and to allow the winegrowers to provide input into the development of the DNDC tool. The purpose of these assessments was to better understand the operational and economic feasibility of management practices in the diverse wine regions of California. In addition, several working group sessions were held for a larger group of winegrowers to test assumptions and demo the full DNDC tool, and to seek input on the simplified tool.

UC Davis and AGS calibrated and validated the DNDC model based on field data collected at Oakville, California in 2009 and 2010. The groups then modeled and measured nitrous oxide (N_2O) emissions and found they were similar and both were relatively low for vine rows. Daily measurements of N_2O were compared with daily modeled emissions from the DNDC. The DNDC model captured the general magnitudes and peaks of N_2O emissions.

AGS applied the validated DNDC model to estimate GHG emissions across CA winegrape vineyards. The DNDC biogeochemical model was used to simulate GHG emissions from a range of winegrape vineyard management practices common in the state. Information was derived on yield, fertilizer and irrigation water use, and GHG emissions for the 10-year period from 2001 to 2010. Information was partially derived through meetings and calls with winegrowers. In addition, AGS estimated baseline vineyard management, grape yield, and water use based on the information in the Cost & Return Studies provided by the UC Davis, Agricultural and Resource Economics Department. To achieve appropriate growth and GHG emissions, grape crop parameters were calibrated using baseline management and estimated grape yield. AGS estimated: (1) mean budbreak date and harvest date to estimate season length, and thus, grape maturity timing; (2) maximum grape biomass and plant tissue characteristics (carbon to nitrogen ratios) based on estimated yield; and (3) water use based on reported irrigation water used.

Based on baseline management, AGS created and modeled emissions from over 50 alternative management scenarios hypothesized to reduce GHG, examining combinations of the following:

- Alternative fertilizer rates: 0, 5, 15, 30, 60 pounds N / ac
- Alternative tillage: conventional, no-till, alternating tillage annually
- Compost applications: none, 3 fresh short tons / ac / year

- Cover cropping: bare soil, annual, perennial, resident vegetation and legume cover crop

In addition, AGS assembled numerous input datasets for the simulation:

- Maps of vineyards based on data from the California Department of Water Resources (DWR) Land Use Survey data and the U.S. Geological Survey(USGS), National Land Cover Dataset (NLCD)
- Weather data from the DAYMET meteorological model
- Atmospheric nitrogen deposition data from the National Atmospheric Deposition Program (NADP) National Trends Network (NTN)
- Soils data from the USDA, Natural Resource Conservation Service (NRCS) Soil Survey Geographic (SSURGO) Database

The results of these simulations were then used to create a Web-GIS tool for querying and visualizing DNDC model results, enabling users to evaluate changes in GHG emissions associated with a practice change at vineyard, user defined region, American Viticulture Areas (AVA) and county scales. AGS developed and demonstrated this Web-GIS tool, which is designed with user authentication to allow different users access to data and with the goal of the system providing all the DNDC model outputs at a range of scales from individual vineyards to AVA and counties. This system was developed using primarily open source tools including Django, GeoNode, and OpenLayers. The URL for this query tool is: http://winegrapes.appliedgeosolutions.com/.

During the project development and implementation, CSWA held a series of meetings and workshops with both the project team and industry stakeholders. During these sessions, CSWA and AGS determined that, in addition to the full DNDC model, winegrowers would more likely use a simplified version of the model that is web-based and requires only a few inputs. As a result, AGS designed, built and deployed a simplified web-based service that produces DNDC GHG estimates for winegrapes agriculture in response to a reduced set of input parameters. This simplified model utilizes a data mining approach to mimic the functioning of the full complex model while allowing easy access over the web to access DNDC emissions estimates. Development of this model addressed issues related to the complexity of DNDC and effort required to set up and execute DNDC simulations.

The metamodel service relies on a very large database of over 9 million pre-computed DNDC output records that represent a factorial set of scenarios. The chosen scenarios represent variations in key parameters that were identified as being dominant controls over GHG emissions in winegrapes systems. All other parameters remained fixed based on general assumptions applied to all farm fields. Climate data, which is necessary for execution of DNDC, was drawn from a large gridded weather database called DAYMET for the years 2003-2011. This web service for running a simplified DNDC model was integrated with the CSWA Sustainable Winegrowing Programs (SWP) online system's Performance Metrics site. The Performance Metrics tool was developed as part of an NRCS Conservation Innovation Grant to help growers and vintners measure and track key data points within their operation. Integrating the DNDC simplified tool into the Performance Metrics site gives California winegrape growers and vintners access to the tool in a user-friendly format. An interface was developed for routine testing and can also be used outside of the SWP metric tool, although the interface was not designed as a standalone web site. (See Attachment A for more information regarding educational resources and tools that have been developed as a result of this project.)

CSWA coordinated and facilitated two workshops and three webinars for winegrape growers in June 2013 to showcase the new DNDC online tool, and educational materials including a video and grower-friendly handout were also developed. CSWA will continue to highlight the project and the online tool at educational workshops and industry events around the state. (See Attachment B for a list of educational events and sample agendas)

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The project team completed the following activities to achieve the performance goals and measurable outcomes for the project:

(1) Completed validation of the California winegrape DNDC crop model and field testing of management practices to enhance carbon sequestration and reduce GHG emissions associated with cultivation of winegrapes in California with research results from UC Davis and ARS scientists based on field data collected at Oakville in 2009 and 2010.

The groups modeled and measured N2O emissions and found they were similar and both were relative low for the vine rows. Daily measurements of N2O were compared with daily modeled emissions from DNDC. The DNDC model captured the general magnitudes and peaks of N2O emissions.

(2) Completed the first modeling analysis of GHG emission from grape vineyards in California.

The DNDC biogeochemical model was used to simulate GHG emissions from a range of winegrape vineyard management practices common in the state. Information was derived on yield, fertilizer and irrigation water use, and GHG emissions for the 10-year period from 2001 to 2010. Information was partially derived through field assessments, meetings and calls with winegrowers, as well as from Cost & Return Studies provided by the UC Davis, Agricultural and Resource Economics Department and other sources noted in this report. The results of these simulations were then used to create a Web-GIS tool for querying and visualizing DNDC model results, enabling users to evaluate changes in GHG emissions associated with a practice change at vineyard, user defined region, AVA and county scales.

(3) Developed credible emission reduction quantification methods that could provide the basis for an accounting protocol addressing GHG emissions reductions from vineyards.

This goal was met; however, development of a protocol was not appropriate given the high level of efficiency of California vineyards. Through the model validation, data input by winegrape growers and resulting emissions data, it became clear to the protocol development partner, the EDF, that California winegrape production is a low GHG emission source compared to many other agricultural crops. This scenario is not a good candidate for protocol development in the opinion of CARB and other GHG regulators and trading entities, thus CSWA did not pursue that path.

(4) Developed Web-GIS quantification tools that allow users access to the detailed DNDC model without requiring detailed inputs.

This simplified model utilizes a data mining approach to mimic the functioning of the full complex model while allowing easy access over the web to access DNDC emissions estimates. Development of this model addressed issues related to the complexity of DNDC and effort required to set up and execute DNDC simulations. This web service for running a simplified DNDC model was integrated with the CSWA SWP online system's Performance Metrics site. The Performance Metrics tool was developed as part of an NRCS Conservation Innovation Grant to help growers and vintners measure and track key data points within their operation. Integrating the DNDC simplified tool into the Performance Metrics site gives California winegrape growers and vintners access to the tool in a user-friendly format. Although the DNDC model was not integrated into the online system until the end of the grant period, the vineyards that have been using the Performance Metrics system represent approximately 15% of California acreage (approximately, 80,000 acres). Therefore, CSWA anticipates reaching the goal of 20% of vineyard acres using the DNDC tool within the year.

(5) Results were disseminated through 5 workshops (2 workshops and 3 webinars) and websites, including a video case study and grower-friendly handout that were developed as part of the grant, reaching 2,000+ California winegrowers and other wine regions and specialty crops.

Results were also intended to be disseminated via 5 or more trade publications. While they were disseminated via CSWA and Wine Institute publications, and via a press release to dozens of trade publications, additional articles were not published by the end of the grant period. The CSWA does, however, anticipate that trade publications may cover the tool in the future as part of other stories relevant to GHG emissions in the wine industry. In addition, CSWA will continue to highlight the project and online tool at educational workshops and industry events around the state (e.g. at Unified Wine & Grape Symposium that attracts approximately 14,000 attendees annually.)

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The California wine industry benefited from this project. The targeted vineyards benefited from the project by providing input into the calibration and validation phase and ensuring that the model was representative of management practices in California winegrape vineyards. They further benefited from the resulting simplified tool that has been integrated into the SWP's online performance metrics calculator site. They are able to use this site to calculate the GHG emissions and carbon sequestration of their vineyard, which informs their own sustainability efforts as well as the possibility of being useful in the future in terms of regulatory or voluntary greenhouse gas credit initiatives.

The DNDC tool and development of the simplified model is a valuable resource to California's 4,600 winegrape growers. More than 60 of the state's winegrape growers attended a workshop or webinar in June 2013 to learn how to use the DNDC simplified model through the online tool. (See Attachment B.) Additionally, the project team reached more than 2,000 winegrowers through a variety of CSWA, Wine Institute and California Association of Winegrape Growers (CAWG) communication tools. In addition, a DNDC educational video was produced and educational materials developed that were posted on the SWP website which has broad reach (e.g., more than 45,000 unique visitors to the website during the grant period). The four-page DNDC educational handout available on the CSWA website has been distributed at workshops and tradeshows. CSWA issued a DNDC press release that was distributed to select wine trade to further disseminate information about the grant project results and availability of the DNDC tool. (See Attachment A). Information was also shared with other specialty crop groups, including the National Grape & Wine Initiative and the Stewardship Index for Specialty Crops.

The DNDC model was calibrated and validated for California winegrape vineyards. Because the model was calibrated and validated specifically for winegrapes, the model would not be useful for other crops. All workshops were promoted and educational material disseminated to California winegrape growers via the CSWA, Wine Institute, the California Association of Winegrape Growers and regional winegrowing associations' membership lists**.**

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

While the project was successful in meetings its overall goals, several of the proposed tasks were changed during the project implementation due to lessons learned. Key lessons include:

(1) The full DNDC model is too complicated and requires too many inputs for general use by vineyard managers. The model is clearly more usable by the research community at this point. While the project team made strides in making it more user friendly, additional work is needed to meet the demand for the information that the model can provide as a decision support tool for sustainable management of vineyard landscapes.

(2) Vineyard production systems in California have generally low GHG emissions from soil. As a result, opportunities for participating in a agricultural offset market is limited due to low emission reduction potential on an acre basis and current prices of carbon of the offset markets.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Please see Attachment A and B for more information, including website links, educational materials, and a list of workshops and event with sample agendas.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 51	**Project Title:** Development of Market Based Best Practices for California Kiwifruit	
Grant Recipient: California Kiwifruit Commission	**Grant Agreement No.:** SCBG 10051	**Date Submitted:** December 2012
Recipient Contact: Nicholas Matteis	**Telephone:** (916) 441-0678	**Email:** nmatteis@agamsi.com

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The purpose of the project was to look at how a pricing per pound strategy and space allocation in the retail sector could increase volume of kiwi sales and increase kiwi dollars. The proposal was based on preliminary sales data supplied by an industry member who had convinced a major retailer to switch from a pricing per each strategy to a pricing per pound strategy.

Initial sales data indicated that the retailer saw a 24.2 % increase in kiwifruit sales; and volume sold increased 36% 27 weeks after implementing a price per pound strategy. These statistics were based on a price set at $ 1.49 per pound on ad and $ 1.99 off ad price. Further, during the ad period 35% more kiwifruit was sold and the retailer outperformed the region and the United States in green kiwifruit sales.

The motivation for the project was to address the issue of pricing per pound versus pricing per piece for kiwifruit. It had been thought that pricing per pound would actually increase the dollars and volume of kiwifruit sold. Based on some preliminary testing performed by industry where significant increases in sales were realized during the market test period, the former California Kiwifruit Commission (CKC) proposed to conduct its own market test.

Additionally, the intent was to incorporate a study on space allocation into the pricing per pound testing to test whether greater space allocation would also increase volume of sales and kiwi dollars.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

In October 2010 the CKC held a grower referendum that resulted in an insufficient number of votes casted to continue the work of the Commission. This unfortunate result led to a delay in progressing with the project, as staff needed to seek direction from the board of directors to determine whether the project would proceed. At its December 1, 2010 meeting, the board gave the direction to staff to proceed with the project. At that time staff had identified the Perishables Group as a likely firm to conduct the pricing per pound testing, but had not proceeded with any further development until after the December 1, 2010 board meeting. This caused a significant delay in the estimated dates of completion indicated on the submitted work plan.

Conduct Pricing Per Pound Test in Retail Space

Staff contracted with the Perishables Group to conduct a historical sales analysis, and with the historical data design and perform a pricing per pound test in the retail space. Based on the historical analysis, the Perishables Group designed a Match Panel and Chain-wide market test in the retail space. Due to the delays in the process the Perishables Group was only able to perform the chain-wide test with Lunds. The market test was performed from July 2, 2011 to August 2011. The testing included category analysis for kiwifruit sold in bulk and by container in Lunds test stores and the rest of market Lunds control stores.

Conduct Testing for Greater Space Allocation

In addition to the market testing, staff intended to include in the contract with the Perishables Group a testing for space allocation in addition to pricing per pound. However, there were insufficient historical data to perform and analysis to create a baseline of volume and price obtained in relationship to space allocation.

Conduct A-Z Category Analysis

The Perishables Group also performed a category analysis on kiwifruit in the US market, which detailed the level of market penetration in the United States, detailed the consumer demographic from the most likely to purchase kiwifruit to the least likely to purchase kiwifruit, provided data on kiwifruit sold by container versus bulk and provided conversion analysis between pricing per each to pricing per pound.

Develop Best Management Practices

Based on the results from the price testing with the Lunds retail chain, staff contracted with MJR Creative Group to produce Best Management Practices for converting from pricing per each to pricing per pound. However, due to less than compelling results supporting the switch to pricing per pound MJR has committed to providing a one page retail piece dedicated to identifying the potential benefits of pricing per pound in relationship to recommendations to increase volume of sales of kiwifruit. The piece is to be based on the analysis results from the A-Z Category Analysis.

Educate kiwifruit growers on implementation

Because the CKC was not voted to continue in a grower referendum, the only activity staff was able to complete was posting the final reports from the project on the industry website so it is available to kiwifruit growers.

Evaluate market changes and response

Because the CKC was not voted to continue in a grower referendum, no further evaluation was performed aside from an analysis of the project as well as other markets and the report posted on the industry website.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Goal: To establish that pricing kiwifruit per pound would increase sales dollars and volume of sales for retailers.

Outcomes Achieved: Though the delay significantly impacted the progress of the project and the results from the chain-wide retail testing were not as compelling as staff had hoped, the data from the testing did indicate an increase in volume of sales. This finding in addition to some changes to the design of the retail testing is believed would have made this grant project a good candidate for an extension had the grower referendum passed and the Commission remained in place.

The analysis at the following link will provide more detail on the increase volume of sales: http://www.kiwifruit.org/downloads/category-research/Market-Trends-and-Pricing-Strategy-Report-IKO-2012.pdf.

Further the final project report is at the following link:
http://www.kiwifruit.org/downloads/category-research/Kiwi-Pricing-Test-Results.pdf

Goal: To provide a current performance snapshot of the category as a whole and some comparisons between pricing per each versus pricing per pound.

Outcomes Achieved: The Perishables Group conducted a complete and A-Z Category Analysis to provide a baseline for performance of the kiwifruit category. The analysis provides data on the top market drivers and implications for the kiwifruit category, an overview of past and present kiwi performance and implications for both the kiwifruit industry in California and the retail industry. The A-Z analysis was completed in lieu of the match panel testing that could not be completed as originally planned due to the delay in the project. The analysis was effective in providing a tool for the assessment of the category and to look at the implications of what pricing per pound in the United States market would look like compared to pricing per each.

Goal: To develop best management practices for a retailer to switch from pricing per each to pricing per pound.

Outcomes Achieved: MJR Creative Group was to develop the best management practice manual for the price switch. However, due to the lack of compelling data for the switch in pricing, based on the retail testing completed by the Perishables Group development of a manual was not possible. However, based on the A-Z Category Analysis work MJR has created a series of one page sales tips for both the California kiwifruit industry and the retail industry. However, promotion within the California kiwifruit industry and to the retailer industries of the one page sales tips is not possible as the CKC was effectively in the wind down process as directed by statute.

A best practices guide was generated for industry to utilize in addressing its pricing and marketing strategy as a whole. The test results did not generate the expected increase in dollars, though it did in volume of sales. In part this was due to the timing of the failure of the Commission to pass a grower referendum vote which caused delays in getting the testing completed relative to a California marketing season. On a more global scale, the initial research that spurned the concept as proposed was conducted prior to the Great Recession. Analysis from the referenced test period found the chain which implemented the pricing per pound strategy suffered significant loss of market share. Also, the CKC management that conducted the initial testing left that position so the data was not as complete as was hoped. Finally, though the retailer had recovered some market share since the crash of 2008, sales over time were much flatter than expected.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Though the data in the retail testing that had been done by the Perishables Group had not provided the expected result that was implied in the initial data on which the research grant was based, the retail industry and kiwifruit industry have a better concept of the implications of pricing per pound and a basis, should another industry group be authorized by the industry, to perform further research project on pricing per pound, as the increase in volume of sales does indicate potential for the pricing switch. Had the Commission still been in existence, staff would have applied for an extension and changed the design of the project with further input from industry members in order to obtain more compelling results.

Dissemination of project materials (including the one page sales tips) to CA kiwifruit growers, marketers, and retailers was hampered by the dissolution of the CKC. Due to the timing of this dissolution, it is difficult to quantify the exact number of beneficiaries. However, project materials were still distributed on a limited basis. The project findings related to the different pricing mechanisms have been widely, though informally, communicated to both retailers and CA growers. Therefore, the continued dissemination of project materials and information will still benefit and impact the approximately174 growers in the industry.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

This current recession had a severe impact on the sales of the retailer that had supplied the promising sales data which indicated significant growth in sales volume and sales dollar in the first 27 weeks after implementing the pricing per pound strategy. Due to the overall impact of the recession on the retail industry and the relative loss of market share due to the retailer's (who supplied the initial data) delayed response to the downturn further analysis of the chain's performance showed a more flat trajectory in kiwifruit sales volume and sales dollars. This preliminary analysis conduct by the Perishables Group caused a fairly significant set-back in determining real trends and in identifying a retail partner for the proposed retail testing. Further, the Lunds retail chain only had New Zealand kiwifruit available by the time that the Commission was able to perform the chain-wide test, which created some difficulty in determining the pricing structure. Had the Commission been continued and the grant extended staff would identify a retailer for the California kiwifruit season, and would have established an ad and off-ad pricing similar to $1.49 per pound and $1.99 per pound rather than $2.42 per pound that was established by the Lunds test stores. Lastly, space allocation is extremely variable between retail chains making it difficult to design a space allocation test as originally proposed.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

No additional information to report.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 55	**Project Title:** Developing and validating practical strategies to improve microbial safety in composting process control and handling practices	
Grant Recipient: The Regents of the University of California, Davis, Center for Produce Safety	**Grant Agreement No.:** SCB10055	**Date Submitted:** December 2013
Recipient Contact: Bonnie Fernandez-Fenaroli	**Telephone:** (530) 757-5777	**Email:** bfernandez@cps.ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Fresh produce has been a major source of foodborne illnesses in the United States according to recent Center for Disease Control estimates. Interventions to control contamination at the farm level will help reduce incidental contamination of finished product (processed produce) and eventually reduce foodborne illnesses. The increased number of *Escherichia coli* O157:H7 and *Salmonella* outbreaks associated with consumption of fresh produce has led researchers to investigate the mechanisms of produce contamination at the farm level. Raw or inadequately composted manure can be a potential source of contamination. The elevated temperature during thermophillic composting has been considered as the major factor for pathogen inactivation in compost. Previous USDA-National Integrated Food Safety Initiative (NIFSI) research revealed that fresh compost covered with finished compost can speed up the inactivation of pathogens on the surface of the compost pile. Recently, the Environmental Protection Agency (EPA) and California Leafy Greens Marketing Agreement (LGMA) recommended the use of finished compost to cover static piles. The depth of cover and the effect of cover on windrow piles requires further investigation. The validation of finished compost as covering for static and windrow piles is essential to support EPA and California LGMA recommendations and subsequent guidelines/regulations for inactivation of pathogens in compost piles.

The finished compost may not be free from foodborne pathogen contamination since a few survived or reintroduced pathogenic cells may grow in the compost during the curing stage or storage periods when exposed to favorable environmental conditions. However, there is a lack of study on determining the critical factors affecting pathogen survival in the finished compost under farm conditions. As the compost ecosystem is very complicated with succession of microflora as the composting process proceeds, the interactions among different microbial species can be synergistic or antagonistic. Suppression of pathogens by indigenous microorganisms has been documented in biosolids, live animals or food products. Therefore, applying competitive exclusion microorganisms to the cured compost may prevent the pathogen from regrowth. In order to ensure the microbiological safety of animal waste-based compost as organic fertilizers or soil amendment for growing fresh fruits and vegetables, a systems approach to address biological hazard control during the composting process and subsequent storage and handling of finished products is needed. Developing and validating some practical strategies which can be used by growers is also needed.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Research activities for this project are conducted by Clemson University, subaward principal investigator.

The following were the activities and tasks performed:
1) Validating the thermal inactivation data collected from outbreak strains in compost using naturally occurring *E. coli* O157:H7 and *Salmonella*.
2) Optimizing and validating the finished compost as physical covering and straw as base of freshly formed static compost heaps or windrow compost piles.
3) Applying the pathogen growth model to determine the potential of finished composts to support the growth of human pathogens.
4) Investigating the growth, survival, and control of foodborne pathogens in the finished compost.

The following are the significant findings from the research and the conclusions and recommendations.

Obj. 1: The naturally occurring strains of *E. coli* O157:H7 and *Salmonella* survived the thermophilic composting phase better than the corresponding outbreak strains in dairy and poultry composts, respectively. Therefore, the time/temperature combination data reported for these 2 pathogens using outbreak strains should be considered as the minimum and need to be verified for specific composting process in order to reduce the risk of pathogen survival during composting. Due to the prolonged survival of a few resistant neural stem cells in compost, it is recommended to validate the complete killing of pathogens in the finished compost by using sensitive detection methods coupled with an enrichment step.

Obj. 2. The finished compost as cover can increase the temperature at the interface of freshly constructed compost surface and the finished compost cover, while hay at the base of the composting heaps showed little impact on the composting temperature. Due to the presence of ammonia, *Salmonella* was inactivated rapidly even when the depth of finished compost was only 10 cm in thickness. The effectiveness of finished compost, as a covering material on pathogen reduction, was also validated in static and windrow composting systems on a commercial scale. Additionally, there is a strong association between inactivation of weed seed germination and *E. coli* O157:H7 growth; further studies to validate weed seed germination as an indicator of pathogen reduction in finished compost would be helpful. Based on the results of this study, it is recommended to cover the composting heaps or piles with about 10-30 inches of the finished compost, especially during winter months when the ambient temperature is low, and use less finished compost for covering poultry compost heaps.

Obj. 3**:** By analyzing some representative agricultural waste-based composts, the research found certain types of compost may have the potential for supporting pathogen growth due to the types and levels of indigenous microorganisms, although all these composts met the microbiological criteria and maturity of finished compost. Further studies are needed to identify those key microbial species responsible for pathogen control in the compost. Therefore, just relying on microbiological test results on fecal coliforms, *E. coli*, *Salmonella*, and *E. coli* O157:H7, and maturity or stability tests may not be sufficient to predict if pathogen growth can occur in the finished compost.

***Obj. 4*:** The results revealed that the compost with larger particle size supports pathogen survival more than the compost with small particle size, and the initial rapid moisture loss in compost contributes to fast inactivation of pathogens in the finished compost. By applying competitive exclusion microorganisms to the finished compost with at least 30% moisture, up to 99% of the population of those *E. coli* O157:H7 cells, due to cross-contamination, can be effectively inactivated within 2 days during colder seasons (winter and fall). As for those heat-adapted *E. coli* O157:H7 cells surviving the thermophilic composting process, longer treatment with competitive exclusion (CE) cultures is needed, suggesting the cross-resistance of those heat-adapted population. Additionally, both compost moisture and season of application may affect the efficacy of this biological control method as well. Based on the results of this study, it is recommended to cover the fresh compost surface with the finished compost or other physical barrier to reduce the aerosolization of compost particles. Produce field in very close proximity to the composting site should be checked periodically for possible pathogen transmission from the fresh compost heaps. To avoid the pathogen growth in the finished compost due to cross contamination, a cocktail mixture of CE can be applied a few days prior to the use of the finished compost, preferably in the colder seasons.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

In this proposed study, first, CPS used naturally occurring *Escherichia coli* O157:H7 and *Salmonella* strains isolated from compost to validate thermal inactivation data acquired from outbreak strains, which was conducted inside an environmental chamber to mimic the early phase of the composting process (**Objective I**). The naturally occurring strains of *E. coli* O157:H7 and *Salmonella* survived the thermophilic composting phase better than the corresponding outbreak strains in dairy and poultry composts, respectively. To inactivate pathogens on the compost surface, CPS applied the finished compost as covering material and the hay as the base of compost heaps to minimize heat loss (**Objective II**). Four field trials of static composting heaps in spring and winter revealed that the 20-cm thickness of finished compost (FC) covering resulted in higher compost temperature and rapid inactivation of both *E. coli* O157:H7 and *Salmonella* species as compared with the 10-cm FC covering, whereas hay at base had no effect either on the compost heap insulation or the rate of pathogen inactivation. In a commercial scale of composting conducted in Maryland, the use of finished compost as covering (30-cm thickness) significantly increased the number of days ≥55°C in windrow piles at all locations and in static piles at top location which resulted in rapid reduction of inoculated pathogens. Further, the rate of bacterial reduction was rapid in windrow piles. Weed seed placed in non-covered piles and static piles were able to germinate after 28 days concurrent with *E. coli* O157:H7 survival in those piles. CPS also determined the correlation between the compost maturity index and the potential of finished composts to support pathogen growth by analyzing 31 finished composts made of different agricultural wastes (**Objective III**). The results suggested that certain types of compost may have the potential of pathogen growth due to the types and levels of indigenous microorganisms, although all these composts met the microbiological criteria and maturity of finished compost. In the finished compost, pathogen growth and survival can be affected by various factors (**Objective IV**). Three greenhouse trials revealed that the pathogen survived better in the dry compost with larger particle size, and the initial rapid moisture loss in compost may contribute to fast inactivation of pathogens in the finished compost. Application of competitive exclusion microorganisms isolated from the composts successfully reduced up to ca. 2 logs of *E. coli* O157:H7 in compost under greenhouse condition by simulating the storage conditions on the farm.

These results indicate that compost microflora can be an efficient tool to control foodborne pathogens in the finished compost and reduce the potential for soil and crop contamination. CPS' outcomes as described above have met or exceeded the original goals for providing the practical methods or practices on compost production and handling to eliminate or reduce pathogen contamination of compost, thereby helping produce industry to grow safe products for human consumption as a long term goal.

Dr. Xiuping Jiang, Clemson University, presented a poster and gave a presentation of interim results at the 2012 CPS Produce Research Symposium in California, and presented a poster of final research results at the 2013 CPS Produce Research Symposium in New York. The attendees represented the produce marketing chain, regulatory agencies and academic scientists. The 2012 symposium had 325 attendees and the 2013 symposium had 300 attendees. Survey respondents rated the relevance of the research as very valuable or somewhat valuable.

In addition to presentation of results at the annual CPS Produce Research Symposiums, the following activities will provide information for implementation of recommendations:

Final reports are posted on the CPS website (https://cps.ucdavis.edu/grant_opportunities_awards.php) after the June symposium.

CPS works with scientists to publish results in scientific journals after the project is completed. Awards and abstracts can be found on the CPS website (www.cps.ucdavis.edu).

The Center for Produce Safety's Board of Directors and members of the Technical Committee distribute a series of information throughout the year on their websites, and through presentations, meetings and webinars. An example of this occurred on July 18, 2013 when Western Growers Association held a webinar for their members. Information discussed at the webinar is now part of the "Key Learnings" on the CPS website:
https://cps.ucdavis.edu/amass/documents/document/186/Key%20Learnings_2013%20CPS%20Symposium.pdf

The following websites provide additional resources on the final reports and symposium proceedings:
Center for Produce Safety: https://cps.ucdavis.edu/resources.php
Produce Marketing Association: http://pma.com
Western Growers Association: http://www.wga.com/

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Fresh produce growers and compost suppliers are the primary beneficiaries of the research. According to the US Composting Council (http://compostingcouncil.org/), there are 1,000 plus licensed compost producers in the U.S. Of these, there are nearly 170 businesses in California that produce compost and mulch (http://www.calrecycle.ca.gov/organics/processors/). There are 41,992 farms representing produce crop growers in California according to the 2007 Census (http://www.agcensus.usda.gov/publications/2007/). Compost processors will utilize this research data, use finished compost as a cover to rapidly reduce pathogens during the composting process or apply the competitive exclusion microorganisms for preventing pathogen growth due to cross-contamination. Farmers will be able to obtain compost free from pathogens and thereby be able to reduce cross contamination of fresh produce via soil amendment. The ultimate beneficiary will be the U.S. public who will get safe fresh produce in their homes and will have increased confidence in fresh produce with limited number of food recalls or illnesses.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The composting process is a complex process; several factors are involved in inactivation of pathogens during composting and subsequent handling. Sample preparation and placement require meticulous care in compost studies as differences will affect the variables (surviving populations) during the study. Direct plating does not yield results as compost samples have very low levels of pathogens and therefore enrichment of the sample is required. Sensitive detection procedures such as most probable number (MPN) will be helpful to recover low levels of surviving pathogen populations.

This is the first study to employ weed seed germination as an indication of finished compost in compost piles constructed using on-farm composting procedures, and all piles and windrows were exposed to conditions present in the unprotected outdoor environment. Additional studies will be helpful to further evidence the relation between inactivation of pathogens and weed seed germination.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Publication list:

Kim, J., S. Heringa, J. Diao, and X. Jiang. 2011. Fate of *Escherichia coli* O157:H7 and *Salmonella* spp. in animal manure-based composts during storage. Abs. 111th Gen. Mtg. Am. Soc. Microbiol. New Orleans, LA, May 22-24.

Jiang, X.P. 2011. Developing and validating practical strategies to improve microbial safety in composting process control handling practices. The 2nd Produce Research Symposium, Center for Produce Safety, Omni Orlando Resort at Champions Gate, FL, 6/28/2011.

Singh, R., M. Shepherd, X. Liu, J. Kim, J. Diao, C. Ionita, and X. Jiang. 2012. Developing and validating practical strategies to improve microbial safety in composting process control handling practices. Western Food Safety Summit, Hartnell College, May 10 & 11, 2012.

Diao, J., Z. Chen, and X. Jiang. 2013. Influence of Compost Particle Size on Pathogen Survival Under Greenhouse Condition. Abs. 100th Annu. Mtg. Intern. Assoc. Food Prot., Charlotte, NC, July 28-31.

Ionita, C., J. Kim, and X. Jiang. 2013. Survival of *Escherichia coli* O157:H7 in finished compost in the presence of cometitive exclusion bacteria. Clemson University, Life Sciences Facility Dedication - Feb. 8, 2013.

California Department of Food & Agriculture
Specialty Crop Block Grant Program
FINAL PERFORMANCE REPORT

USDA Project No.: 56	**Project Title:** Evaluation of amphibians and reptiles as potential reservoirs of foodborne pathogens and risk reduction to protect fresh produce and the environment	
Grant Recipient: Regents of the University of California, Davis, Center for Produce Safety	**Grant Agreement No.:** SCB10056	**Date Submitted:** December 2012
Recipient Contact: Bonnie Fernandez-Fenaroli	**Telephone:** 530-757-5777	**Email:** bfernandez@cps.ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

This project measured the occurrence of *E. coli* O157:H7 and *Salmonella* among common species of wild amphibians (frogs, toads, salamanders, newts) and reptiles (lizards, snakes) in the central California coast produce production region and the Suwannee watershed in southeastern Georgia. Ten farms comprising 44 individual sampling sites were enrolled in California, including conventional and organic produce farms. Five mixed-produce irrigation ponds in Georgia were enrolled with assistance from collaborators at the University of Georgia. Researchers collected and tested 1,444 and 510 samples in California and Georgia, respectively. *Salmonella* was cultured from several common species of amphibians (frog, toad, newt, salamander) and reptiles (snake, turtle). The highest prevalence of *Salmonella* was among snakes (60%) in California and turtles (20%) in Georgia. *Salmonella* was also cultured from non-irrigation waterbodies in California (natural and tailwater ponds, grassed ditch, wetland) and all 5 irrigation ponds in Georgia. *E. coli* O157:H7 was only cultured from a single tailwater pond sample in California, but non-O157 shiga toxin-producing (STEC) strains were found in animals (snake, newt, toad) and surface water in California including one irrigation reservoir sample. The highest concentration of generic *E. coli* was found in tailwater pond samples (mean 1,147 colony forming units (CFU)/100 ml; range 0 – 12,080 CFU/100 ml). Irrigation reservoir samples in California had the lowest concentration of generic *E. coli* (Mean 27 CFU/100 ml; range 0 – 243 CFU/100 ml). Water samples positive for foodborne pathogens ranged from 14 – 12,080 (mean 1,806) CFU/ 100 ml.

Findings from this study are being shared through presentations to key stakeholders, including the produce industry, conservation community, wildlife management, and regulatory agencies. The science-based data from this study will support both food safety and environmental stewardship. Specifically, the results will improve pre-season and pre-harvest environmental assessments and interventions in produce safety practices, in particular those addressing animal intrusions and irrigation water quality.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Produce farms and conservation lands in California and Georgia were enrolled confidentially in the study. A standardized questionnaire was used to collect environmental and farm management data during each sampling period. Animals were live-captured using a combination of passive and active trapping depending on the target species and location. A cloacal and ventral swab was collected from animals over 2 cm; adult and larval animals were placed in a 250-500 ml sterile phosphate buffered saline (PBS) "bath" for 10 minutes and allowed to defecate. Animals were identified to the species level, and released. Paired water samples were collected during each sampling. *E. coli* O157 and other STEC and *Salmonella* were cultured from animal and water samples using pre-enrichment followed by IMS (immunomagnetic separation) concentration and selective plating. Generic *E. coli* was enumerated using standard methods. Genetic relatedness of animal and water isolates will be compared using pulsed-field gel electrophoresis (PFGE) and multilocus variable number tandem repeat analysis (MLVA). The United States Department of Agriculture, Agricultural Research Service (USDA,ARS) Western Regional Research Center provided microbiological support for the project through a Center for Produce Safety (CPS) subaward including secondary confirmation testing and molecular characterization of isolates. The University of Georgia provided field sampling support in the Suwannee watershed through a subaward with the University of California, Davis (UC, Davis) Western Center for Food Safety (WCFS), a Food and Drug Administration Center for Food Safety and Applied Nutrition (FDA,CFSAN) Center of Excellence.

The study goals, objectives, methods, results and conclusions were included in the outreach presentations. Implications for wildlife risk assessment (for example, LGMA pre- and post-harvest environmental assessments). The serotype profiles were summarized and implications for human health shared. In California, the serotypes were mostly rare and not commonly associated with human illnesses. In Georgia, the serotypes were common and most had been associated with human illness. List of outreach activities 2011-2012:

Presentations and Posters

2011 June Jay-Russell MT. Evaluation of amphibians and reptiles as potential reservoirs of foodborne pathogens and risk reduction to protect fresh produce and the environment. Center for Produce Safety Research Symposium, Orlando, FL, Orlando: FL.

2012 February 22, Wild Thing: defining the role of wildlife in the microbial contamination of fresh produce field in three US/Mexico production regions (Invited Speaker), University of Florida, Gainesville, FL.

2012 March Jay-Russell M, Montfort J, Liu Y, Huang S, Gorski L, Cooley M, Mandrell R, Wheeler J, Reis D, Li X, Atwill R. Zoonotic risks from amphibians and reptiles. Proceedings of the 25th Vertebrate Pest Conference, Monterey, CA.

2012 March Atwill R, Jay-Russell M, Li X, Martin B, Newman PD, Sherman J. Food safety and wildlife panel discussion. 25th Vertebrate Pest Conference, Monterey, CA. 2012 April 2, Wildlife Risk (Invited Speaker), UCGAPs Practical Skill Building for On-Farm Risk Assessments Workshop, Davis, CA.

2012 May 11 Jay-Russell MT, Gorski L, Montfort J, Liu, Y Fisher A, Huang S, Wheeler J, Reis D, Mandrell RE, Li X, Atwill ER. Evaluation of amphibians and reptiles as potential reservoirs of foodborne pathogens and risk reduction to protect fresh produce and the environment. Western Food Safety Summit, Hartnell College, Salinas, CA.

2012 May 11, Western Food Safety Summit: Meeting the Challenges - Roundtable (Invited Panel Member), Salinas, CA

2012 June Jay-Russell MT. Evaluation of amphibians and reptiles as potential reservoirs of foodborne pathogens and risk reduction to protect fresh produce and the environment. Center for Produce Safety Research Symposium, Davis, CA.

The results were presented at the Center for Produce Safety (CPS) Research Symposium in June 2012. In addition, the findings and recommendations were shared at four different venues and discussed during two round tables: Invited seminar on wildlife at the University of Florida; Abstract presented at the 25th Annual Vertebrate Pest Conference (followed by panel discussion); Presentation at the University of California Good Agricultural Practices training for on-farm risk assessments; Poster at Western Food Safety Summit (and panel discussion). An abstract was submitted to the 2013 International Association for Food Protection Annual Conference. One peer-reviewed manuscript is In Press and two are in preparation.

In Press

Gorski L, Jay-Russell MT, Liang AS, Walker S, Bengson Y, Govoni J, Mandrell RE. 2012. Diversity of pulsed field gel electrophoresis pulsotypes, serotypes and antibiotic resistance among Salmonella strains isolated from wild amphibians and reptiles in the California central coast.
Foodborne Pathogens and Disease.

In Preparation

Jay-Russell MT, Gorski L, Hake L, Montfort J, Bengson Y, Cooley M, Wheeler, Reis D, Li X, Mandrell RE, Atwill ER Influence of water quality on foodborne pathogen occurrence in herpetofauna captured near coastal fresh produce fields and wetlands.

Aminabadi P, Smith L, Adams P, Vellidis G, Coker D, Bengson Y, Atwill RE, Jay-Russell MT. Evaluation of foodborne pathogens in aquatic wildlife and irrigation ponds in southeastern Georgia.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The overall goal of the research was to identify science-based approaches to reduce or eliminate bacterial pre-harvest contamination of fresh produce by wildlife while minimizing negative impacts on native fauna and their habitat. The specific objectives of this project were to determine if 1) wild amphibians and reptiles are reservoirs of *E. coli* 0157:H7 and *Salmonella* in large- and small-scale produce growing regions in the California central coast and southeastern Georgia; 2) identify farm production practices, environmental factors and control strategies that reduce the risk of contamination in fresh produce growing environments near riparian and wetland habitats; and 3) share knowledge gained from this research with the produce industry, conservation community, and other stakeholders.

A total of 10 farms comprising 44 sites (conventional and organic produce; conservation lands) in California and 5 mixed-produce irrigation ponds in Georgia were enrolled in the study from March through October 2011. Staff collected and tested 1,444 and 510 samples in California and Georgia, respectively. In California, *Salmonella* was cultured from 11 (3.3%) of 331 frog, 1 (5%) of 20 toad, 1 (20%) of 5 newt, 0 of 6 salamander, 23 (60%) of 39 snake, 7 (12%) of lizard, and 16 (13.6%) of 118 nearby waterbodies. *Salmonella* was recovered from non-irrigation water sources (e.g., natural pond, grassed ditch, wetland, tailwater pond); irrigation reservoirs in California were negative. In comparison, *Salmonella* was cultured from 0 of 17 frog, 22 (19.8%) of 111 turtle, 0 of 10 siren, and 8 (18.6%) of 23 irrigation water (pond) samples in Georgia. Where multiple samples were taken from individual animals in both states, *Salmonella* was recovered more often from PBS baths compared with cloacal and ventral swabs.

E. coli O157:H7 was cultured from a single tailwater pond sample in California; all other animal and water samples were negative for this strain in both states. Staff also cultured for non-O157 STEC from California samples. Non-O157 STEC was isolated from three species (coast garter snake, western toad, rough skinned newt) and from natural pond water. One irrigation reservoir sample was positive for non-O157 STEC.

Interestingly, the highest concentration of generic *E. coli* was found in tailwater pond samples (mean 1,147 CFU/100 ml; range 0 – 12,080 CFU/100 ml). Irrigation reservoir samples in California had the lowest concentration of generic *E. coli* (mean 27 CFU/100 ml; range 0 – 243 CFU/100 ml). Water samples positive for foodborne pathogens ranged from 14 – 12,080 (mean 1,806) CFU/ 100 ml. *E. coli* concentrations could not be determined for Georgia irrigation ponds because water was pre-filtered for shipping to California.

These findings provide baseline data on the occurrence of key foodborne pathogens in common amphibian and reptile species in two important produce production regions of the United States (objective 1). A more detailed statistical analysis of environmental, climate, and farm practice data is underway (objective 2); submission of a peer-reviewed publication is anticipated in mid-2012. The findings are being shared with stakeholders through professional presentations and abstracts (objective 3).

Dr. Michele Jay-Russell, UC, Davis, presented interim research results at the 2011 CPS symposium in Florida, and final research results at the 2012 CPS symposium in California. The 2011 symposium had 249 attendees, and survey respondents rated the relevance of this project to the fresh produce industry as 2.4

(1=very important; 5=very unimportant). The 2012 symposium had 325 attendees and survey respondents rated the relevance of this project to the fresh produce industry as 1.8 (1=very important; 5=very unimportant).

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The findings from this study will be used to develop and enhance species-specific mitigation strategies to protect irrigation ponds and fresh produce from microbial contamination. In California, the results will be shared with stakeholders in the produce industry, conservation, and regulatory communities. The data can be used to improve pre-season and pre-harvest environmental assessments and interventions as required in the Leafy Green Marketing Agreement metrics, in particular those addressing animal intrusions and irrigation water quality. In Georgia, more in-depth studies of *Salmonella* occurrence in the Suwannee watershed are underway to better understand the ecology of these ponds and development of mitigation strategies. Wildlife isolates from this study will be shared with investigators at the University of Florida to compare genetic relatedness with their Suwannee watershed *Salmonella* strains.

The enrolled farms (10 farms/44 sites) included conventional and organic vegetables and fruits. In California, these included leafy greens, herbs, and an apple orchard. In Georgia, mixed produce farms grew blueberries, squash, melons, and tomatoes. The Georgia data provides a regional comparison with the California Central coast.

Unfortunately, it is difficult to provide quantifiable data on the users of the data. The project directly benefits CA central coast leafy green producers, an industry that has in the past harvested and distributed leafy greens with a value of $1,175,728,000 just in Monterey and San Benito counties. Additional information is also provided to CA central coast leafy green producers about potential reservoirs of pathogenic E. coli and Salmonella. For amphibians and reptiles, STEC was rare and no E. coli O157 was found. Knowing this, aquatic and terrestrial frogs, toads, lizards, snakes, etc. would not likely be important in follow-up to a recall, for example. However, Salmonella was readily isolated from snakes, lizards, frogs, and toads. In the central coast, most serotypes were reptile-associated (Group III arizonae and Group IV diarizonae). There have been occasional recalls involving these serotypes, so growers should be aware of some Salmonella risk if the animals enter the crop; however, the risk is probably low unless larger groups of animals are involved.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The study results confirm that common wild amphibian and reptile species at both the California and Georgia study sites are reservoirs of *Salmonella*, but not *E. coli* O157:H7. The research team found *Salmonella* in aquatic and terrestrial species near produce irrigation reservoirs at several California sites, but no evidence of *Salmonella* in the irrigation water. *Salmonella* was recovered from non-irrigation water sources at the California sites including natural ponds, tailwater ponds, grassed ditches, wetland areas, and the Salinas River. In contrast, *Salmonella* was cultured from both aquatic turtles and ponds used for produce irrigation at the Georgia sites; preliminary results from PFGE analysis reveal that *Salmonella* strains from the pond water and turtles are genetically related.

More detailed statistical analyses are underway to examine environmental and management practices that may impact water quality and pathogen prevalence. However, seasonality was not evaluated in this study due to an unanticipated delay in the original proposed timeline. Specifically, although the principal investigator had a Department of Fish and Game (DFG) scientific collection permit prior to starting this CPS project, the Primary Investigator had to hire additional field staff with expertise in herpetology to achieve the goals and objectives of the study. The field staff was required to apply for individual DFG permits, which took several weeks. As a result, the winter 2011 sampling period was missed. Additionally, the cold and wet spring on the coast delayed emergence of many of the common frog and snake species, thus there was low trap success during the spring months. To address these issues and reach the desired sample size, intensive sampling was conducted during the summer when animals were abundant. The sample size goal was successfully reached, but a longer-term follow-up study would be needed to evaluate seasonal effects, and better evaluate species more abundant in the winter months (e.g., salamanders).

Interestingly, in the laboratory *Salmonella* strains were unexpectedly found from amphibian and reptile samples with atypical colony morphology on standard agar plates. In order to confirm and identify these strains, additional tests were conducted at both the UC Davis and ARS laboratories. The labs confirmed that some of these unusual strains belong to *Salmonella enterica* Group III (Arizonae), a serogroup associated previously with amphibians and reptiles in captivity and linked to human outbreaks from fecal-oral contact with these animals.

In summary, the science-based data from this study fills a gap in knowledge related to the potential for wild amphibians and reptiles in proximity to produce production fields and waterbodies to serve as reservoirs of foodborne pathogens. The information can be used to develop co-management strategies to promote both food safety and environmental goals.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Publications and abstracts:

Gorski, L., C. T. Parker, A. Liang, M. B. Cooley, M. T. Jay-Russell, A. G. Gordus, E. R. Atwill, and R. E. Mandrell. 2011. Prevalence, Distribution and Diversity of *Salmonella enterica* in a Major Produce Region of California. Appl. Environ. Microbiol.

Jay-Russell, M. T., J. Montfort, Y. Liu, S. Huang, L. Gorski, R. E. Mandrell, J. Wheeler, D. Reis, X. Li, E. R. Atwill. 2012. Zoonotic Risks from Amphibians and Reptiles. 25th Annual Vertebrate Pest Conference, Monterey, California (accepted).

Presentations:

Jay-Russell, M. T. Poster presentation*, Evaluation of amphibians and reptiles as potential reservoirs of foodborne pathogens and risk reduction to protect fresh produce and the environment*. June 28, 2011. 2nd Annual CPS Produce Research Symposium, Orlando, FL.

Jay-Russell, M. T. Session I, Good Agricultural Practices – Buffer Zones and Animal Vectors. June 27, 2012. 3rd Annual CPS Produce Research Symposium, University of California, Davis.

Other:

The final research report written for the CPS Technical Committee is posted on the CPS website https://cps.ucdavis.edu/grant_opportunities_awards.php

The final research report and publications resulting from this research will be included in the CPS Global Research Database https://cps.ucdavis.edu/global_research_database.php

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.:	Project Title:	
57	*E. coli* O157:H7 in bioaerosols from cattle production areas: evaluation of proximity and airborne transport on leafy green crop contamination	
Grant Recipient: The Regents of the University of California, Davis, Center for Produce Safety	**Grant Agreement No.:** SCB10057	**Date Submitted:** December 2013
Recipient Contact: Bonnie Fernandez-Fenaroli	**Telephone:** 530-757-5777	**Email:** bfernandez@cps.ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Either directly or indirectly, cattle and their manure are significant sources of the pathogen *Escherichia coli* O157:H7 that may contaminate human food and water. Recent *Escherichia coli* O157:H7 outbreaks due to the consumption of spinach and lettuce have focused attention on cattle as potential sources of the contamination, and thus, fueled the need for information about *E. coli* O157:H7 transmission from cattle production facilities. Guidelines provided in the California Leafy Greens Marketing Agreement (LGMA) propose an interim guidance distance of 400 feet between concentrated animal feeding operations and leafy green crop to reduce the risk of pathogen contamination of the crop. However, these guidelines admit that there is lack of science supporting this guidance distance. The goal of this project was to determine the effects of proximity to a beef cattle feedlot on *E. coli* O157:H7 contamination of a leafy green crop, and focused on the potential for *E. coli* O157:H7 to be transported in air by dust or wind, and by cattle pest flies. This information is critical to the produce industry for understanding the risks associated with growing crops near cattle production facilities, and for determining safe distances between cattle feedlots and crop production that will reduce the risk of foodborne illness resulting from the consumption of fresh produce.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Research activities for this project were conducted by the USDA subaward principal investigator.

In each of two years, leafy greens (spinach, turnip greens, and/or mustard greens) were planted in nine plots that were located 200, 400, and 600 feet from a cattle feedlot (three plots each distance). Additional subplots were planted every few weeks so that leafy greens were available for sampling from June to September. The plots were located in a field north of the feedlot in order to take advantage of the prevailing south winds that are typical in this region during these months. To understand the effects of proximity on transmission of *E.*

coli O157:H7 from the feedlot to the leafy greens crop, four sample types were collected and analyzed several times throughout each project season (June to September): feedlot surface manure (FSM), leafy greens, air samples, and cattle pest flies. The percentage of *E. coli* O157:H7-positive FSM samples was high at each sampling, ranging from 47% to 98%, with an average prevalence of about 72% in both years. *E. coli* O157:H7 was recovered in leafy greens at low rates, but was found in samples at all three plot distances tested, including 600 feet. In addition to their use to isolate viable *E. coli* O157:H7, microbial enrichment cultures of all leafy greens and FSM samples were applied to Flinders Technology Associates (FTA) cards and stored for later DNA purification. DNA was extracted from the FTA cards and analyzed by polymerase chain reaction (PCR) for genes common to *E. coli* O157:H7 and other pathogenic *E. coli* strains. The PCR procedure detected 73% of the *E. coli* O157:H7-positive leafy green samples and 99% of the *E. coli* O157:H7-positive FSM samples.

Air samples (1000-liter volumes) were collected at the edge of the feedlot pens and at each of the nine leafy green plots when the wind was from the south, and analyzed for both *E. coli* O157:H7 and total generic *E. coli*. Although *E. coli* O157:H7 was not recovered in air samples at any location, total *E. coli* was recovered from air samples collected at the edge of the feedlot and at all three plot distances, which indicates that airborne transport of *E. coli* O157:H7 also occurs. On some sampling days, decreases in total *E. coli* concentrations in air samples were suggested as distance from the feedlot increased. To assess the effects of environmental conditions on the transport of *E. coli* O157:H7, weather data were collected continually during the project season by an on-site weather station, which recorded a number of measures including air temperature, precipitation volume and intensity, and wind speed and direction. In addition, the condition of the feedlot pen surfaces was periodically evaluated. Results from both leafy greens and air sampling suggest that the risk for transport of *E. coli* O157:H7 from cattle production is increased in situations where cattle pen surfaces are very dry after little rainfall, especially in combination with cattle management activities that generate substantial airborne dust.

The primary cattle pest fly species captured at the edge of the feedlot and at the leafy green plots included house flies, face flies, stable flies, flesh flies, and blow flies. Over both years, the percentage of *E. coli* O157:H7-positive fly pools were significantly higher at the edge of the feedlot (18.5%), although the pathogen was found in 10.4, 8.5, and 9.5% of fly pools at 200, 400, and 600 feet from the feedlot, respectively. All *E. coli* O157:H7 isolates from leafy greens, FSM, and pest flies were subjected to pulsed field gel electrophoresis analysis. This is a DNA fingerprinting method that distinguishes unique types among the isolates and determines any links between these different sample types. In both years, pulsed field gel electrophoresis types that were found in the leafy greens also were found in FSM and in pest flies. This information is critical for understanding the risks associated with growing leafy greens crops near cattle production facilities, and for determining safe distances between cattle feedlots and crop production. The results of this study suggest that the current leafy green field distance guidelines of 400 feet may not be adequate to limit the occurrence of *E. coli* O157:H7 in crops planted near concentrated animal feeding operations.

The success of this project required collaborative efforts of many people. Project collaborators include the University of California, Davis (US Davis) and U.S. Department of Agriculture, Agricultural Research Service (USDA, ARS), Beltsville, MD provided critical input in the planning stages. Major Farms, Inc. and Snow Seed Company provided production advice and spinach seed. Collaborator USDA, ARS, Clay Center, NE managed the on-site weather station that collected information needed for data interpretation.

Collaborators from USDA, ARS, Lincoln, NE and USDA, ARS, Clay Center, NE were directly involved in fly collection and analyses, and were critical to training and instruction of lab personnel on fly identification. UC Davis was responsible for analyses to detect genes of O157 and non-O157 Shiga toxin-producing *E. coli* strains in FSM and leafy green samples. The Western Institute for Food Safety and Security loaned the MAS-100 Eco microbial air samplers. Also critical to the research was the assistance and hard work of student interns and numerous members of technical staff, farm crew, and feedlot crew of the U.S. Meat Animal Research Center (USDA, ARS, Clay Center, NE).

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The overall goal of the project was to target Core Food Safety Research Need 1.2 *Buffer Zones from Domestic Animals to Fruit and Vegetable Production*, by evaluating the impact of proximity to a beef cattle feedlot on the E. coli O157:H7 contamination of a leafy green produce crop, with special attention to the potential for airborne transport of E. coli O157:H7 and transmission of E. coli O157:H7 by cattle pest flies. This was accomplished by conducting a comprehensive study over two seasons that included intensive sampling of leafy greens, feedlot surface manure, air, and cattle pest flies. The study was designed in the context of the current California LGMA guidelines, that recommend a distance of 400 feet between concentrated animal feeding operations and leafy green crops, by planting the leafy green plots 200, 400, and 600 feet from the feedlot. The recovery of E. coli O157:H7 from leafy greens of the same DNA fingerprint types as E. coli O157:H7 recovered in feedlot surface manure demonstrated the transport of this pathogen from the feedlot to the crop. In addition, the recovery of the pathogen from leafy greens planted at all three plot distances indicates the risk for planting these crops near cattle feedlots. Bioaerosol or airborne transport of E. coli O157:H7 was not observed, as the air sampling technique that was used likely was not adequately sensitive to detect this pathogen in air. However, airborne transport of total E. coli was verified, which indicates that airborne transport of E. coli O157:H7 also can occur. Total E. coli was detected in air samples at all three plot distances, including 600 feet, although decreases in the levels of total E. coli were observed as the distance from the feedlot increased. Results obtained from the cattle pest fly analyses provided quantitative data regarding the occurrence of E. coli O157:H7-positive flies in a leafy green crop planted near a cattle feedlot, and information about the different fly species that can carry this pathogen. This work provided the first report of the carriage of E. coli O157:H7 by face flies and flesh flies. E. coli O157:H7-positive pest flies were found at leafy green plots at all three distances tested.

Dr. Elaine Berry, USDA, ARS, presented a poster of interim results at the 2012 Center for Produce Safety (CPS) Produce Research Symposium in California, and final research results at the 2013 CPS Produce Research Symposium in New York. The 2012 symposium had 325 attendees and survey respondents rated the relevance of the research as important. The 2013 symposium had 300 attendees and survey respondents rated the relevance of this project to the fresh produce industry as 1.6 (1=very important; 5=very unimportant).

The CPS's Board of Directors and members of the Technical Committee distributed a series of information throughout 2013 on their websites, and through presentations, meetings and webinars. An example of this occurred on July 18, 2013 when Western Growers Association held a webinar for their members. Information discussed at the webinar is now part of the "Key Learnings" on the CPS website: https://cps.ucdavis.edu/amass/documents/document/186/Key%20Learnings_2013%20CPS%20Symposium.pdf

The following websites provide additional resources on the final reports and symposium proceedings:
Center for Produce Safety: https://cps.ucdavis.edu/resources.php
Produce Marketing Association: http://pma.com
Western Growers Association: http://www.wga.com/

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The primary beneficiaries of this research project included lettuce and spinach industries that harvest 320,900 acres per year with an annual value of $2,412,239,000. Furthermore, this project impacted the fresh produce industry and its allied agricultural industries, and ultimately fresh produce consumers. This project demonstrated that E. coli O157:H7 can be transmitted from a cattle feedlot to leafy greens planted up to 600 feet away from the feedlot. In addition, E. coli O157:H7-positive pest flies were captured in leafy greens plots at distances up to 600 feet from the feedlot. This distance is greater than the current guidance distance of 400 feet between concentrated animal feeding operations and leafy green crops. This information can be used by the produce industry to reduce the risk of contamination of leafy greens crops, thereby reducing foodborne illness and product recalls associated with this product, and enhancing the competitiveness of the industry.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The major findings of this work were the occurrence of E. coli O157:H7 both in leafy greens and pest flies at distances up to 600 feet from the cattle feedlot. Although the pathogen was not detected in air samples at 600 feet, the detection of total E. coli in air samples collected at this distance indicates the risk for airborne transport of E. coli O157:H7. These findings suggest that the current leafy green field distance guidelines of

400 feet may not be adequate to limit the occurrence of E. coli O157:H7 in crops planted near concentrated animal feeding operations. However, as 600 feet was the greatest distance examined, an appropriate set-back distance between cattle feedlots and crop fields to reduce contamination risk was not identified. Additional research will be needed to determine a safer set-back distance that will further reduce contamination risk.

While this study provided detailed data regarding the transmission of E. coli O157:H7 to leafy greens from a feedlot, the findings did not fully confirm the roles for either of airborne transport and pest flies in this dissemination. Further work is suggested to determine the significance of these two potential modes of pathogen transmission to the microbial safety of produce, which may suggest other potential means to reduce the risk of produce crop contamination. More sensitive techniques may be needed to detect E. coli O157:H7 in air samples.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 58	Project Title: Impact of organic load on sanitizer efficacy and recovery of *E. coli* O157:H7 during commercial lettuce processing	
Grant Recipient: Regents of the University of California, Davis, Center for Produce Safety	**Grant Agreement No.:** SCB10058	**Date Submitted:** December 2012
Recipient Contact: Bonnie Fernandez-Fenaroli	**Telephone:** 530-757-5777	**Email:** bfernandez@cps.ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

In response to continued outbreaks involving *E. coli* O157:H7 and other bacterial pathogens, the safety of fresh produce has now become a top priority. Although bagged salad mixes and other such products available in supermarkets have been commercially washed multiple times in various chemical sanitizers to minimize the risks from hazardous microorganisms, such practices will not totally ensure end-product safety. As product residues accumulate in the water during processing and reduce the effectiveness of commonly used commercial sanitizers, bacterial contaminants in this water are readily transferred to previously uncontaminated product. This study explored some of the water quality issues related to chlorine effectiveness with the goal being to identify several easily measureable water-related factors (example - the amount of lettuce debris in the water) that can be easily monitored by the industry to increase the effectiveness of chlorinated sanitizers.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

With multiple *E. coli* O157:H7 outbreaks in 2006 linked to commercially bagged fresh-cut leafy greens, increased attention was placed on processing practices as a source of contamination. It is well known that chlorine will interact with organic material in water used to wash leafy greens, thereby making it less effective against hazardous bacteria such as *E. coli* O157:H7. Chlorine is routinely used in flume tanks during leafy green processing to reduce such hazards both in the water and on the product. However, its efficacy continues to be questioned. Consequently, the two aims of this study were to: 1) determine the ability of sodium hypochlorite, alone and with an acidifier to reduce *E. coli* O157:H7 populations on shredded iceberg lettuce during simulated commercial processing; and 2) assess the relationship between various physicochemical parameters (e.g. solids content, water turbidity, filtration rate), organic load of the wash water, and sanitizer efficacy.

In this study, the work was primarily completed using a pilot-scale leafy green processing line which shreds, conveys, washes, shakes, and dries various types of leafy greens. In order to simulate the used wash water commonly seen in industry, iceberg lettuce was blended and added to tap water along with chlorine or chlorine + citric acid. Organic load levels as high as 10% were used in the wash water, so in the 240 gallon tank this meant 200 pounds of lettuce was added to the wash water to simulate the worst-case scenario that could be seen in an industrial processing line.

Results from work performed in this study show that wash water containing chlorine was more effective than water alone in decreasing the numbers of *E. coli* O157:H7 on lettuce. If the pH of the wash water containing chlorine was reduced to a pH of 6.5 with citric acid, the chlorine was even more effective. In wash water, the acidified chlorine proved to be more effective than chlorine or water alone at reducing *E. coli* O157:H7 populations. As the organic load increased in the wash water increased, the effectiveness of chlorine and acidified chlorine against *E. coli* O157:H7 on lettuce and in wash water was reduced. As organic load increased, there were several water parameters that correlated to both sanitizer efficacy and organic load. The parameters are simple enough to be tested on a regular basis in a commercial processing facility, so the work completed for this project has direct applications to food safety.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The two goals of this study were to: 1) determine the ability of sodium hypochlorite, alone and with an acidifier to reduce *Escherichia coli* O157:H7 populations on shredded iceberg lettuce during simulated commercial processing; and 2) assess the relationship between various physicochemical parameters and organic load of the wash water on sanitizer efficacy. Both goals were met in this study by work completed in a laboratory and in a pilot-scale leafy green processing line. Work completed in this study determined that sodium hypochlorite was effective at reducing *E. coli* O157:H7 populations in wash water, on iceberg lettuce, and on equipment surfaces. Efficacy of chlorine was significantly enhanced by the addition of citric acid. It was determined that various physicochemical parameters tested correlated to organic load and sanitizer efficacy.

Dr. Elliot Ryser, Michigan State University, presented a poster of interim results at the 2011 CPS symposium in Florida, and final research results at the 2012 CPS symposium in California. The 2011 symposium had 249 attendees, and 83% of survey respondents rated the relevance of the posters as very valuable or somewhat valuable. The 2012 symposium had 325 attendees and survey respondents rated the relevance of this project to the fresh produce industry as 1.7 (1=very important; 5=very unimportant).

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Commercial leafy green processors will be the first beneficiaries of this project. Given the correlation of various wash water parameters to sanitizer efficacy, processors will now be able to more effectively determine the ability of their wash water to reduce and eliminate pathogens in the presence of different organic loads. This research was completed using a pilot-scale processing line which provides data that better correlate to industrial conditions than previous work which relies on strictly on bench-top experiments.

If commercial leafy green processors have the tools to determine if their wash water containing a chlorine-bases sanitizer and an organic load is effective or not, the final product that is distributed to consumers should be safer, resulting in fewer recalls and outbreaks.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The efficacy of chlorine against *E. coli* O157:H7 in wash water containing various organic loads was evaluated using two different methods. The bench-top method involved the use of a 4 L carboy containing wash water with one of four organic loads and a chlorine-based sanitizer. The system was inoculated with an *E. coli* O157:H7 cocktail after which water samples were collected, neutralized and examined for *E. coli* O157:H7 survivors. Preliminary results indicated that the bench-top system would yield comparable results to those for the pilot-scale leafy green processing line. After completing the bench-top work, it became clear that the two methods did not yield comparable results. While the *E. coli* O157:H7 results were significantly different between the two systems, the same trends in the physicochemical parameters were noticed depending on the organic load or sanitizer concentration. This unexpected outcome resulted in more attention being placed on the processing line. This oversight became clearer to all concerned after Gordon Davidson presented his findings at the annual meeting of The International Association for Food Protection in Milwaukee, WI in August 2011.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Publications:
Davidson, G.R., C.N. Kaminski, and E.T. Ryser. 2011. Persistence of Escherichia coli O157:H7 during pilot-scale processing of iceberg lettuce using flume water containing sanitizers and an organic load. J. Food Prot. (In preparation).
Davidson, G.R., C.N. Kaminski, and E.T. Ryser. 2011. Impact of organic load on sanitizer efficacy against Escherichia coli O157:H7 in simulated leafy green processing water. J. Food Prot. (In preparation).

Presentations:
Davidson, G.R., C.N. Kaminski, L. Ren, and E.T. Ryser. 2012. Impact of organic load on Escherichia coli O157:H7 persistence during pilot-scale processing of iceberg lettuce with acidified sodium hypochlorite. Abst. Ann. Mtg. Int. Assoc. Food Prot. Providence, RI. July 22- 25.
Ryser, E.T. 2012. Session IV, Wash Water and Process Control. 3rd Annual CPS Produce Research Symposium. University of California, Davis. June 27.
Davidson, G.R., Y. Xu, and E.T. Ryser. 2011. Persistence of Escherichia coli O157:H7 during pilot-scale processing of iceberg lettuce using flume water containing sanitizers and an organic load. Abst. Ann. Mtg. Int. Assoc. Food Prot. Milwaukee, WI. July 31- August 4. Gordon Davidson was awarded 1st place in the Developing Scientist competition for this technical presentation.
Davidson, G.R., H. Wang, and E.T. Ryser. 2011. Impact of organic load on sanitizer efficacy against Escherichia coli O157:H7 in simulated leafy green processing water. Abst. Ann. Mtg. Int. Assoc. Food Prot. Milwaukee, WI. July 31- August 4.
Ryser, E.T. 2011. Poster session. Impact of organic load on sanitizer efficacy and recovery of *E. coli* O157:H7 during commercial lettuce processing. 2nd Annual CPS Produce Research Symposium. Orlando, FL. June 28..

Other:
The final research report written for the CPS Technical Committee is posted on the CPS website https://cps.ucdavis.edu/grant_opportunities_awards.php
The final research report and publications resulting from this research will be included in the CPS Global Research Database https://cps.ucdavis.edu/global_research_database.php

California Department of Food & Agriculture
Specialty Crop Block Grant Program
FINAL PERFORMANCE REPORT

USDA Project No.: 59	**Project Title:** Non-invasive imaging approaches to evaluate potential infusion of pathogens during vacuum cooling of lettuce leaves and real time dynamics of microbes on leaf tissues as a function of moisture content	
Grant Recipient: Regents of the University of California, Davis, Center for Produce Safety	**Grant Agreement No.:** SCB10059	**Date Submitted:** December 2012
Recipient Contact: Bonnie Fernandez-Fenaroli	**Telephone:** (530) 757-5777	**Email:** bfernandez@cps.ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Internalization of bacteria in fresh produce is a major food safety risk factor as internalized bacteria are refractory to most washing and sanitation procedures. Vacuum cooling has been identified as one processing step that can enhance internalization of microbes in fresh produce. Currently there is limited insight into what factors during vacuum cooling influence internalization of microbes.

The aim of this study was to elucidate the risk of internalization of surface inoculated *E. coli O157:H7* upon vacuum cooling of lettuce as a function of microbial inoculation (high: 6log CFU (colony forming unit) per leaf disk) or low: 3log CFU per disk) and surface moisture and on both sides (abaxial and adaxial side) of lettuce leaves. To measure internalization of microbes in intact leafy greens multiphoton 3-dimension (3D) microscopy was used. This novel microscopy approach addresses challenges of autofluorescence and limited depth penetration to enable 3D microscopy of intact leaves.

Commercial lettuce purchased from a grocery store was washed, and the leaf surface was sprayed evenly with a solution of *E. coli O157:H7* green fluorescent protein (GFP) to inoculate the surface of lettuce. After vacuum cooling treatment the lettuce leaves were imaged with multiphoton microscopy. For quantitative and statistical analysis, the number of microbes associated with stomata and infiltrated into the leaf was quantified.

Results based on imaging measurements demonstrated that the vacuum cooling does not significantly increase the risk of internalization ($p>0.5$) of surface inoculated E. *coli* into an intact lettuce leaf. The imaging results also indicated that the vacuum cooling process increased the number of bacteria associated with stomata for both high moisture and low moisture conditions for samples inoculated on abaxial and adaxial surface of lettuce leaves. However, this increase in microbial association with stomata was only statistically significant for the high levels of microbial inoculation on abaxial surface under low moisture conditions. The imaging measurements highlight that the vacuum cooling process does not significantly increase the risk of internalization of microbes.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Objective 1: Develop a non-invasive imaging approach for in-situ measurement of localization of microbes in a plant matrix

Multiphoton imaging of microbes on surface and inside of lettuce leaves: To enable detection of infiltration of microbes in lettuce leaves induced by the vacuum cooling process, it is essential that the selected imaging approach can detect both the surface dispersed and the internalized microbes in individual lettuce leaves. Figure 1 (a and c) shows the z- stack images (images of planes at various depths within the sample) acquired using multiphoton microscopy to map spatial distribution of GFP expressing microbes on the surface and inside of lettuce leaves respectively. To represent the distribution of microbes along the depth of the microbes, the individual z- stack images were combined to generate a projection image. Figure 1(b and d) shows the z-projection of surface dispersed and infused microbes in lettuce leaves. To infiltrate the microbes in lettuce leaves, the microbes were infused into lettuce leaves using a vacuum infusion process. It is important to note that the vacuum infusion process is significantly different from the vacuum cooling process although both processes are based on using vacuum pressure. In the vacuum infusion process, the microbes are dispersed in the aqueous solution and the aqueous solution is infused into lettuce leaves using a rapid release of vacuum pressure. In a vacuum cooling process, leaves are not submerged in an aqueous solution and the vacuum pressure levels are an order of magnitude higher than the vacuum pressure used for vacuum infusion process. The results demonstrate that multiphoton imaging can detect distribution of microbes on both the surface and inside of lettuce leaves without any significant contributions from plant autofluorescence. Furthermore, the results also show that multiphoton imaging can image microbes at depth levels greater than 80 microns (spanning the full depth of lettuce leaves). In summary, detecting distribution of microbes both on the surface and inside of lettuce leaves can be done using multiphoton imaging.

Comparison of Multiphoton and Confocal Microscopy for Imaging Microbes on Plant Surface: In a previously published vacuum cooling study and in vacuum infusion literature, internalization of microbes through stomata has been reported. To evaluate the increase in internalization of microbes using vacuum cooling process, it is essential to detect stomata on intact plant leaves and image microbes both on the surface and inside of stomata. Figure 2 (a-d) compares the fluorescence and the overlay of differential interference contrast (DIC) and fluorescence images of plant leaf surfaces acquired using confocal and multiphoton microscopy respectively. Comparison between the fluorescence images from confocal and multiphoton (Figures 2 (a-c)) measurement based on an intensity line scan through a selected region of microbes on surface of lettuce leaf highlight the improvement in spatial resolution with multiphoton microscopy as compared to confocal microscopy. The improved spatial resolution is critical in mapping localization of microbes on a spatially varying topology of a plant surface. Figures 2 (b-d) compares the overlay of fluorescence and DIC images acquired using near-infrared (NIR) excitation in multiphoton imaging as compared to visible excitation in confocal imaging. The results of this comparison clearly illustrate the improvement in detection of stomata on plant surface using NIR multiphoton excitation as compared to visible excitation in confocal microscopy (the stomata are marked with arrows on the image). The improvement in the DIC image results from decreased scattering of NIR excitation light as compared to visible excitation in confocal microscopy. In summary, the results clearly demonstrate that multiphoton imaging has significantly improved spatial resolution to detect stomata in plant tissue and microbial distribution as compared to confocal imaging. In a previous report, the stomata on lettuce leaves were detected based on plant autofluorescence signal that often overlaps with the fluorescent signal from GFP expressing microbes. This can significantly limit the sensitivity to detect microbial association with stomata as well as often lead to confounding measurement. Use of multiphoton microscopy addresses this limitation as illustrated in the results of Figure 2.

Objective 2: Evaluate potential of infiltration during vacuum cooling

Design of experiment: Table 1 outlines the design of experiment to assess potential infiltration of microbes during vacuum cooling. With this design of experiment, the impact of both wet and dry conditions on infiltration of microbes was measured at two level of microbial inoculation of both adaxial and abaxial surfaces of lettuce leaves. To quantify localization of microbes as a function of the selected variables in Table 1, the experimental approach outlined in Figure 3 was used for both adaxial and abaxial surfaces. Acquisition of multiple z- stack images (10-z stack images per imaging sample) for both adaxial and abaxial surface of lettuce leaves was used. The imaging results were quantified to measure association of microbes with stomata and internalization of microbes in lettuce leaves using the methods outlined in the materials and methods section. Association of microbes with stomata was quantified based on localization of microbes within the structural boundary of stomata as illustrated in Figure 4 (a). This boundary was defined based on the DIC white light images of multiphoton microscopy. Figure 4 (b) illustrates the imaging approach to characterize internalization of microbes in stomata. The figure shows a z-stack that illustrates the localization of microbes at different depth levels within stomata. To evaluate the significance of the selected variables in influencing localization of microbes on surface of lettuce leaves, the statistical analysis section was conducted.

Abaxial Surface: This section describes the results based on inoculation of microbes on surface of lettuce leaves for high moisture and low moisture conditions. Figures 5 and 6 show the representative micrographs and quantification of imaging data to illustrate the potential infiltration of microbes inoculated on abaxial surface of lettuce leaves maintained under high and low moisture conditions. These results clearly demonstrate that no significant increase in internalization (defined by localization of microbes inside stomata and under stomata-penetration into leaf) of microbes was observed under the experimental conditions selected for this study. The quantitative comparison of vacuum treated sample as compared to control does indicate a slight increase in association of inoculated microbes with stomata for vacuum cooled samples under both high and low moisture conditions. Based on statistical analysis, this increase in association of microbes with stomata with vacuum cooling was not significant ($p>0.5$) for high moisture conditions and significant ($p<0.5$) in case of low moisture conditions.

Adaxial Surface: The same design of experiment as outlined in Figure 3 was used for measuring the potential infiltration of microbes through the adaxial surface. Figures 7 and 8 show the representative micrographs and quantification of imaging data to illustrate the potential infiltration of microbes inoculated on surface of lettuce leaves maintained under wet and dry conditions. These results clearly demonstrate that no significant increase in internalization (defined by localization of microbes inside stomata and under stomata-penetration into leaf) of microbes was observed under the experimental conditions selected for this study. These results are similar to the results obtained on abaxial surface. It is also important to note that the total number of stomata on adaxial surface is significantly less (approximately 30-40 % less than the similar measurements on abaxial surface). Similar to the results on abaxial surface, the results on adaxial surface also show an increase in number of stomata associated with microbes in vacuum cooled samples as compared to control samples under both dry and wet surface conditions. Based on statistical analysis, this increase in association of microbes with stomata was not significant ($p>0.5$).

Low Inoculum Levels: In addition to high inoculum (6 log CFU), similar experimental measurements were also conducted using low inoculum level of microbes (3 log CFU) on surface of lettuce leaves. The results of these measurements demonstrate similar trends as observed with high inoculum levels on both adaxial and abaxial surfaces although the absolute number of stomata associated with microbes decreases significantly in case low inoculum levels. In summary, the results with local inoculation levels demonstrate no significant increase in infiltration of microbes with vacuum cooling.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The project addressed all the goals proposed in the original proposal. The following activities were completed to achieve the performance goals and measurable outcomes:

- Demonstrated a novel application of multiphoton imaging to measure distribution of microbes both on the surface and inside of intact lettuce leaves.
- Multiphoton imaging results demonstrate significant improvement in spatial resolution and definition of plant structure as compared to standard confocal imaging.
- Evaluated the potential of microbial infiltrated during vacuum cooling as a function of surface moisture on both abaxial and adaxial sides of lettuce leaves using both high and low inoculum levels.

Dr. Nitin Nitin, University of California, Davis, presented a poster of interim results at the 2011 Center for Produce Safety (CPS) symposium in Florida, and a poster of final research results at the 2012 CPS symposium in California. The 2011 symposium had 249 attendees, and 83% of survey respondents rated the relevance of the posters as very valuable or somewhat valuable. The 2012 symposium had 325 attendees and survey respondents noted the poster session provided information with practical application of the results.

In addition to presentation of results at the annual CPS Produce Research Symposiums, the following activities will provide information for implementation of recommendations:

Final reports are posted on the CPS website (https://cps.ucdavis.edu/grant_opportunities_awards.php) after the June symposium.

CPS works with scientists to publish results in scientific journals after the project is completed. Awards and abstracts can be found on the CPS website (www.cps.ucdavis.edu).

The Center for Produce Safety's Board of Directors and members of the Technical Committee distribute a series of information throughout the year on their websites, and through presentations, meetings and webinars. An example of this occurred on July 18, 2013 when Western Growers Association held a webinar for their members. Information discussed at the webinar is now part of the "Key Learnings" on the CPS website: https://cps.ucdavis.edu/amass/documents/document/186/Key%20Learnings_2013%20CPS%20Symposium.pdf

The following websites provide additional resources on the final reports and symposium proceedings:
Center for Produce Safety: https://cps.ucdavis.edu/resources.php
Produce Marketing Association: http://pma.com
Western Growers Association: http://www.wga.com/

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The fresh produce industry in California and the United States benefit as this research provides an assessment of potential risk of infiltration of microbes during post-harvest cooling of lettuce. The state produces about 70 million carton equivalents of iceberg lettuce per year. There are about 60 iceberg lettuce handlers in the State handling product for several hundred iceberg lettuce growers.

Vacuum cooling equipment manufacturers also benefit. Vacuum cooling is the leading approach to preserve the quality of fresh produce using energy efficient cooling methods. Detailed understanding of factors that may control internalization of microbes is critical to address any potential risks. In this study it was demonstrated that with large inoculation levels there may be some dispersion of microbes that may lead to their association with stomata (although not statistically significant). The results demonstrated no significant internalization of microbes through stomata under the conditions evaluated in this research.

The research community benefits from this project as well. The research provides a novel approach to evaluate internalization in intact leafy greens and also use of imaging methods to address research in food safety.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

Results of multiphoton imaging highlight the significant advantages in spatial mapping of the distribution of microbes on the surface and inside of intact lettuce leaves as compared to confocal microscopy.

Results of microscopic measurements demonstrate no significant increase in infiltration of microbes during vacuum cooling process. These results were validated using fresh lettuce from green houses as well as lettuce leaves from the market.

Results also highlight a slight increase in association of microbes with stomata with vacuum cooling as compared to control lettuce samples. However, statistical analysis of the data highlight that the increase was not significant for all conditions except high inoculation level of microbes on lettuce leaves (6 log CFU/ leaf disk) under low moisture conditions.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Presentations:

Nitin, N. 2011. Poster session. 2nd Annual CPS Produce Research Symposium. Orlando, FL. June 28.

Nitin, N. 2012. Poster session. 3rd Annual CPS Produce Research Symposium. University of California, Davis, CA. June 27.

Other:

The final research report written for the CPS Technical Committee is posted on the CPS website:
https://cps.ucdavis.edu/grant_opportunities_awards.php

The final research report and any publications resulting from this research will be included in the CPS Global Research Database:

https://cps.ucdavis.edu/global_research_database.php

Tables and Figures referred to in this report are included as an attachment.

USDA Project No.: 60	Project Title: Developing buffer zone distances between sheep grazing operations and vegetable crops to maximize food safety	
Grant Recipient: Regents of the University of California, Davis, Center for Produce Safety	**Grant Agreement No.:** SCB10060	**Date Submitted:** December 2012
Recipient Contact: Bonnie Fernandez-Fenaroli	**Telephone:** (530) 757-5777	**Email:** bfernandez@cps.ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Ruminants play an important role in sustainable agricultural systems. Sheep are particularly useful in converting vast renewable resources from rangelands, pasture and crop residues into edible food. Sheep producers in California are dependent on the use of inexpensive forage for grazing. In addition to the economic benefits associated with such practices, the manure produced by the sheep serves as an organic fertilizer that improves soil structure and contributes to plant nutrition. This grazing system in Imperial County involves intensive grazing for short time periods. Up to 1,500 head of sheep are typically turned into a 40 acre field. Once the forage is grazed close the sheep are moved to another field. If the next field is located nearby (within 2 to 3 miles), this is often accomplished by herding them along public roads. California ranks second in the nation for sheep production and contributes $50 million to the California agricultural industry, producing over 3 million pounds of wool and 325,000 lambs annually. The sheep industry relies heavily on the ability to graze crop, vineyard and orchard fields throughout California.

The Imperial Valley has long been recognized as the “winter salad bowl” for the United States. With over 100,000 acres of fresh market vegetable production with a farm gate value of one half billion dollars and nationwide product distribution, the industry has a tremendous impact on the local economy as well as the nationwide food supply. Successful production of fresh market vegetables is dependent on the capacity of growers to rotate vegetable crops with crops that provide a suitable economic return while reducing pest pressure in the subsequent vegetable crop. Alfalfa is the standard rotation with vegetable crops in Imperial County. The integration of crop and animal agriculture can result in detrimental consequences. Contamination of agricultural produce with *Escherichia coli* O157:H7 has been documented through application of raw manure, use of contaminated irrigation water and deposition of feces by livestock and wild animals. Recent outbreaks of human disease in California have been associated with consumption of raw spinach and lettuce.

Due to food safety concerns, over 99% of the volume of California leafy greens, including those grown in the Imperial Valley, are produced and marketed under the California Leafy Green Products Handler Marketing Agreement (LGMA). The participating companies have committed themselves to sell products grown in compliance with the food safety practices accepted by the LGMA board. The board recognizes the need for further research to validate or adjust these guidelines based on scientific evidence. One area stated by LGMA as needing additional research relates to setback distances, or "buffer zones." There is a paucity of information related to appropriate combinations of time and distance between livestock operations and crop systems, particularly in terms of pathogen survival in animal feces, soil, and aerosols, as well as the pathogen movements through wind, water or flies. The LGMA suggests that a distance of 400 feet exist between a concentrated animal feeding operation and the edge of a crop and 30 feet for grazing lands/domestic animals.

While considerable attention has been paid to the prevalence of potential food-borne disease organisms in cattle, less is known about the epidemiology of *E. coli* O157:H7 in grazing sheep. Similar to cattle, prevalence of this organism in sheep varies considerably with levels as low as 0.2% being reported in some studies and as high as 68% in others. Given that there are approximately 650,000 sheep and lambs in California, and as many as 150,000 in the Imperial Valley on a seasonal basis, knowledge of the ecology of important human pathogens associated with sheep is essential. Therefore, the primary objective of this research project was to develop data that can be used to accurately define "buffer zones" appropriate for grazing of sheep near production of leafy greens.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Fecal and soil samples were collected from alfalfa fields where bands of sheep, consisting of between 1,200 and 1,800 head of approximately 6-month old lambs from numerous locations throughout the Western United States, were grazing or had recently grazed. For each collection 40 samples of fresh feces (minimum 10 g) and 40 samples of soil (minimum 10 g) were placed into individual containers and immediately placed on ice. Samples were shipped overnight by courier and processed within 24 hours of collection. Most bands of sheep were sampled once, however four groups were sampled twice and two groups were sampled three times.

Standard microbiological techniques were used to enumerate commensal *E. coli,* and to identify *E. coli* O157:H7 and *Salmonella* spp. Mean commensal *E. coli* and coliform bacteria concentration in feces and soil was determined by dispersing 1.0 g of feces or soil in 39 mL of phosphate buffered solution (PBS) using a rotational mixer for 5 minutes. The feces/soil–PBS solution was then The *E. coli* concentration in diluted feces/soil–PBS solution was determined by direct membrane filtration and culturing onto CHROMagar EC (Chromagar Microbiology, Paris, France) at 44.58C for 24 hours (American Public Health Association, 1989).

Fecal and soil samples were enriched for *Salmonella* spp. using US EPA Method 1682 (United States Environmental Protection Agency, 1998). *Escherichia coli* O157 samples were enriched in tryptic soy broth (TSB), exposed to an immunomagnetic separation step, and then cultured on cefixime potassium tellurite sorbitol MacConkey (CT SMAC) and Rainbow agar containing novobiocin and tellurite (NT Rainbow) as previously described. *E. coli* O157:H7 colonies identified were further analyzed by real-time polymerase chain reaction (RT-PCR) to detect presence of virulence genes. Pulsed-field gel electrophoresis was performed on *E. coli* O157:H7 isolates with the standard PulseNet procedure by using XbaI restriction enzyme.

Air samples were collected from the edge of the field where the sheep were grazing. Samples were collected in duplicate or triplicate at each collection distance, which consisted of 2, 5, 10, 20, 50, and 100 meters from the field edge. A sample was also obtained from an upwind location to serve as a control. The prevailing wind direction was used to determine which side of the field was sampled. The Microbial Air Monitoring System (MAS) – 100Eco (Merck) was used to test levels of total bacteria. The MAS-100 aspirates air at the rate of 100 liters of air per minute, and after initial tests it was determined that a sampling time of 10 minutes was appropriate given the low concentrations of bacteria in the air. Specific agar (Chromocult) was used to enumerate colonies, which was converted to colony forming units per cubic meter of air. Air samples were obtained the same time/day as the fecal/soil collections. Air samples were collected on five additional occasions as well. Meteorological data (wind speed, temperature, relative humidity, rainfall) was recovered from the closest California Irrigation Management Information System (CIMIS) weather station on a daily basis.

The completion of this project required collaborative efforts from many individuals and groups. The California Woolgrowers Association provided sheep-producer contacts in the Imperial Valley. The sheep producers were amazingly cooperative. They allowed researchers free access to their flocks and answered all questions. Without that assistance, the project could not have occurred. University of California Cooperative Extension (UCCE), Holtville, provided laboratory space to conduct the air sampling portion of the project. The Principal Investigator (PI) was also fortunate to be able to enlist a staff member from a researcher's laboratory to assist with sampling efforts. The original collaborator from UCCE (Dr. Henderson) left Holtville after the spring sampling, so the project is very grateful to the Holtville center for providing support. Finally, the staff in the Atwill Water and Foodborne Zoonotic Disease Laboratory, UC Davis, must be commended for the very rapid and complete analysis of all the samples collected.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Samples were collected from January 2011 to March 2011 and again from October 2011 to December 2011. Total precipitation during these two time periods was 1.84 inches (2011 total precipitation was 2.04 inches), average air temperature was 56.5^{0}F and average wind speed was 4.2 mph. A total of 1,440 individual fecal and soil samples were collected throughout the project. Of the 720 fecal samples, 13 (1.8%) were found to be positive for *E. coli* O157:H7, and of the 720 soil samples, 3 (0.4%) were positive for *E. coli* O157:H7. The highest prevalence in feces at any one sample collection was 10% (4 positive out of 40 samples). *E. coli* O157:H7 positive fecal samples were obtained at 7 of 18 sample collections and *E. coli* O157:H7 positive soil samples were obtained at 2 of 18 sample collections. There were no statistically significant differences in the proportion of positive samples on any of the collection dates. No significant associations between prevalence and management factors such as duration of grazing, irrigation events or source of sheep were detected. There was also no association between duration of sheep grazing and presence of bacteria in the soil. Pulsed-field gel electrophoresis was performed on several of the *E. coli* O157:H7 isolates recovered. In general, isolates from the same date and same group of sheep shared a PFGE pattern, while other groups of sheep sampled on different dates had unique patterns.

Salmonella spp. was detected in 6 (0.8%) fecal samples and 3 soil samples (0.4%). All positive soil samples were obtained on the same sampling date, while fecal positive samples were obtained from 3 sampling dates. Interestingly, a significant precipitation event (over 1 inch within a 2-day period) occurred a few days before the *Salmonella* positive soil samples were collected.

The mean commensal *E*. coli and coliform bacteria concentration in feces and soil were also measured. The overall mean coliform count from feces over the entire project was 1.05 × 107 CFU/g feces [colony-forming unit (CFU)], while mean commensal bacteria count from soil was 3.5 × 103 CFU/g soil. Finding coliform bacteria in feces and soil reassured that shipping the samples via overnight courier did not result in significant reduction of bacterial counts.

Air sampling revealed that few bacteria were being dispersed through the air. The maximum number of colony forming units per cubic meter of air was 16.5 from a sample obtained on October 21. The mean number of CFU/m^3 was greatest at a distance of 2m, however a one-way analysis of variance demonstrated that there was no statistically significant difference at any distance measured, nor was there significant correlation between distance and bacterial count. Using linear regression it was determined that there were no significant correlations between fecal/soil *E. coli* counts and aerosol bacterial counts at any of the distances measured.

The outcomes of the project match very closely with the original objectives. Many of the analysis returned non-significant results, such as the relationship between management factors and prevalence of fecal pathogens. It is the belief of the project team that for many of the analyses, this was related to the very low prevalence of pathogens detected. While larger sample sizes may have resulted in some significant findings, that was somewhat limited by laboratory capacity.

Dr. Bruce Hoar, University of California, Davis, presented a poster of interim results at the 2011 Center for Produce Safety (CPS) symposium in Florida, and final research results at the 2012 CPS symposium in Davis, California. The 2011 symposium had 249 attendees, and 83% of survey respondents rated the relevance of the posters as very valuable or somewhat valuable. The 2012 symposium had 325 attendees and survey respondents rated the relevance of this project to the fresh produce industry as 1.6 (1=very important; 5=very unimportant).

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Integrated livestock and crop operations are beneficial to producers of both products. Crop residues are an important source of food for livestock, however domestic and wild animals represent a potential source of foodborne pathogens. Results from this project will prove useful to both sheep growers and leafy green vegetable producers in the Imperial Valley and beyond. Finding a low prevalence of potential human pathogens in fecal material and soil associated with grazing sheep will provide sheep owners with data they can use to negotiate access to potential grazing areas. This study has confirmed previous work by Dr. Hoar's group indicating that grazing sheep (as opposed to feedlot sheep) have very low prevalence of infection with *E. coli* O157:H7 and *Salmonella* spp.

The leafy greens industry can utilize this data on prevalence of potential human pathogens in feces and soil and concentration of airborne bacteria to confirm that the LGMA proposed distances for buffer zones are reasonable and should provide sufficient protection from potential contamination associated with sheep grazing. While the prevalence of pathogens was low, it was not zero, therefore intrusion of a crop by sheep does warrant a thorough risk assessment, as outlined in the LGMA guidelines.

The California sheep industry generates over $50 million annually to the state economy, while the leafy green industry in the Imperial Valley alone generates over $500 million at the farm gate. Clearly, the economic implications of integrating these two industry segments are significant.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The results from this and previous studies indicate that sheep grazing on alfalfa in the Imperial Valley have a low prevalence of *E. coli* O157:H7 and *Salmonella* spp. in their feces and that these bacteria are rarely found in soil from fields with grazing sheep. Airborne dispersal of bacteria is possible, however the concentration of bacteria and distance traveled are both minimal. Based on Dr. Hoar's results, the current LGMA guideline of 30 ft. between grazing lands/domestic animals and the edge of a crop is more than adequate to minimize any potential contamination of nearby crops.

The information generated by this project will be helpful to other states and specialty crop stakeholders as they move forward with developing sustainable production practices on land used for agriculture. Specialty crop producers will be reassured to know that sheep grazing in nearby fields represent a very low risk of contamination to their products. The current guidelines that suggest a minimum of 30 ft.

between grazing lands/domestic animals and the edge of a crop will provide an adequate buffer distance to minimize potential crop contamination. While individual animal groups and individual crop commodities present unique situations (and therefore a risk determination for other animal/crop combinations would be useful), the information provided in this study represents the best available knowledge related to sheep grazing on alfalfa.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Presentations:

Hoar, B. 2012. Session I, Good Agricultural Practices – Buffer Zones and Animal Vectors. 3rd Annual CPS Produce Research Symposium. University of California, Davis. June 27.
Hoar, B. 2011. Poster session. Developing buffer zone distances between sheep grazing operations and vegetable crops to maximize food safety. 2nd Annual CPS Produce Research Symposium. Orlando, FL. June 28.

Other:

The final research report written for the CPS Technical Committee is posted on the CPS website https://cps.ucdavis.edu/grant_opportunities_awards.php

The final research report will be included in the CPS Global Research Database https://cps.ucdavis.edu/global_research_database.php

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 61	**Project Title:** Developing a program to educate the walnut supply chain as it pertains to product handling and safety	
Grant Recipient: Regents of the University of California, Davis, Center for Produce Safety	**Grant Agreement No:** SCB10061	**Date Submitted:** December 2012
Recipient Contact: Bonnie Fernandez- Fenaroli	**Telephone:** 530-757-5777	**Email:** bfernandez@cps.ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Walnuts have recently been implicated in two food borne illness outbreaks caused by *E. coli* O157:H7. Recent *Salmonella* outbreaks associated with almonds and more recently pistachios have also highlighted the vulnerability of nut crops as potential vectors for food borne pathogens. The California walnut industry has a critical interest in preventing outbreaks associated with walnuts and limiting the scope should there be such an outbreak. Various print resources are available to walnut handlers, including Food and Drug Administration (FDA) Guidelines, University Good Agricultural Practices (GAP) programs, and a comprehensive *Nut Safety Handbook* prepared by the Grocery Manufacturers Association. Nevertheless, many walnut handlers have not fully adopted the recommendations from these resources. Since a food borne illness outbreak caused by one handler could cause substantial economic damage to all handlers, enhancing the food safety and security programs of all handlers up to a high common level offers the best protection for the industry as a whole. This training program was constructed to raise the level of awareness and understanding of food safety in the walnut industry and to put practical food safety tools in the hands of California walnut handlers.

Tree nuts, including walnuts, have been implicated as vectors of food borne illness in the past several years. Walnuts are a major crop in California that contributes substantially to the agriculture economy. Consumer perceptions that walnuts may not be safe to eat could result in large losses for all walnut growers and handlers. The California Walnut Commission (CWC) had recognized that the level of food safety awareness among walnut handlers was uneven with some operators having little or no experience with constructing food safety programs.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

This was not a traditional research project, but rather a teaching and training project. As such, the project did not use research methods. Rather a two part education and training program was designed to provide necessary background information and guided hands-on training to teach walnut handlers how to assess and address risks in their operations. This consisted of on-line food safety training followed by a series of hazard analysis workshops.

1. The self-paced on-line food safety learning program consisted of a series of twelve PowerPoint presentations with a multiple choice exam following each one. The purpose was to introduce the important concepts of food safety so that participants had a common understanding and common food safety vocabulary. Upon completion of the on-line training, each received a certificate of completion.
2. Groups of handlers then got together and Dr. Devon Zagory of Devon Zagory & Associates LLC, led the group through a step-by-step hazard analysis. These workshops took place in 2012 on February 1 in Parlier, California (CA), February 7 in Chico, CA, and February 15 in Modesto, CA.
3. All participants prepared and sent flow diagrams of their operations in advance of the workshops.
4. Before the hazard analysis workshop, a composite generic flow diagram was constructed that contained all of the process steps from all of the companies that were to participate in the workshop.
5. During the workshops, as participants went through the hazard analysis, all of the hazards/risks identified at each process step were recorded.
6. Dr. Zagory and the participants also discussed and agreed upon interventions and programs that the group decided were appropriate to address.
7. Dr. Zagory assembled documents, forms, lists, policies and other materials necessary for the identified programs and interventions.
8. A hazard/risk analysis was assembled for each company for the process steps included in the flow diagram for that company.
9. Appropriate documentation was assembled for those risks by Dr. Zagory.
10. All of the materials were put in an electronic food safety manual specific to each operation. The food safety manuals included:
    1) A detailed hazard analysis for those unit operations that were included in each company's flow diagram.
    2) Suggested actions to address the identified hazards.
    3) Suggested validation strategies.
    4) Supporting materials specific to the activities in each operation:
        i. These included such things as training materials, sign off sheets, sample policies, sample sanitation standard operating procedures, and information supporting the food safety program.

NSF Davis Fresh, now called NSF Agriculture, played a key role assisting in the development of the on-line training modules. NSF hosted the training on their servers and provided the tracking of participants and awarding of certificates. Eileen Chase of NSF Agriculture participated in some of the hazard analysis workshops as well.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

throughout California to lead walnut handlers through the process of developing a hazard analysis for their individual operations. The workshop format was meant to teach participants the process of developing a hazard analysis, which forms the basis of a rigorous food safety program. Relatively few members of the walnut industry or the California produce industry in general understand the development and role of a hazard analysis in food safety management systems. This approach was developed specifically to address that need.

The training took longer to develop than anticipated, in part because members of the CWC were very specific in what they wanted included and excluded in the training. Multiple rounds of revisions were required until everybody was satisfied with the training modules. The original proposal called for two sets of workshops to teach how to develop trace/recall and food defense programs. The CWC decided this was unnecessary. Upon investigation it was discovered most handlers already have trace/recall and food defense programs. In addition, the Food and Drug Administration (FDA) is developing regulations as part of the Food Safety Modernization Act. Most handlers would rather wait to see what FDA requires before putting further resources into refining these programs. For these reasons it was agreed to suspend the final workshops. Further investigation on the scope of the participation is underway. While the numbers seemed small, it is anticipated that the percent of the industry represented by these participants will be high.

Due to the sensitivity of food safety issues in the industry, CWC did not send a questionnaire about the workshops to their members (Note: the survey about the CPS symposium was sent to registered attendees; it was not pertinent to a walnut handler who did not attend the symposium). The CWC opted to make personal contact with handlers concerning the risk analysis workshops and materials. During the follow-up, CWC contacted approximately 30% of the handlers who attended. CWC wanted to explore the value of the project results with the handlers by means of site visits and phone calls. This allowed CWC to interpret their understanding of the risk analyses and build assurances with the handlers without creating privacy concerns. With the stress of production and harvest schedules, and the privacy concern, CWC felt handlers would be reluctant to reply to a questionnaire or survey.

Dr. Devon Zagory presented a poster of interim results at the 2011 CPS symposium in Florida, and a poster of final research results at the 2012 CPS symposium in California. The 2011 symposium had 249 attendees, and 83% of survey respondents rated the relevance of the posters as very valuable or somewhat valuable. The 2012 symposium had 325 attendees; 72 completed and returned a survey about the event. Survey respondents noted the poster session provided information with practical application of the project results. A copy of the 2012 survey and responses are included with this report as an attachment.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The beneficiaries of the training were the walnut-handler attendees at the three hazard analysis workshops and those handlers who went through the on-line food safety training. The CWC reported that the handlers were positive about the training sessions. The flow chart enabled them to develop a HACCP (hazard analysis and critical control points - a systematic preventive approach to food safety risks analysis) based on physical, chemical, and microbiological factors at each handler's site. The walnut handlers felt understaffed in risk analysis, and this gave them a tool to use across the industry. The CWC represents walnut handlers in 15 California counties, from Visalia in the south to Tehama to the north. There are 81 handlers in California, representing 100% of the US walnut production. The three regional workshops attracted about 150 participants. CWC estimated that 75% of the handlers they contacted reported the training workshop was very worthwhile, and provided them with a valuable tool that would be used to perform risk analyses at their facilities.

Estimating the economic impact of food safety activities is always difficult since it relies on estimating the value of something not happening rather than the value of what happened. While it cannot be known with assurance, it is possible that these training sessions will avoid a food borne illness outbreak that would otherwise have happened. If so, then the economic benefit will have been enormous.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

This project required working with several different organizations for computing and information services. More time should have been allowed for uploading and delivering of on-line training. Harvest schedules caused delays in publicizing and organizing the training and in inducing handlers to participate.

In spite of the delays, all the goals of the project were achieved.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Presentations:
Zagory, D. 2012. Poster session. 3rd Annual CPS Produce Research Symposium. University of California, Davis. June 27.
Zagory, D. 2011. Poster session. 2nd Annual CPS Produce Research Symposium. Orlando, FL. June 28.

Other:
The final report (written for the CPS Technical Committee) is on the CPS website
https://cps.ucdavis.edu/grant_opportunities_awards.php
The posters are available on the CPS website
https://cps.ucdavis.edu/poster_session.php
The Produce Marketing Association (PMA) has 2 links to information presented at the 2012 CPS symposium
http://www.pma.com/resources/food-safety-resource-center/information
http://www.pma.com/sites/default/files/education/DavisGoldCircle/index.htm

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.:	Project Title:	
62	The likelihood of cross contamination of head lettuce by *E. coli* O157:H7, *Salmonella* and norovirus during hand harvest and recommendations for glove sanitizing and use	
Grant Recipient: Regents of the University of California, Davis, Center for Produce Safety	**Grant Agreement No.:** SCB10062	**Date Submitted:** December 2013
Recipient Contact: Bonnie Fernandez-Fenaroli	**Telephone:** 530-757-5777	**Email:** bfernandez@cps.ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

As produce consumption has increased in the United States, there has been a marked increase in reports of foodborne disease related to produce and a growing public concern over food safety. In addition, an emerging threat to food safety, human noroviruses are now recognized as the leading cause of foodborne illnesses in the U.S. Heightened food safety awareness in the leafy green industry has driven important procedural changes in the way leafy greens are handled in the harvest environment. One such change has been the widespread requirement that gloves be used by all persons coming into contact with pre- or post-harvest produce. However, it is unclear if this practice reduces the likelihood that pathogens are transferred from the harvest environment to gloves, with subsequent cross-contamination of produce. Also uncertain, is the impact of glove composition, frequency of glove changing, and efficacy of glove disinfection using glove-dunk buckets containing chlorine, which is a common practice in lettuce-harvesting operations.

In this study, the impacts of glove use (glove type/composition) and disinfection (with traditional and novel sanitizers) on cross-contamination of raw head lettuce by bacterial (*E. coli* O157:H7, *Salmonella*) and viral (norovirus) pathogens during harvest was investigated.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Research activities for this project are conducted by the University of Georgia (UGA) subaward principal investigator.

Re-creating field conditions in the laboratory was a priority from the start of this project. Field data was collected during a visit to the Central CA Valley, where UGA investigators followed iceberg lettuce-harvesting crews for one week. Gloves worn by lettuce harvesters were shipped to UGA and analyzed for levels of accumulating soil, lettuce debris, lettuce sap and moisture. This information was the basis of protocols developed to re-create "soiled" gloves (gloves with soil, lettuce debris, and lettuce sap on them) in the lab. The next process analyzed was how well pathogens on the surface of gloves could be killed by a novel sanitizer (levulinic acid plus SDS) or traditionally used sanitizers like a Purell hand sanitizer, or chlorine solution (50 – 200 ppm). Different types of gloves were investigated (Uniseal Latex, Uniseal Nitrile, Ansell Canner's, Glove Plus Latex, and Fisherbrand Latex) using both clean and gloves that were "soiled" in the lab. Pathogen transfer to gloves during glove application and from gloves to heads of lettuce was also investigated with noroviruses (using murine norovirus, a model virus representing human norovirus).

High levels of virus were demonstrated to be transferred to gloves during the process of putting on gloves. Also demonstrated that noroviruses on gloves can be killed using waterless hand sanitizers (Purell or 5% levulinic acid plus 2% SDS foam) (90-99% reduction) or by treating gloves (rubbing them together) in a bucket containing 50 ppm chlorine (pH 7) (99% killing of virus on latex gloves and 99.9-99.99% killing of virus on nitrile gloves). Bacterial pathogens *E. coli* O157:H7 and *Salmonella)* were also killed in these "glove-dunk buckets" containing chlorine concentrations of at least 50 ppm (pH 7). When bacteria contamination was low on gloves (≤ 1,000 bacterial cells), complete inactivation was achieved; if bacteria contamination was high (10,000 to 1,000,000 bacterial cells), 99.99 to 99.9999% killing of bacteria could be achieved, but complete killing of all bacterial cells was not always achieved, especially when the bacteria were on nitrile gloves. Alternative sanitizers can also be used to kill pathogens on gloves, but the lower effectiveness of Purell and the high cost of levulinic acid plus SDS sanitizers make these alternatives less attractive.

Taken together, the following recommendations are made: Strict hand hygiene is imperative prior to glove application. To minimize contamination by noroviruses disinfecting gloves in a chlorine (at least 50 ppm; pH 7) glove-dunk bucket after each time gloves are applied is recommended. Alternatively, or in addition, consider double-gloving or wearing glove liners. [Note: if non-disposable glove liners are worn, lines should be laundered under sanitizing conditions (hot water) each day after use.] To minimize contamination by bacterial pathogens, gloves should be disinfected in chlorine (at least 50 ppm) glove-dunk buckets before beginning work, before each break or lunch period, and when returning back to work after each break or lunch period. Gloves should be rubbed aggressively, palms-together for 5-10 seconds while gloved hands are immersed up to the wrist in the bucket. Sponges should not be used with glove-dunk buckets. Free chlorine and pH should be measured and maintained above 50 ppm and neutral pH in the glove-dunk buckets. Measurements should be taken before use and should be covered when not in use to prevent chlorine dissipation. Buckets may need to be refreshed after each break period, especially when latex gloves are used or if lettuce or soil debris begins to accumulate. Gloves should not be taken home by employees (cannot control what the gloves will be used for at home). Disposable gloves should be discarded at the end of each day of use.

Collaborators: Food Safety Staff at Dole Fresh Vegetables.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The major accomplishment of this study is providing recommendations for glove use and sanitation that are backed by scientific support. Communication of these findings to a broader audience and implementation of recommendations will be the next important step in achieving the ultimate goals of reducing pathogen cross-contamination in the harvest environment and improving the safety of fresh and minimally processed leafy greens.

Dr. Jennifer Cannon, University of Arizona, presented a poster of interim results at the 2012 CPS Produce Research Symposium in California, and final research results at the 2013 CPS Produce Research Symposium in New York. The 2012 symposium had 325 attendees and survey respondents rated the relevance of the research as important. The 2013 symposium had 300 attendees and survey respondents rated the relevance of this project to the fresh produce industry as 1.8 (1=very important; 5=very unimportant).

In addition to presentation of results at the annual CPS Produce Research Symposiums, the following activities will provide information for implementation of recommendations:

Final reports are posted on the CPS website (https://cps.ucdavis.edu/grant_opportunities_awards.php) after the June symposium.

CPS works with scientists to publish results in scientific journals after the project is completed. Awards and abstracts can be found on the CPS website (www.cps.ucdavis.edu).

The Center for Produce Safety's Board of Directors and members of the Technical Committee distribute a series of information throughout the year on their websites, and through presentations, meetings and webinars. An example of this occurred on July 18, 2013 when Western Growers Association held a webinar for their members. Information discussed at the webinar is now part of the "Key Learnings" on the CPS website: https://cps.ucdavis.edu/amass/documents/document/186/Key%20Learnings_2013%20CPS%20Symposium.pdf

The following websites provide additional resources on the final reports and symposium proceedings:
Center for Produce Safety: https://cps.ucdavis.edu/resources.php
Produce Marketing Association: http://pma.com
Western Growers Association: http://www.wga.com/

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Direct beneficiaries include those involved in the production and harvesting of iceberg lettuce. Indirect beneficiaries include those involved in the harvesting or handling of fresh or minimally processed produce. These groups may find the most benefit in the recommendations of glove use and sanitation provided. The state produces about 70 million carton equivalents of iceberg lettuce per year. There are about 60 iceberg lettuce handlers in the State handling product for several hundred iceberg lettuce growers.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The field study conducted and the conversations with persons working closely with lettuce harvesting crews were imperative to the study. Doing this in the early months of our project turned out to be very well timed. The firsthand experience gained by following lettuce-harvesting crews around for an entire week allowed adjustments to be made to the experimental plan that would make the experiments more relevant to the target audience. An understanding was also gained of the operation speed, which was kept in mind as glove-disinfecting strategies were developed. Test only practical solutions were developed that could be applied directly to the target audience.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Publications and Presentations

Bulletins, Reports or Technical Communications

2013 Cannon, JL. and G. Kotwal. *Norovirus Cross-Contamination With/Without Gloves.* At-a-Glance. Vol. 22 No. 1. March 2013 issue. Center for Food Safety, University of Georgia publication.

Invited Presentations

2012 *Recommendations to Prevent Cross-contamination During Hand Harvest.* Western Food Safety Summit. Hartnell College, Salinas, CA. May 11, 2012.

Conference Abstracts/Proceedings

2013 Kotwal, G. and **JL Cannon.** Norovirus cross-contamination during produce handling with or without gloves. Center for Food Safety Annual Meeting, 2013. Atlanta, GA. Mar. 5, 2013.

2012 Kotwal, G., Q. Wang, and **J.L. Cannon.** Enteric Virus Contamination of Food Worker Gloves and Cross-Contamination during Produce Harvest or Preparation. USDA-AFRI Food Virology Collaborative (NoroCORE) Meeting. November 11-12, 2012.

2012 **Cannon, JL,** MC Erickson, and MY Habteselassie. The likelihood of cross-contamination of head lettuce by *E. coli* O157:H7, *Salmonella* and norovirus during hand harvest and recommendations for glove sanitizing and use. Western Food Safety Summit. Hartnell College, Salinas, CA. May 10, 2012.

2012 **Cannon, JL,** MC Erickson, and MY Habteselassie. The likelihood of cross-contamination of head lettuce by *E. coli* O157:H7, *Salmonella* and norovirus during hand harvest and recommendations for glove sanitizing and use. Center for Produce Safety; Produce Research Symposium. University of California-Davis. Sacramento, CA. June 27, 2012.

2011 **Cannon, JL,** MC Erickson, and MY Habteselassie. The likelihood of cross-contamination of head lettuce by *E. coli* O157:H7, *Salmonella* and norovirus during hand harvest and recommendations for glove sanitizing and use. Center for Produce Safety; Produce Research Symposium. Orlando, FL. June 28, 2011.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 63	Project Title: Influence of the pre-harvest environment on the physiological state of *Salmonella* and its impact on increased survival capability	
Grant Recipient: Regents of the University of California, Davis, Center for Produce Safety	**Grant Agreement No.:** SCB10063	**Date Submitted:** December 2013
Recipient Contact: Bonnie Fernandez-Fenaroli	**Telephone:** (530) 757-5777	**Email:** bfernandez@cps.ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Since the mid 1990s, *Salmonella* has been implicated in multiple outbreaks of foodborne illness tied to the consumption of fresh fruits, vegetables, and tree nuts. Exposure to even low levels of *Salmonella* is thought to be sufficient to cause illness, thus survival of the organism from contamination to the point of consumption is an important risk factor. Although the specific strains of *Salmonella* associated with outbreaks have differed, it is clear that some *Salmonella* are able to persist in a wide range of environments that would be expected both before and after harvest of produce and tree nuts. Exposure of *Salmonella* to large swings in moisture, temperature, and nutrient levels are expected in these environments. Introduction of *Salmonella* to produce may occur at any point in the farm-to-fork continuum and the contamination may be in one of many forms: dry (e.g., dust), wet (e.g., decaying organic material), solid (e.g., food-contact surface), and liquid (e.g., water). The relative tolerance of *Salmonella* to environmental conditions is known to differ among strains of *Salmonella* and it is likely that an enhanced ability to survive plays an important role in outbreaks of foodborne illness.

Salmonellosis causes an estimated 1 million illnesses every year and causes more hospitalizations and deaths than any other foodborne pathogen (CDC, 2011 http://www.cdc.gov/vitalsigns/FoodSafety/index.html). Food safety interventions have been successful in reducing the rate of other types of foodborne illness, but rates of salmonellosis have not declined at all in the past 15 years. A better understanding of the factors that influence survival of *Salmonella* on produce and tree nuts is needed to help inform scientifically-targeted controls for this organism in these foods.

In this study, the impact of pre-and post-harvest environmental factors on drying tolerance was evaluated. Strain, growth temperature, medium composition and form (solid surface or broth) were evaluated. All fourteen strains of *Salmonella* evaluated survived better during drying and persisted for a longer time when they were cultured on solid agar surfaces than when they were cultured in liquid medium. *Salmonella* strains that are able to produce cellulose and fimbrae (also called rdar morphotype) survived better during desiccation than strains that did not. Growth conditions that enhance desiccation tolerance (rdar morphotype, growth on agar) did not confer chlorine or acid tolerance. It is recommend that rdar-positive strains of *Salmonella* should be included for research studies that involve desiccation of *Salmonella* and strains should be cultured and collected from agar medium.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Research activities for this project were conducted by University of California, Davis subaward Principal Investigator (PI).

Project objectives were:
1. to evaluate the impact of pre-and post-harvest environmental factors on the formation of aggregative fimbriae and cellulose
2. to characterize the role of thin aggregative fimbriae and cellulose
   a. in the desiccation tolerance and long term survival of *Salmonella*
   b. in acid tolerance and resistance to chlorine

Objective 1. To evaluate the impact of pre- and postharvest environmental factors on the formation of aggregative fimbriae and cellulose.

Construction of a rdar-negative *Salmonella*. In order to better understand the mechanisms of rdar morphotype and its effect on desiccation, an rdar-morphotype negative derivative (or mutant) of *Salmonella* Enteritidis PT30 (SEPT30) was constructed (SEPT30D). The rdar morphotype is related to cellular production of cellulose and fimbriae, which is regulated by the *adr*A gene. A regulatory gene (*adr*A) associated with the rdar morphotype (production of cellulose and aggregative fimbrae) was targeted. A gene conferring kanamycin-resistance was inserted into the adrA gene. Several methods were used to confirm that the insertion was successful. SEPT30D was shown to have a negative rdar morphotype.

Examination of multicellular structures. The wildtype (SEPT30) and mutant (SEPT30D) were cultured in LB broth, diluted and plated onto LB no salt agar (LBNSA); plates were incubated at 28°C for 2 days to encourage the expression of the rdar morphotype. Cells were examined by Scanning Electron Microscopy (SEM). The wildtype SEPT30 appeared to be embedded in significant amounts of extracellular substances while SEPT30D was free of this extracellular material. SEPT30D produced equivalent amounts of fimbrae, but significantly lower amounts of cellulose than SEPT30 on LBNSA.

Effect of substrate (nutrients) on expression of the *adr*A gene. Microorganisms are exposed to a wide range of nutrient levels in the production environment. Low nutrient broth (0.1% LBB), broth (LBB), agar (LBA), and low osmotic strength agar (LBNSA) were used to culture *Salmonella*. Cells grown in 0.1% LBB and on LBA and LBNSA showed significantly up-regulated expression of the *adr*A gene after 12 h of incubation at 28°C compared to cells grown in LBB (baseline). The relative expression of *adr*A for cells grown on LBNSA was 22-fold that observed on LBB and much higher than observed for either 0.1% LBB or LBA. These data suggest that when *Salmonella* grows under conditions of low nutrient availability, in the presence of low levels of salts, and on solid media the expression of *adr*A (and thus cellulose and fimbriae) is increased.

Influence of growth temperature on desiccation tolerance. *Salmonella* may be exposed to a wide range of temperatures in the environment. Although the optimum temperature for growth of this organism is 37°C, rdar expression is often measured at 28°C. SEPT30, SEPT30D, and rdarNeg were cultured in tryptic soy broth (TSB) and on tryptic soy agar (TSA) at 23, 28, and 37°C for 48 h (23 and 28°C) or 24 h (37°C). The cells were collected, suspended in sterile MilliQ water and10 µl inoculated onto glass coverslips. The inoculated glass coverslips were held in a desiccator with relative humidity (RH) adjusted to 72% at room temperature for up to 5 days. Trends at all three temperatures were the same; at all temperatures significantly better survival was observed for plate-grown cultures. The greatest separation of survival of broth and plate-grown cultures was observed at 23°C.

***Salmonella* strains and rdar morphotype.** Rdar morphotype is linked to production of thin aggregative fimbriae and cellulose in *Salmonella*. Fourteen *Salmonella* isolates (outbreak or food strains) were screened for rdar morphotype using a standard method of plating broth cultures onto LBSNA; seven were characterized as rdar-positive and seven were rdar-negative. Some or all of these isolates were used for further studies. To determine desiccation tolerance, cell suspensions were inoculated onto glass coverslips and held in desiccator at a relative humidity of 72-74% for up to 7 days. In the environment *Salmonella* may form colonies on solid surfaces or in aqueous solutions. Thus, *Salmonella* strains (seven rdar+ and seven rdar- strains) were grown on agar medium or in broth. Within rdar morphotype groupings, strains that were cultured on agar survived significantly better than those cultured in broth. Rdar+ strains survived significantly better rdar- strains; survival of rdar+ strains grown in broth was not significantly different from rdar- strains grown on agar.

Objective 2. To characterize the role of thin aggregative fimbriae and cellulose in the desiccation tolerance and long term survival of *Salmonella* and in acid tolerance and resistance to chlorine.

Desiccation tolerance of SEPT30 and SEPT30D under short-term simulated conditions. The influence of rdar morphotype on desiccation tolerance was evaluated by culturing SEPT30 and SEPT30D on LBNSA at 37°C for up to 5 days. The 1-, 3- and 5-day old cultures were collected, cell suspensions were inoculated onto glass coverslips and held in desiccator to dry at a relative humidity of 72-74% for up to 5 days. No significant difference ($P<0.05$) was seen for the numbers of recovered cells between 1-, 3-, and 5-day old cultures after 2 days of drying.

Desiccation tolerance and long-term survival differences between the mutant and wild type. *Salmonella* SEPT30 and SEPT30D were cultured on TSA, cells were collected, and almonds were inoculated and dried for 3 days. Almonds were stored at 23ºC and 72% RH for up to 5 months. Counts on almonds inoculated with SEPT30D were 0.8 log CFU/g lower than for SEPT30 after 3 days of drying. Declines of both strains were similar up to two months after which SEPT30D declined more rapidly than SEPT30.

Sensitivity of SEPT30, SEPT30D and an rdar-negative *Salmonella* to chlorine and acid. The influence of rdar morphotype on chlorine and acid sensitivity was evaluated by culturing SEPT30, SEPT30D, and rdar negative *Salmonella* Oranienberg (rdarNeg) in TSB and on TSA in at 37°C for 24 h. The cells were collected, suspended in sterile MilliQ water and 10 µl was inoculated onto glass coverslips. The inoculated glass coverslips were dried in a desiccator with relative humidity (RH) adjusted to 72% at room temperature. No significant difference was observed in sensitivity to 5 % citric acid or 5 ppm free chlorine between broth or agar-grown cultures or among the rdar-positive or rdar-negative strains.

The following is a list of significant results and accomplishments:

1. An rdar-negative derivative of *Salmonella* Enteritidis PT30 was constructed by insertion into the adrA gene (a regulatory gene for cellulose production).
2. The data showed that the rdar-negative derivative produced significantly lower amounts of cellulose during growth on agar medium.
3. The data showed that while the rdar-negative derivative was not significantly more desiccation tolerant on glass surfaces during short storage times, decreased survival was observed on almonds, particularly after longer storage.
4. The impact of environmental conditions (growth temperature, solid, and liquid medium) on desiccation tolerance was determined.
5. The sensitivity of rdar-negative and rdar-positive *Salmonella* to acid and chlorine exposure was evaluated; no significant differences between the two were noted.

Based on the results of this study, the PI recommends that rdar-positive strains of *Salmonella* should be included for research studies that involve desiccation of *Salmonella* and strains should be cultured and collected from agar medium.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The anticipated outcome of this study was to provide additional fundamental information for understanding the association of *Salmonella* with specific produce outbreaks with a focus on the ability of this organism to persist in dry environments.

It was learned that genes that control the production of cellulose are important to increased survival of *Salmonella* during drying. *Salmonella* strains that have an enhanced ability to produce cellulose survive better during drying. In addition, it was learned that growing *Salmonella* on a solid surface rather than in a liquid culture greatly enhanced the tolerance of this organism to drying. Although temperature and nutrient availability during growth did impact production of cellulose, it was less important to survival during drying. The factors that increased the ability of *Salmonella* to survive drying did not appear to significantly impact sensitivity to chlorine or acid.

This information will be important to designing further research studies and to the evaluation of existing data, particularly when studies are focused on understanding or documenting the behavior of *Salmonella* in low-moisture environments. When studies involve situations where *Salmonella* is exposed to dry conditions, it is recommended that the organism be cultured on solid media. It is also important that researchers consider cellulose production (rdar phenotype) as one of their criteria for strain selection. If not, the survival of *Salmonella* may be significantly reduced potentially impacting the study conclusions.

The goal of this study was to understand the protective role that multicellular compounds, thin aggregative fimbriae and cellulose, play during *Salmonella* desiccation and persistence in low-moisture environments and to evaluate the impact of different environmental factors on their formation. The following summarizes the key findings:

1. *Salmonella* strains that have an rdar-positive morphotype (produce cellulose and aggregative fibmbrae) are more tolerant to desiccation.
2. *Salmonella* strains cultured on agar surfaces are more desiccation tolerant (survive better during drying) than those cultured in broth. This phenomenon was observed for both rdar-positive and rdar-negative strains of *Salmonella*.
3. Loss of the rdar phenotype and possibly reduced cellulose production impacted long-term survival of *Salmonella* on almonds but in model systems, survival for up to 7 days was not significantly impacted.
4. Based on 2 and 3 above, the rdar morphotype alone does not explain the increased desiccation tolerance triggered by growth on agar medium.
5. Growth conditions that enhance desiccation tolerance (rdar morphotype, growth on agar) do not appear to confir enhanced chlorine or acid tolerance.

Dr. Linda Harris, University of California, Davis, presented a poster of interim results at the 2012 Center for Produce Safety (CPS) Produce Research Symposium in California, and final research results at the 2013 CPS Produce Research Symposium in New York. The 2012 symposium had 325 attendees and survey respondents rated the relevance of the research as important. The 2013 symposium had 300 attendees and survey respondents rated the relevance of this project to the fresh produce industry as 1.8 (1=very important; 5=very unimportant).

The Center for Produce Safety's Board of Directors and members of the Technical Committee distribute a series of information throughout the year on their websites, and through presentations, meetings and webinars. For example, Western Growers Association held a webinar for their members. Information discussed at the webinar is now part of the "Key Learnings" on the CPS website: https://cps.ucdavis.edu/amass/documents/document/186/Key%20Learnings_2013%20CPS%20Symposium.pdf.

The following websites provide additional resources on the final reports and symposium proceedings:
Center for Produce Safety: https://cps.ucdavis.edu/resources.php
Produce Marketing Association: http://pma.com
Western Growers Association: http://www.wga.com/

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Low-moisture environments include low-moisture foods such as almonds. The selected strains and specific research focus was the almond industry. The almond industry has used the information generated from this research to support a recent revision and update of standard operating procedures for the validation protocols that are used by the industry to demonstrate that processes applied to almonds are capable of reducing *Salmonella* by the minimum 4-log standard. The almond industry is exceptionally important to the California economy with over 6,000 growers, over 100 processors, and a crop of close to two billion pounds (valued in 2011 at nearly $4 billion U.S.); it is California's second most valuable crop.

Although focused on almonds these data are by no means relevant only to the almond industry. Surfaces of intact crops, such as tomatoes and melons, are also low in moisture. Large swings in moisture levels are common in the produce production and processing environment and desiccation tolerance likely plays an important role in the survival of this organism to the point of consumption. Organisms better able to survive drying are thought to be more likely to survive on tomato and melon surfaces and in the production and packinghouse environments. Thus, the key findings and recommendations are broadly applicable to these other specialty crop industries.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The original project proposal planned to use microcentrifuge tubes as an inert surface for the short-term desiccation studies. However, the PI ultimately substituted thin sterile glass chips. While not easy to measure, it is believed that the rate of drying plays an important role in survival of *Salmonella*. Controlling the drying rate was easier to achieve when the inoculum was spread out over a larger surface area (glass chip) rather than in a tube.

As addressed earlier in this report, rdar-positive strains should be included for research studies that involve desiccation of *Salmonella*, and strains should be cultured and collected from agar medium.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Wang, L., and L.J. Harris. 2011. Rdar morphotype and its relationship to desiccation tolerance in *Salmonella* spp. IAFP Annual Meeting, Milwaukee, WI, July 31-August 3. (P3-31)

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

<table>
<tr><td>USDA Project No.:
64</td><td colspan="2">Project Title:
Outreach and Education for Small-Scale Specialty Crop Farmers and Farmer's Market Managers Project</td></tr>
<tr><td>Grant Recipient:
California Department of Food & Agriculture</td><td>Grant Agreement No:
SCB10064</td><td>Date Submitted:
December 2013</td></tr>
<tr><td>Recipient Contact:
Jeff Cesca
Allen Moy</td><td>Telephone:
(916) 900-5093
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</table>

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The Department of Food and Agriculture partnered with The Small Farm Conference Planning Committee to assist 90 California specialty crop producers – including new and beginning producers and limited resource farmers – to improve their farming and business practices through educational programs on issues of production, marketing and business practices. The project was also designed to assist ten California Farmers' Market Mangers with education issues such as creating successful and sustainable farmers' markets in food deserts and other low-income and rural areas, and customer service skills to boost sales.

The venue for the planned education and informational opportunities was the 2013 California Small Farm Conference (March 2013, Fresno, CA), a statewide educational conference.

The farmers targeted for the educational opportunities were small-scale producers of specialty crops who are more likely to be under-served by training and technical assistance programs and who, without encouragement and financial assistance, would probably not attend educational programs. The market managers targeted were new market managers and those working in rural areas or food deserts.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

<u>Formation and utilization of a Planning Committee to help guide the conference planning process:</u>

The Planning Committee, which ultimately had 15 active members, met three times in person and provided telephone and email support between the in-person meetings. The Planning Committee provided suggestions for educational topics, speakers to address selected educational topics, sites for field course stops, and potential exhibitors for the conference exhibit area.

Offering a scholarship program to support the participation of small-scale specialty crop growers and farmers' market managers:

The project, along with funds from other sources, was able to award 102 scholarships through the scholarship program. There were 109 scholarship applications submitted and 102 scholarship acceptance letters were issued. There were 76 farmer scholarship recipients supported by this grant, and the applications selected were ranked based on a point system by farm and non-farm income, size of farm, receipt of a scholarship in prior years and the applicant's objective in attending the conference. There were also 15 market manager scholarship recipients partially supported by this grant (the market managers were supported at 65% to ensure no SCBGP were used to benefit non-specialty crops).

Providing educational opportunities through off-site field courses, focused workshops, and general sessions with well-known speakers:

The conference organized and offered five off-site field courses that each addressed a different topic of importance to specialty crop farmers, such as agri-tourism opportunities and transitioning to organic production.

The conference organized 25 90-minute workshops, each focused on a different educational topic. Five of the workshops were targeted towards farmers' market managers while the other 20 were targeted towards specialty crop farmers and included, whenever possible, specialty crop farmers among the workshop speakers.

To determine the effectiveness of the educational offering, the conference surveyed scholarship attendees and there was a 66% scholarship survey response rate. Seven percent of those responded that they learned one new skill from the conference to help their business. Ninety-three percent of those surveyed indicated they learned two or more new skills from the conference to help their business The types of business skill acquired ranked in highest response order:

1. Marketing
2. Business Planning
3. Production
4. Organic Farming
5. Resource Conservation
6. Other (Women, Infants and Children Program information, Farmer Market Manager resources, United States Food and Drug Administration food safety rules, water savings, Food Bank Information, and Networking).

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
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- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Proposed Grant Project Goal	Actual Grant Project Outcome
Provide financial assistance to 90 specialty crop growers to participate in the 2013 California Small Farm Conference, a statewide educational conference	Financial assistance was provided to 64 farmers and 12 farmer students, all of whom were actively participating in a farm apprentice program for a total of 76 persons supported.
Provide financial assistance to 10 farmers' market managers to participate in the 2013 California Small Farm Conference, a statewide educational conference	Financial assistance was provided to 15 farmers' market managers.
90% of those directly supported by the project's scholarship program will report that they learned at least one new skill that can improve their business that they intend to implement over the coming year	100% of the scholarship recipients who completed the post-conference survey (66% of all scholarship recipients) indicated they learned at least one new skill they planned to implement.
75% of those directly supported by the project's scholarship program will report that they learned at least two new skills to implement over the coming year	93% of the scholarship recipients who completed the post-conference survey (66% of all scholarship recipients) indicated they learned two or more new skills they planned to implement.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The direct beneficiaries of the project were the 64 specialty crop farmers, 12 student farmers and 15 farmers' market managers whose participation in the 2013 California Small Farm Conference was made possible through the scholarship program supported by this grant project.

The 76 farmers and 15 farmers' market managers who attended the conference with grant support also benefitted from the opportunity to network with the other 350 persons who attended the conference.

It is challenging to quantify the economic impact of an educational event such as the annual California Small Farm Conference. The initial estimate included in the grant proposal assumed 100 persons who learned one or more new skills and a bell curve of new revenue earned or costs avoided from a low of $50 to a peak of $40,000 with the largest single groups around $20,000, creating an estimated economic impact of $88,500. Using the actual number of 76 farmers (of the 91 total persons) directly supported by the grant project who learned new skills and the same bell curve estimate of income generated or costs avoided, this equals an estimated direct economic impact of $63,400.

	Original Projection		**Actual Grant Support**	
Revenue added or cost avoided/grower	**# Farmers**	**Total**	**# Farmers**	**Total**
$100	5	$500	5	$500
$300	10	$3,000	8	$2,400
$500	25	$12,500	21	$10,500
$1,000	40	$40,000	34	$34,000
$2,000	10	$20,000	8	$16,000
	90	**$76,000**	**76**	**$63,400**

The market managers benefited from gaining new skills and knowledge, new ideas, and new perspectives, as well as learning customer service skills and ways to create successful and sustainable farmers' markets in food deserts and low-income and rural areas.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

It is recommended to develop a waiting list of scholarship applicants who meet basic scholarship criteria, but were not among the highest ranking applicants, to fill any slots for scholarship recipients unable to attend.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 65	**Project Title:** A Portal for Supporting the Development of Agritourism and Celebrating California Grown Specialty Crops	
Grant Recipient: California Department of Food & Agriculture	**Grant Agreement No:** SCB10065	**Date Submitted:** December 2013
Recipient Contact: John Quiroz	**Telephone:** 916-900-5025	**Email:** John.quiroz@cdfa.ca.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

There is a critical need for public agricultural literacy in order to have informed consumers who value and enjoy California agriculture. Public outreach through agritourism is a key component in teaching the public the values of California agriculture including its economic impact, use of water and land to grow food, and why preserving agriculture is an important tool in adapting to climate change. Although California fairs have strong connections and involvement with some sectors of California agriculture, most specialty crop growers, agritourism operators, and their supportive organizations are not currently involved with local fairs and are not utilizing the potential for collaboration with the fair industry.

The purpose of this project was to assist farmers, marketers and the fair industry in developing collaborative efforts to increase education about, and access to, California grown specialty crops.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

The California Department of Food and Agriculture (CDFA) Fairs and Expositions representative worked with the University of California (UC) Small Farm Program subcontractor to organize, promote and facilitate seven regional outreach meetings held at district agricultural association fairs. The "Fairground Farms and Farmyard Festivals" meetings held were the following:

Shasta District Fair, Anderson, CA – June 14, 2012

Amador County Fair, Plymouth, CA – July 26, 2012

Ventura County Fair, Ventura, CA – August 2, 2012

Napa Town and Country Fair, Napa, CA – August 9, 2012

Yolo County Fair, Woodland, CA – August 16, 2012

Santa Cruz County Fair, Watsonville, CA – September 13, 2012

Big Fresno Fair, Fresno, CA – October 4, 2012

The total combined attendance at the regional outreach meetings was 166 people. Participation in meetings ranged from 18 people to 31 people. The meeting participants were the following:

47 specialty crop growers/agritourism operators.

59 fair professionals or contracted fair participants.

47 agricultural or community organization representatives, county or state staff or elected officials, educators or advisors.

13 tourism professionals, members of the press or other community members.

Notes from these discussions, information about some of the projects discussed and some of the presentations are on the UC Small Farm Program website: http://sfp.ucdavis.edu/events/12fairs/

Fair-based specialty crop collaboration, promotion and educational activities organized by fair officials, SC growers, and agricultural organizations were shared at the regional outreach meetings. Activities highlighted included: a special exhibit at the Marin County Fair, created in partnership with local agricultural organizations, about Marin County agricultural history and crops; Yolo County Fair's opening night gala featuring local SC growers and vintners; a local food Marketplace at the Tehama County Fair; Orange County Fair's Centennial Farm education program; a plan for creating a business incubator, greenhouse and processing facility at the Plumas Sierra County Fair; and the Healthy Food Options program at the Marin County Fair.

October 2012 through April 2013, CDFA F&E and UC Small Farm Program staff activities:

Presentation and discussion at the November 2012 California Fair Alliance Fall Management Conference Update Session.

Presentation at the Western Fairs Association annual conference in January 2013, located in Reno, Nevada. The presentation is available online at: http://sfp.ucdavis.edu/files/159649.pdf

The UC representative produced an email newsletter, sent to 142 participants in the "Fairground Farms and Farmyard Festivals" workshops.

Project staff worked with specialty crop stakeholders and with the CDFA, Information Technology staff to create and make public an online portal on the CDFA website, providing public information about local specialty crops and connection to farmers' markets, community supported agriculture programs, agritourism operations, agricultural fairs and farm events. (http://blogs.cdfa.ca.gov/CaliforniaFarms/)

Project staff created informational displays and staffed a booth at the 2013 Capitol Ag Day event in Sacramento, promoting the new CDFA website portal, "Discover California Farms."

In response to challenges to specialty crop growers and agritourism operators' involvement in fairs, discussed at the "Fairground Farms and Farmyard Festivals" workshops, project staff organized local planning teams to create exhibits at two district fairs to promote local farmers' markets, Community Supported Agriculture (CSAs), agritourism operations and specialty crops. Contra Costa County and San Joaquin County certified farmers' market managers, CSA operators, agritourism operators, Farm Bureau representatives, fair board members, UC Cooperative Extension and county Department of Agriculture representatives participated in these teams.

The Small Farm Program at the University of California, Davis worked with the Project staff to develop a list of specialty crop farmers to involve in the workshops to ensure grant funds solely enhanced the competitiveness of specialty crops.

The invitation flyer for the fair workshops was addressed specifically to Specialty Crop growers, and attendees were asked to register for the workshop. The project manager contacted all registrants not affiliated with the fair to make sure that each was a specialty crop grower.

Only specialty crop operations are actively promoted on the CDFA blog, which is administered by CDFA Fairs &Expositions staff.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Since the fair workshops were not well attended by specialty crop growers and were more networking and discussion sessions than educational sessions for the growers, the originally stated expected outcome, “It is expected that 80 percent or the participating specialty crop producers will report establishing and/or improving their SC agritourism endeavors as a result of this program” was no longer expected. The changed expected outcome of “50 percent of the participants in the outreach meetings will report establishing and/or improving their SC promotional or educational programs as a result of this program.” was measured in the final survey of all fair workshop participants.

In May and June 2013, the UC Small Farm Program representative conducted an email survey of 143 of the 166 participants in the “Fairground Farms and Farmyard Festivals” workshops. 19 participants responded to the survey. Workshop participants’ responses are summarized below.

- Did you learn from speakers at the workshop about any projects, methods, resources or collaborations that you are considering trying at your fair, farm or agritourism enterprise?
  - 12, or 63% of respondents, said yes (n =19)
- Did you meet any farmers, fair officials or others at the workshop who you are considering collaborating with in the future?
  - 11, or 58% of respondents, said yes (n = 19)
- Did you find group discussion of the issues facing fairs, farmers and agritourism operators useful for your own planning process?
  - 12, or 63% of respondents, said yes (n = 19)

- Have you initiated or planned any changes in your own fair, farm or agricultural operation or other enterprise as a result of discussions or presentations at the "Fairground Farms and Farmyard Festivals" workshop?
  - 8, or 44% of respondents, said yes (n = 18)
- Have you collaborated with farmers, fair professionals or others as a result of this project?
  - 10, or 56% of respondents, said yes (n = 18)

The original proposal stated that the goal of the CDFA website portal was to "provide resources to specialty crop growers for creating and/or enhancing their agritourism opportunities." The purpose of that website portal changed to one that would instead promote the measureable outcome of "increased access by California residents and visitors to fresh fruits and vegetables and to their knowledge of the benefits of those specialty crops" by providing information to the public about local specialty crops and where to access them directly from the growers. The website portal has been established.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

- California specialty crop growers in general benefited from increased attention by the fair industry to the potential for collaborative education about and promotion of specialty crops. 47 (rather than the expected 100) specialty crop growers participated in the 2012 fair workshops. More than half of respondents to the final survey reported increased collaboration as a result of the workshops, with the expectation of these collaborations leading to increased specialty crop revenue. Specialty crop growers also benefited from the increased promotion of local farms on the CDFA website.
- California specialty crop growers benefited from the project through the fairs' increased knowledge about the challenges faced by specialty crop farmers participating in fairs, through increased awareness of innovative fair/farmer collaborations promoting specialty crops at fairs, and by increased collaboration with their local fair communities resulting from discussions at the 2012 fair workshops.
- The California public benefited from the project through increased knowledge about local specialty crops and growers, farms to visit, farmers' markets, agritourism operations, fairs and festivals through the website portal, as well as through increased education about and promotion of specialty crops at district fairs due to collaborations inspired by the 2012 fair workshops.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

Timing is important in working with farmers and fair officials: The outreach meetings were held while the fairs were in session. Host fair officials, in most cases, were too busy managing their fairs to participate in much of the discussion or the education of the farmers. The number of participating specialty crop growers was lower than expected since fair season coincides with harvest time and peak production and selling time for most farmers. Recommendation: Future workshops, education and planning sessions involving specialty crop growers and fair officials should be scheduled at times that do not coincide with fair events or busy agricultural activity seasons. The meetings should also be regional, rather than only involving one fair and its local community.

Most specialty crop growers cannot afford the 4 to 12 day time commitment or the fees for an individual commercial booth at a district or county fair, and fresh produce does not usually sell well enough at the fair events to justify such an investment. Recommendations:
1) Collaborative marketplaces or farmers' markets at fairs, with shared staffing, allow specialty crop growers to participate with minimal individual investment. 2) Fairs can better advertise the availability of free exhibit space to local grower and agritourism organizations, and can consider making free exhibit space available to local specialty crop agricultural organizations, if they do not already do so, in order to increase specialty crop agricultural community participation in local fairs.

Many specialty crop farmers and fair officials see potential for use of fair land and facilities year round, but DAA limits access to USDA Rural Development (RD) Funds. Many ideas were discussed for use of fair facilities by specialty crop growers and their organizations, including aggregation hubs, processing facilities, farm labor housing, educational gardens, farmers' markets, restaurants and production kitchens, collaborative local food sales, wine-making facilities, animal facilities for 4H children, and others. Recommendation: Continue discussions between fairs and farmers' groups about collaborative facility-use possibilities. Consult with USDA RD about alternative funding options, and involve other community members to move mutually beneficial projects forward.

Cross-promotional opportunities by fairs, farmers' markets and agritourism operations are not being utilized, and could benefit everyone involved. Recommendation: Discuss the possibilities.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 66	Project Title: Development of electronic documentation clearinghouse in the California Department of Food and Agriculture (CDFA) for environmental stewardship practices.	
Grant Recipient: California Department of Food & Agriculture	**Grant Agreement No.:** SCB10066	**Date Submitted:** December 2013
Recipient Contact: Amrith Gunasekara	**Telephone:** 916-403-6719	**Email:** amrith.gunasekara@cdfa.ca.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

In 2011, the California State Board of Food and Agriculture produced a strategic plan for the future of the state's agriculture and food system. This strategic plan is termed the California Agricultural Vision (Ag Vision). Ag Vision strategy 7 is titled “Expand Environmental Stewardship on Farms and Ranches”. Specialty crops account for about 64 percent of total sales (2003 data) of California crops. Strategy 7 recognizes that “California farmers and ranchers have continually worked to enhance environmental quality and to reduce the impact of food production on air, water and living systems.” Also noted is that “improved environmental stewardship is likely to have additional economic benefits for agricultural producers.” Several objectives were defined, which include the “documentation of existing environmental stewardship efforts by producers and their value to all Californians” and “widespread adoption of beneficial management practices that improve the farm viability and the agricultural economy as well as the environment”.

There are many environmental issues at the interface of agriculture. In response to address some of these issues, environmental stewardship practices and conservation measures are implemented on specialty crop farmers in California. These practices contribute directly to enhancing the environment but often go unrecognized. They are not documented and difficult to find given the lack of single one-stop-shop information clearinghouse. Documenting environmental stewardship practices will highlight the many benefits, in addition to food production, that specialty crop farming has on the overall health of ecosystems. Also, there is no system in place for information sharing, among specialty crop growers, on successful stewardship practices that have been field tested and implemented to enhance the environment.

There are many environmental stewardship practices, implemented and funded by specialty crop growers, highlighted on farm websites. For example, growers with specialty crops in regions with shallow groundwater systems have moved from flood irrigation to drip irrigation. Such actions offer tremendous ecosystem benefits since the practice reduces water use and reduces fertilizer contamination of water systems. Unfortunately, this information has not been collected and effectively documented beyond the farm websites. Further, such information is not readily available to a wide audience and stakeholder groups since it cannot be found in a centralized location. The result is a lack of knowledge and understanding, among stakeholders and regulators, of positive environmental stewardship practices and conservation measures, including best management practices, that have been implemented.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Three primary objectives were proposed in the project proposal: 1. Gathering, reviewing, and producing a science-based literature review report of environmental stewardship efforts on California specialty crop farms, 2. Creating an electronic documentation clearinghouse from specialty crop farm websites highlighting environmental stewardship and conservation measures, and 3. Conducting a survey to understand what environmental stewardship practices and conservation measures implemented at the specialty crop farm level.

1. Literature Review

The literature review was a science-based review of environmental stewardship practices and conservation measures. The Graduate Student Assistants used a scientific database (Web of Knowledge/Science) to search, gather, review, and summarize existing scientific information on environmental stewardship. The Ecosystem Services in agriculture definition, developed by the CDFA Environmental Farming Act Science Advisory Panel, was used as a foundational platform for identifying details associated with environmental stewardship practices and conservation measures. The Ecosystem Services definition consisted of 12 categories; http://www.cdfa.ca.gov/Environmental Stewardship/EcosystemServices.html. This scientific literature review produced a chapter for each category. Each chapter is supported by a general overview followed by specific conservation measures supported with scientific references. For example, the Biodiversity and Wildlife Habitats chapter discussed five main conservation measures taken on specialty crop farms to enhance environmental stewardship efforts; 1. Buffer strips, 2. Hedgerow installations, 3. Cover cropping, 4. Nesting site installation, and 5. Crop diversity. The conservation measures were followed by several specific examples of use on specialty crop farms in California. Nine scientific journal articles were used for this particular Ecosystem Service category. In total 65 references were used in the literature review. The following project activities were fulfilled from this work; " Research and review several electronic scientific databases for environmental stewardship efforts", "Identify peer-reviewed journal articles highlighting environmental stewardship efforts from the scientific databases" and "Categorize collected science based works by crop and identify geographic region of study in California".

2. Electronic clearinghouse

A web-based database of specialty crop farms providing any two or more of the Ecosystem Service categories associated with the definition, was developed; http://apps.cdfa.ca.gov/ecosystemservices/ Information in the database was gathered from specialty crop farm websites and other databases focused on highlighting a topic (e.g., irrigation). All farmers in the database were notified by mail of the use of their information in the database, from their public websites. Any requests for removal from the database were respected. The database has approximately 300 specialty crop farms in it. The database was presented to the California Department of Food and Agriculture (CDFA) Environmental Farming Act Science Advisory Panel for comments. Final procedures prior to release of the database included: 1. Review of database by several specialty crop stakeholders, 2. News release to announce database and 3. Highlight electronic clearinghouse on the CDFA environmental stewardship website. The database was made public in August 2013. (http://apps.cdfa.ca.gov/EcosystemServices/) The following activities described in the project proposal were fulfilled by this work; “Identify non-peer-reviewed articles highlighting environmental stewardship efforts from the world-wide-web”, “Research and review commodity and coalition group websites for environmental stewardship information”, “Contact commodity and coalition groups to obtain data on environmental stewardship efforts”, “Summarize data obtained by commodity and coalition groups and list in a unique electronic spreadsheet categorized by specialty crop and location” and “Provide outreach effort by promoting clearinghouse to specialty crop growers including hardcopy mailer”.

Approximately 100 entries in the database are non-specialty crop entries; however, the costs associated with these entries were not charged to the grant and SCBGP funds were used to benefit only specialty crops.

3. Survey

CDFA developed a survey to query specialty crop growers about on-farm Ecosystem Services. Surveys were distributed, along with a 15-minute presentation, at three grower meetings and at the annual California Farm Bureau meeting on March 12, 2013 in Sacramento. The response from the meetings was overwhelmingly positive with more than four hundred surveys handed out. In total there have been 92 surveys returned (55 mail-in and 37 online). Completed survey information has been entered into Survey Monkey for analysis. There are approximately 45 questions in the survey, all designed to query growers about on-farm Ecosystem Services. Statistical analysis of the survey results was completed and results are being compiled into a summary report. The summary report is currently under review by the Science Advisor at CDFA. Once completed, the survey will be posted on the CDFA website to inform specialty crop growers about the survey results. The following activities described in the project proposal were fulfilled by this work; “Identify a feasible electronic and hardcopy survey method for specialty crop growers to inquire about non-peer-reviewed environmental stewardship efforts implemented”, “Compile, distribute, and collect survey information” and “Study, evaluate, and list survey information on electronic information clearinghouse”.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The goal of this project was to highlight the many environmental stewardship efforts and conservation practices implemented on specialty crop farms. This was accomplished primarily through the use of the CDFA Ecosystem Services definition and associated categories. To complement the database, several other efforts were taken including completing a survey of specialty crop growers and a literature review of the scientific information to support the different categories associated with the Ecosystem Services Definition.

There has been ongoing progress to date on this effort. With the implementation of the Ecosystem Services Database, the number of new entries submitted is tracked (an indication of environmental stewardship efforts in California agriculture). There have been eight requested entries since the database was released. It is too early to conduct surveys for growers to determine whether growers have implemented environmental stewardship efforts in the fields. Several surveys on environmental stewardship efforts will be initiated in the fall at several grower meetings. Given the drought the state is going through at the present time, the 40% increase is most likely an overestimate. The number of requests to become part of the Ecosystem Services Database might be a better quantitative measure, not originally anticipated, as an indication of environmental stewardship efforts on specialty crop farms in California.

Information about the Ecosystem Services Database, which contains environmental stewardship practices, has been distributed through the Specialty Crop Council of California and the State Board of Food and Agriculture.

Information about the Ecosystem Services Database was provided to several state agencies including CalEPA, the Water Board, and the Office of Environmental Health Hazard Assessment. Dialog with other agency staff about environmental stewardship efforts in specialty crop agriculture continues, using the context of Ecosystem Services, at regular science panel meetings. The Ecosystem Services Database is also highlighted in a two year report on scientific activities completed in coordination with the CDFA Environmental Farming Act Science Advisory Panel.

The Ecosystem Services Database was presented to the Environmental Farming Act Science Advisory Panel on December 14, 2012. The Ecosystem Services Database has been acknowledged as a useful product by the science panel and is included in its bi-annual report. A presentation on the Ecosystem Services Database was made on December 4, 2012.

Although, the Ecosystem Services Database has been posted to the CDFA website, analytical tools have not been initiated yet to determine use. In the next four months, several preliminary activities will be completed to gather quantitative information on database use in California. These activities will include:

- Determining the number of hits per month to the database since it was first released
- Determine which Ecosystem Services search criteria are being used most frequently
- Determine which locations in the state are querying the database and link to an specialty crop mapping layer
- Evaluate other quantitative data that can be gathered to determine the extent to which the database is being utilized and benefitting specialty crop growers

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Specialty crop growers will be able to access the database and determine if they would be like to part of the database to further inform a wide audience about the many Ecosystem Services provided, evaluate other farmers in the same region to determine what services are practical for implementation, and obtain information on how to implement environmental stewardship practices and conservation measures through established NRCS conservation practices.

California's specialty crop industry is very valuable economic entity in the state; global exports of specialty crops in 2011 were worth $43.5 billion. This project will help enhance the sector and ensure its sustainability as an economic backbone of California, leader in Ecosystem Services and national and global food supply provider.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The following activity was not completed since there was a lack of "location" information in the scientific information: "Summarize scientific information in each article into a unique electronic spreadsheet categorized by specialty crop and location".

The original intent was to use scientific articles as case studies in the database along with case studies identified through the internet. However, the scientific articles did not have location-specific information and instead used multiple non-specific location information to study the ecosystem benefits of agricultural systems. As the database is driven by location as the primary method of organizing the information, the case studies in the scientific articles could not be used in the database. This did not affect the successful outcome of the project as there was sufficient location-specific information available from other sources.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Attachment: Survey

USDA Project No.: 67	**Project Title:** The Central Valley Farm-to-school Pilot Program: connecting rural communities, farms, and schools through better food access, distribution, and collaboration.	
Grant Recipient: California Department of Food & Agriculture	**Grant Agreement No.:** SCB10067	**Date Submitted:** December 2013
Recipient Contact: Josh Eddy Judy Culbertson	**Telephone:** (916) 403-6731 (916) 561-5625	**Email:** josh.eddy@cdfa.ca.gov Judy@LearnAboutAg.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

California is the number one agricultural state in the nation, producing more than 400 different commodities, most of which are considered specialty crops. Although most of the products are grown in California, they are not always consumed in California. California's Central Valley produces a majority of the fruits and vegetables consumed in America and it is also one of the poorest areas of the country. The residents have little access to fresh produce at an affordable cost. There is a misconception that students in rural areas have access to most of the produce that is grown in the area and that they are knowledgeable about the nutritional value and farmers who grow them.

The purpose of the Central Valley Farm-to-School Pilot Program was to educate students in a rural town about the importance of agriculture and the many crops that are grown around them. By learning about the locally grown commodities, students saw the benefits of eating fruits and vegetables and were introduced to the abundant supply of the products that are grown in their community that they might not be aware of. This pilot program was a resource for school administrators and food service directors who would like to begin a Farm-to-School program at their schools.

Chatom Elementary School in Turlock, California was selected as the pilot school for this project because it is located in a rural area that grows a variety of specialty crops. There are 484 students enrolled in the school and 86 percent of the students participate in the Free/Reduced Lunch Program. The pilot program started in June of 2012 and ended in June of 2013. The program included teaching the students about specialty crops and the growers of specialty crops through educational resources for teachers, a field trip, school-wide assemblies, an on-site farmers' market, and the installation of a salad bar into the food service program. Students met local farmers who grow the produce, learned about the products they grow, tasted a variety of produce and chose healthy options from the salad bar at school.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

The pilot program activities took place from June 2012 to June of 2013. In June 2012 the Central Valley Farm-to-School Pilot Program was presented to the school and approved by the administration and food service director. The terms of the pilot program were outlined for all parties involved (see attachment).

Students participated in two school-wide assemblies, monthly taste tests, a field trip to a local farm, and an onsite farmers' market. The students were educated about the benefits of eating healthy foods through educational resources and opportunities. Students increased their consumption of fresh fruits and vegetables that were available through an extended salad bar.

The initial roll-out event, a school-wide assembly, was held on September 7, 2012. The Secretary of the California Department of Food and Agriculture (CDFA), Karen Ross, California Farm Bureau Federation president, Paul Wenger, and staff of the California Foundation for Agriculture in the Classroom and California Bountiful Foundation attended the event. Students learned how every person is involved in agriculture - from the food we eat, to the clothes we wear, to most of the supplies used in schools. The Afterschool Science Club performed a skit demonstrating the process some products go through to get from the farm to the store. Secretary Ross spoke to the students about the more than 400 different commodities grown in California, explaining that many of them cannot be grown in other states. She told them why it is important to know about your food, who grows it, how it is grown, and the importance of eating fruits and vegetables so everyone can live healthy lives. Many of the students have parents or family members who live or work on farms, but few knew which crops grew around them. Secretary Ross helped the students learn a simple way to remember how agriculture is part of our everyday lives by breaking it into five "F's" - food, fiber, flowers, forests, and fuel. Paul Wenger, who farms walnuts in Modesto, talked to the students about being a farmer and his walnut orchard. The roll-out event concluded with a peach taste test. Students compared fresh and canned peaches.

A second school-wide assembly was held on October 12, 2012. During this assembly, the students learned about the Native American tale, "Three Sisters Garden." Students learned how different crops work together to thrive. One sister provided shade, one provided support and one provided soil nutrients. Through the story, students learned what plants need to grow. They also reviewed the five "F's" of agriculture that they learned from the initial assembly. The taste test for October consisted of three different kinds of walnuts that were donated by Paul Wenger.

The cafeteria expanded its menu to include a salad bar with a selection of fresh fruits and vegetables as toppings two times a week. This provided an opportunity for students to have access to an abundance of fresh produce as a lunch option. To ensure the students were getting the proper serving size of vegetables, the food service director created a Toppings Bar. The students were given a pre-measured amount of lettuce and directed to the Toppings Bar to add more California specialty crops or "toppings." The toppings were served by a food service employee for food safety purposes. Toppings offered included: tomatoes, cucumbers, broccoli, carrots, kale, sprouts, onions, bell peppers, bananas peppers, green onions, strawberries, oranges, mushrooms, green beans, snap peas, fennel, apples, walnuts, almonds and beets. Every week a different topping was featured on a student-made poster to teach about the nutritional value of the various toppings. The posters highlighted the nutritional value and fun facts about the selected fruit or vegetable. The posters also enticed students to taste the toppings in the salad bar. According to the food service director, there was an increase in school lunches purchased on days when the salad bar was an option. Student-sized salad bar equipment was purchased so students will be able to select the toppings with more ease. For future programs it is recommended to buy the student sized salad bar at the beginning of the year.

A field trip to the Rattos Brothers Farm offered an enrichment opportunity for every second grade student at Chatom Elementary School; 84 students, teachers and chaperones participated in a guided tour of the facility that grows and processes a variety of row crops. The group was split into two groups in order to increase the learning experience. The field trip fulfilled second grade standards to learn about local community and California education. The students walked the fields where the produce was grown and learned why certain plants were grown during specific times of the year. The farmers talked about how the plants are irrigated and given nutrients, as well as how they are harvested. The tour ended at the processing facility. The students were amazed at how fast workers were able to get the produce from the field to the processing plant. To extend the information from the field to the classroom, each second grade teacher received a packet of resources that included information about the specialty crops grown on the farm. The Rattos Brothers Farm was recommended by the Stanislaus County Farm Bureau as a farm that provides school tours. The Rattos Brothers Farm also donated produce for a taste test and for a farmers' market booth. It was recommended to have a shorter tour for the students as their attention span is shorter than the older students.

The farmers' market took place on May 8, 2013 during Chatom Elementary School's Open House. The grant allowed the students to use "Chatom Bucks" to purchase items from the market. More than 200 students and families attended the farmers' market. The market consisted of six booths featuring different California commodities: Grandpa Wrights Almonds, Great Valley Farms, Legacy Toffee, Golden Comb, After School Science Club, and Bountiful Produce with produce provided by the Rattos Brothers Farm. The specialty crops featured included almonds, honey, various leafy greens, kale, chard, various root crops, rutabaga, beets, as well as specialty crop plants that were grown by the Afterschool Science Club using funds from the grant. When the market ended, the remaining produce was donated to the school and used for a taste test and in the salad bar. All the farmers involved in the farmers' market agreed that it is important for students to learn about where their food comes from. For many of the farmers it was their first experience working directly with a school. They were happy to participate in the program and look forward to participating in the future.

During the farmers' market students told their parents about the different produce they had tasted throughout the year. Many of the commodities were available at the booths and students used their "Chatom Bucks" to bring produce home. In the cafeteria, the salad bar was set up for parents to see and learn about the new option in the school lunch menu. Posters were also displayed around the cafeteria and salad bar. Each teacher received a resource with activities that can be conducted at or around farmers' markets.

A one hour teacher in-service/professional development training was held for the teachers at Chatom Elementary where 17 teachers attended, representing all grade levels. Resources were distributed to help educate students about the benefits of healthy eating habits. The training focused on resources and materials that can be used to incorporate agriculture into the classroom and tie what the students are seeing and eating in the cafeteria to classroom curriculum. At the beginning of the year each teacher received a bag of resources that included California Agriculture in the Classroom's *Fruits and Vegetables for Health* lesson plan unit, Ag-Bites and WEgarden activity packets, class sets of the student newspaper, *What's Growin' On?* and copies of the *California is Everywhere* coloring book for their students. During the in-service training the resources were reviewed. The teachers also received additional resources about California specialty crops and a packet containing instructions about how to cook with kids using specialty crops. For future programs it is recommended to conduct the teacher in-service at the beginning of the school year.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Measureable Outcomes:

A pre and post survey was distributed to the third through fifth grade students. The same questions were asked so we could assess how much the students learned about California specialty crops throughout the program.

A total of 157 students took the pre program survey and 200 students took the post program survey. The results proved that the students increased their knowledge about California specialty crops. The number of students who could name one of the three specialty crops increased from 10 percent to 36 percent after the program and there was an increase from 56 percent to 70 percent of students who could identify where to buy specialty crops (see attachment).

According to the Food Service Director, the number of students who purchased school lunches on salad bar days increased since the beginning of the year by 12 percent. She said that the taste tests, eye appeal of the toppings bar and posters drew the students to the salad bar.

In the grant proposal the goal was to work with 20 specialty crop farmers for two years. In the 2012-2013 school year we worked with 16 farmers. The initial program concluded and the school is hosting another farmers' market and they will be inviting new farmers using a list that was provided by California Foundation for Agriculture in the Classroom.

A goal of three schools was set to establish a farm-to-school program within the pilot project school district. There are only three schools in the Chatom Unified School District and two participated in the program in 2012-2013 - Chatom Elementary School and Chatom Preschool. The food service director is the same for the middle school in the district and she was excited to bring the model to the middle school and offer the salad and toppings bar to those students.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

California specialty crop growers benefited from the program because students began consuming more California specialty crops after having tasted them during the taste tests. Students increased their consumption of fresh fruits and vegetables through the salad bar and were excited to buy California specialty crops at the farmers' market to share with their families.

Students at Chatom Elementary School benefited from this program. It is located in Turlock, in Stanislaus County in the Central Valley of California. There are 484 Students enrolled in the school with 86 percent on the Free/Reduced Lunch Program. Through this project, the school was provided with a program that let the students learn about commodities grown around them and the importance of eating healthy foods. The students learned about California specialty crops through assemblies and curriculum provided to the teachers, a salad bar, monthly taste tests, a farmers' market, and the student field trip.

California Foundation for Agriculture in the Classroom was able to share resources about California specialty crops with a new audience of teachers who were not previously teaching agriculture in their curriculum. The program helped students connect the food they eat in the cafeteria with their classroom curriculum.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

Many lessons were learned about working with farmers, food service directors, teachers and school districts. Each person involved in bringing a farm-to-school program to students has certain goals they want to accomplish. The farmers want students to learn about their commodities so they will consume more and create a demand for the product. The food service director must follow state and federal mandates for food that can be served to get reimbursed for feeding the students. Teachers have state and common core standards that must be taught in a short amount of time with limited funds. School administration wants students to be healthy and ready to learn. As the facilitating organization we facilitated the needs of all groups for the good of the students and to teach students about agriculture.

One of the goals was to connect the foods the students were eating in the cafeteria to the lessons being taught in the classroom. The food service director and the teachers worked together to decorate the cafeteria where the students eat. Each classroom was given a section to post pictures of the classes' favorite fruits and vegetables. To help students learn about the commodities featured in the toppings bar, a lesson was given to the teachers for each monthly taste test. There was no resistance from the teachers to help decorate the cafeteria but there was no survey to see how many of the teachers used the provided taste test resources.

In the middle of the project the original food service director who we worked with in the summer of 2012 left the school. The new food service director started midyear and was willing to continue the program. She brought in her field knowledge of buying produce and was dedicated to offering healthy options for the students. Her addition to the program was great because she was enthusiastic and excited to have the opportunity. But, it also delayed the implementation of the program as she was learning the policies of school food services department.

As far as events held for the students and farmers, the farmers' market was initially planned for February but was postponed because there was very little variety of produce available in that season. Farmers' markets are best after May and before October. There is more variety of produce available and most farmers' markets end during the winter.

Getting products donated for the taste tests was not a challenge. The specialty crop farmers were very generous and happy to donate product for the students. It was more of a challenge getting local produce into the cafeteria. We used produce from well-established farmers who distribute on larger scales. Given the time limit, the cafeteria sourced the fruits and vegetables from their distributor. Now that a planned menu has been created, waste is limited and the school is able to purchase, in a fiscally responsible manner, produce that is sourced from local farmers.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

The attachment includes the Memorandum of Understanding, a list of specialty crop farmers involved in the project, monthly taste test commodities, and the complete pre and post student surveys.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 68	**Project Title:** Statewide Plant Pest Prevention and Management Program Environmental Impact Report Human Health and Ecological Risk Assessment	
Grant Recipient: California Department of Food & Agriculture	**Grant Agreement No:** SCB10068	**Date Submitted:** December 2013
Recipient Contact: Laura Petro Michele Dias	**Telephone:** (916) 403-6727 (916) 403-6628	**Email:** Laura.Petro@cdfa.ca.gov Michele.dias@cdfa.ca.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The project used the services of an environmental consulting firm to prepare the Risk Assessment (RA) component of a Program Environmental Impact Report (Program EIR). The RA includes a list of chemicals that have been thoroughly analyzed by a newly developed modeling and reporting tool that will document future risk and report on existing risk for chemical applications. Estimating the quantitative and qualitative value of risk related to the use of pesticides to control and eradicate invasive pests on a statewide level will help put the proper approaches in place for rapid response to invasive pests and strengthen the interface between commercial specialty crop production and regulatory crop protection. The RA is a necessary component of the Program EIR and representative approaches for pest management will be included in this comprehensive document.

This project is necessary to effectively and efficiently address the growing threat of invasive pests coming into California that affect the varied specialty crops grown throughout the State. The RA will facilitate the California Department of Food and Agriculture's (CDFA) ability to implement rapid response to invasive pests affecting the specialty crop industry. It is critical to understand and convey how pesticides may impact humans and the environment as well as how the materials are used to control, suppress, or eradicate pests. The RA considers a full range of receptors, including pesticide applicators, specialty crop agricultural workers, and individuals in non-agricultural areas and also evaluate potential aquatic and terrestrial ecological receptors. The statewide scale of the study ensures that environmental impacts are discussed and reviewed for all representative regions, including areas where residents may be underrepresented or areas where there are high potential for cumulative impacts. Where appropriate, the RA considers the full formulations of pesticides, not just active ingredients (to the extent such information exists). Because toxicity data is regularly re-evaluated, updated toxicity data has been researched and reviewed. Risks are considered in the context of the actual specialty crop settings in which the pesticides would be used.

The importance of this project is due to the export value of California's unique specialty crops. Protecting specialty crops from invasive pests will also ensure protection of the food supply not only in

California, but throughout the world. The RA not only assesses existing risk, but estimates future risk and will educate the public about the benefits of invasive pest eradication, both at home and in the field.

The Program EIR is not scheduled to be completed/ published until 2014. This RA is a component of the Program EIR and will be incorporated in the Program EIR by December 2013. http://www.cdfa.ca.gov/plant/peir/

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Chemical Identification was described in Program Material Data Sheets (PMDS) to identify types and formulations of pesticides and application rates and methods. All eight CDFA programs were completed. Over 170 scenarios were developed to represent pesticide use and resulting exposure. Numerous models were evaluated and used to estimate human and ecological receptor exposure. A total of 26 separate and distinct conceptual site models were produced to correspond to the exposure of 12 different human and 59 different ecological receptors. Toxicity data for humans and over one dozen ecological receptors were gathered for a variety of pesticides, lures and trapping agents. Over 100 spreadsheets were then consolidated into a Comprehensive Risk Analysis workbook to calculate exposure and estimate risk. Joint CDFA, Cal/EPA Office of Environmental Health Hazard Assessment (OEHHA) and Department of Pesticide Regulation (DPR) meetings were held six times to address exposure & risk, as well as additional separate meetings with key staff to discuss and confirm appropriate assessment approaches, and review elements of the various CDFA programs. Furthermore, CDFA staff was regularly consulted for essential information on program activity.

Significant progress was made on one of the two expected outcomes, the development of a modeling tool to assess human and ecological risk. Complete physical, chemical, environmental fate and toxicity (PCFT) baseline data was gathered for the eight programs under assessment. These accomplishments met or exceeded established goals and deadlines.

Two of the most important partners in the project have been the OEHHA and DPR. Both of these agencies have expertise in the assessment of human and ecological risk and as a result, have regularly and consistently offered valuable feedback. As described above, six meetings were jointly held with OEHHA, DPR, CDFA and the consultant staff to review the risk assessment approach and to establish future review processes. This feedback has been valuable and informative to the work on risk assessment. Joint OEHHA/DPR/CDFA/Consultant meetings are scheduled to continue take place every six weeks until RA completion. On multiple occasions, additional intervening meetings were held to promptly address topics that needed immediate attention, or would otherwise disrupt the project schedule. These meetings allowed frequent and regularly scheduled forums to provide feedback and share knowledge on approaches being taken, which has been advantageous to this project.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Significant progress was made and preparation of program Material Sheets with scenario assumptions was completed. Chemical identification and confirmation of pesticides, lures and attractants is complete. Human Health Exposure assessments are complete, and are being reviewed by CDFA with input from OEHHA and DPR. Ecological Toxicity Assessments are complete and are being reviewed by CDFA and subject matter experts from OEHHA and DPR. The protocol for Risk Assessment review is to run the assumptions through the models and receive a draft set of results. In the field of toxicology, assumptions are set very conservatively to be input into the models, and sometimes the assumptions need further research to refine them to the exact output. Numerous models were evaluated and used to estimate human and ecological receptor exposure.

At this time the Public Review Draft and Noticing of the Draft PEIR are scheduled for May 2014. The website is updated as the PEIR process continues. Public Hearings/Meetings are tentatively scheduled for June 2014 in five different locations throughout the state. The risk assessment will be included as part of the public review and comments will be taken during the review period. Long term, a tiering strategy will be developed and future programs will be evaluated as new pests are detected and protocols dictate action on these new pests.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

California produces 99 percent of 14 specialty crop commodities that are enjoyed throughout the United States, including artichokes, dates, kiwifruit, olives, pomegranates, and pistachios. Farming, processing, and closely related activities are especially significant to the economy of California's Central Valley where agriculture generates 24.2 percent of the private sector employment.

California has remained the number one state in cash farm receipts in 2011, representing 11.6 percent of the U.S. total. The state accounts for 15 percent of the national receipt for crops. Field crops contribute to $4.93 billion of California's cash receipts, while fruits and nuts account for $15.32 billion. The state has more than 400 commodities, and produces almost half of U.S. grown fruits, nuts and vegetables. The U.S. consumers frequently buy many crops that are produced exclusively in California.

In 2011 the number of growers that are specialty crop producers was 81,500 farms, which were functioning in California, which is 3.7 percent of the national total. Over 24 percent of California farms produced commodity sales totaling over $100,000, compared to 18 percent for the U.S. as a whole. The California average farm size was 312 acres, while the U.S. average farm size was 420 acres.

The number of specialty crops for California leads the nation in the production of many crop commodities, including Apricots, Asparagus, Avocados, Deans (Dry Lima), Broccoli, Brussels Sprouts, Chinese Cabbage, Cabbage, Carrots, Cauliflower, Celery, Chicory, Eggplant, Escarole/Endive, Flowers (Bulbs), Flowers (Cut), Flowers (Potted Plants), Garlic, Grapes (Table), Grapes (Wine), Greens (Mustard), Herbs, Kale, Kumquats, Lemons, Lettuce (Head), Lettuce (Leaf), Lettuce (Romaine), Limes, Mandarins and Mandarin Hybrids (Including Tangelos, Tangerines and Tangars) Melons (Cantaloupe), Melons (Honeydew), Nectarines, Nursery Crops, Dry Onions, Green Onions, Parsley, Peaches (Clingstone), Pears (Bartlett), Peppers (Chile), Peppers (Bell), Persimmons, Plums, Pluots, Raspberries, Spinach, Tomatoes (Processing), and Watermelons.

California is the sole producer (99 percent or more) of many commodities. These are Almonds, Artichokes, Dates, Figs, Grapes, Raisins, Kiwifruit, Olives, Peaches (Clingstone), Pistachios, Dried Plums, Pomegranates, and Walnuts. Almonds continue their prolific increase in value, surpassing grapes by a small amount to become California's second ranked commodity.

Specialty crop exports due to a pest infestation or disease are adversely impacted when trade partners refuse to accept a crop unless appropriate treatments are initiated. Another consequence from the spread of invasive pests occurs when commodities are unacceptable to the consumer due to blemishes, size, etc. Additionally, production costs to specialty crop produces increase directly when invasive pests proliferate. The Program EIR/RA will allow prompt action and appropriate treatment, minimizing the negative impacts to specialty crop growers.

The Specialty Crop Industry as a whole will therefore benefit from the RA when the Program EIR/RA is complete, as the findings will ensure the protections of specialty crops without causing undue harm to humans or negative impacts to the environment. The Program EIR/RA will also seek to mitigate the unintended negative effects of the regulatory process on the specialty crop industry so that specialty crop growers will be able to grow and market their product in a timely fashion. Additionally, CDFA completed an extensive review of all the approaches necessary to address the invasive species problems, through the RA, and through the Program EIR/RA process, will coordinate with partners to provide a unified response that will ensure protection for California's Specialty Crop Industry for future generations.

The certification of the Program EIR for the Specialty Crop Protection Program is supported by the growers and handlers of specialty crops across the state. Included on this list, but not limited to these supporting entities are: California Invasive Plant Council, California Apple Commission, California Blueberry Commission, California Cut Flower Commission, California Date Commission, California Farm Bureau, California Grape and Tree Fruit League, California Nurseries and Garden Centers, California State Floral Association, California Strawberry Commission, California Tomato Growers

Association, Nisei Farmers League, Western Growers Association, Western Pistachio Association, and Wine Institute.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

Capturing the full range of pest management activities including, exclusion, pest detection, emergency projects and quarantine regulations conducted by a State Department of Agriculture is very challenging. Developing representative assumptions for these areas is also similarly challenging due to the wide variety of scenarios that exist in a State wide program that reacts to an invasive pest invasion rather than performs a routine task. The RA portion was very complex and detailed, and could not have been done without thorough scrutiny of programs that were of a multi agency response. The results of the RA were highly dependent upon the assumptions used and could not move forward without a clear understanding of each situation. Generally accepted methodologies for conducting risk assessment do not necessarily accurately capture certain aspects of the pest management scenarios (e.g., no acceptable models exist for evaluating the effect of soil buffers). In September of 2012, CDFA contacted DPR and OEHHA to discuss an ongoing review of sections of the Risk Assessment as they were developed. These meetings have been highly productive and allowed CDFA to consult with sister agencies, as well as allowed feedback from subject matter experts while the process was ongoing. The goodwill between agencies, as well as the ability to make revisions and updates in real time produced benefits that far exceeded the expectations.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 69	Project Title: Climate Change Consortium.	
Grant Recipient: California Department of Food & Agriculture	**Grant Agreement No.:** SCB10069	**Date Submitted:** December 2013
Recipient Contact: Amrith Gunasekara Carolyn Cook	**Telephone:** 916-403-6719 209-491-9341	**Email:** amrith.gunasekara@cdfa.ca.gov carolyn.cook@cdfa.ca.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

California's specialty crop industry is not prepared for climate change according to recent surveys. In 2010, the California Department of Food and Agriculture (CDFA), in collaboration with American Farmland Trust, released a report titled, *California Agricultural Vision: Strategies for Sustainability*. This report outlined 12 strategies that addressed challenges to California agriculture into the future. One of these strategies is "Assure Agricultural Adaptation to Climate Change." In an effort to move forward on this strategy, the CDFA submitted a grant proposal for the establishment of the Climate Change Consortium for specialty crops. The purpose of the Consortium was to develop a plan to develop strategies to protect California's specialty crops from climate change. The strategies will be developed using feedback from a broad consortium of specialty crop stakeholders. The proposal will also support work to close an important data gap, and identify climate change strategies that are currently available, will be available, or should be available that can be adopted in California to protect specialty crops from climate change and extreme events. The outcome of this work will have a direct benefit on the specialty crop industry by helping growers prepare and implement strategy recommendations to adapting to future impacts from climate change.

The global climate has changed over the last 150 years due to anthropogenic emissions of greenhouse gases. To name a few impacts on a local level, California has experienced an increase in average temperatures, a corresponding loss of winter chill (necessary for some fruit and nut tree production), and a decrease in snowpack and water resources. Despite these alarming trends, recent studies by researchers at the University of California indicate that growers do not consider climate change to be a high priority when making on-farm management decisions.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Eleven tasks were identified in the project proposal under the work plan. All tasks were completed. In August of 2012, the CDFA issued a press release to announce the formation of the Climate Change Consortium for specialty crops (see attached). Over the next several weeks, applicants for the Consortium were solicited and 21 members were selected.

Over 100 documents, primarily scientific journal articles, were gathered for this effort using an electronic scientific database. The Environmental Scientist identified and invited lead scientific researchers to present at one of four two-day meetings of the Climate Change Consortium. Twenty-nine scientists working on different aspects of climate change at the interface of agriculture gave technical presentations over the course of the four meetings. The objective was for the scientific community doing climate change research to inform and share the results with the Consortium members and suggest possible adaptation measures. The Consortium members were then asked to consider the scientific findings and recommendations, and also use their own experiences to identify adaptation strategies for climate change in California's specialty crop agricultural sector. Twenty-five different adaptation measures were identified under four major categories. Following each meeting the Environmental Scientist provided a summary of recommendations for a total of four summaries. These activities fulfilled the project activities described in the project proposal work plan, "Read, review, and summarize scientific findings as related to specialty crops and climate change," "Identify applicability of scientific findings to California specialty crops," "Organize, schedule and plan consortium meetings," "Hold consortium meetings to identify specific, practical solutions," "Create web page and list meeting results/strategic solutions." The web page for the Climate Change Consortium is http://www.cdfa.ca.gov/environmentalstewardship/ClimateChangeAdaptConsortium.html (public). An internal webpage based on SharePoint was created for the Consortium members at CDFA to access per-meeting documents, communications, and other information (internal password protected).

The Graduate Student Assistant was responsible for the literature review of climate change in agriculture. This served as a foundation for the final report, which was co-authored by the Environmental Scientist. The final report provided both background material on climate change impacts and the Consortium's recommendations. Throughout the writing process, the Consortium members were asked to review the document and further define the recommendations. The scientific researchers that presented technical information to the Consortium were also asked to provide feedback. This process led to a comprehensive final report. These activities fulfilled the work plan activities listed in the project proposal, "Research electronic science research findings through databases and scientific journal articles," "Compile final report," and "Research and document solution strategies that are currently available.

In the final report, the Consortium's recommendations focus on activities to help the specialty crop agricultural sector adapt to climate change in the future, and specific measures that individual specialty crop growers can undertake now to reduce their vulnerability to climate change impacts.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

As outlined in the project proposal, this project was designed to make specialty crop growers more aware of the potential impacts of climate change and assist with strategic solutions that can be practically applied at farm level. The project achievements in relation to this goal are outlined below:

1. The Consortium had 21 members from both the agricultural sector (specialty crop growers and representatives from specialty crop associations) and university researchers. The members heard from leading researchers that work on climate change and agriculture. Before the start of the first Consortium meeting the members all completed a survey to self-evaluate their knowledge of climate change impacts. They completed the same survey after the final meeting. A comparison of the results of the pre-Consortium and post-Consortium survey show that the Consortium members gained additional knowledge and understanding of how climate change will impact specialty crop agriculture and the uniqueness of California's situation (see attached summary of results). For example before the first Consortium meeting, 33 percent of the members ranked themselves as "very concerned" about climate change impacts in relation to agriculture. At the final meeting, 52 percent ranked themselves as "very concerned." Additionally, before the first meeting, 75 percent of the members believed that growers should consider climate change when making farming decisions. At the conclusion of the project, 95 percent of the members believed that growers should consider climate change when making farming decisions. This represents a positive measureable outcome for the project. In the project proposal, it was anticipated that 50 percent of survey respondents will strongly consider implementing a recommendation as determined from the survey collected after the meeting. The survey data support the anticipated results.
2. The CDFA compiled a final report for release to the public on the Department website. This document will serve to educate growers and the broader public about climate change impacts and raise awareness throughout the industry. The Consortium's recommendations fall into five categories: 1) On-farm Strategies to Improve Resilience (directed toward growers), 2) Planning and Resource Optimization, 3) Research Needs, 4) Outreach and Education, and 5) Technology and Innovation. This report will not only serve as a foundation for outreach efforts into the future, but will help guide future climate change adaptation activities for specialty crop growers in California.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Specialty crop growers will be able to access the final recommendations of the Consortium through the website and through distribution of the final report through specialty crop grower associations (e.g. California Specialty Crop Council). The report was written to be a resource for information on California-specific impacts and adaptation strategies for climate change. The impacts of climate change are often referred to as regionally-specific and crop-specific. Growers can use this document to better understand risks and to help make decisions. California's specialty crop industry is very valuable; global exports of specialty crops in 2011 were worth $43.5 billion. This project will help to protect the sector and ensure its sustainability as an economic backbone of California and national and global food supply.

California specialty crop agriculture benefited from the cooperative industry interaction and feedback. The Department was able to compile a report outlining 25 specific and comprehensive strategies for climate change adaptation, which will guide future adaptation activities. Additionally, the Consortium provided prioritization for these recommendations, and the report can also be a foundation for more tailored outreach documents and presentations.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The Consortium was made up of a diverse and passionate group of individuals and it was clear that a facilitator would be beneficial to the meeting structure and overall goals of the project. The facilitator was able to add structure and maintain continuity throughout the four meetings. Utilizing a facilitator proved to be a positive choice and improved the final product.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Public information about the Climate Change Consortium can be found at:
http://www.cdfa.ca.gov/environmentalstewardship/ClimateChangeAdaptConsortium.html

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 70	**Project Title:** Small Farm Food Safety: Increasing Specialty Crop Marketability and Safety through Small Farm Outreach and Education	
Grant Recipient: California Department of Food & Agriculture	**Grant Agreement No.:** SCB10070	**Date Submitted:** December 2013
Recipient Contact: Steve Patton	**Telephone:** (916) 900-5205	**Email:** steve.patton@cdfa.ca.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Outbreaks of food borne illness and the increasing popularity of small farmers selling specialty crops at farmers markets has made small farm food safety an important emerging concern. New food safety regulations, in the process of being enacted at the federal level, are targeted toward large scale farming operations; however, there were no comprehensive farm food safety educational materials targeted toward small specialty crop growers.

The California Department of Food and Agriculture's (CDFA) grant program aimed to increase the marketability and safety of California's specialty crops. Specifically, this program was intended to enhance food safety practices for small, socially disadvantaged farmers producing specialty crops. This was Phase Two of a two-phased program, which was the "implementation and distribution phase." The program worked to inform small farmers the benefits of, and how to go about, creating and enacting a comprehensive food safety program analogous to the adoption of the United States Department of Agriculture's (USDA) Good Agriculture Practices (GAP). These standardized practices help to improve the safety and quality of food, add marketability, and promote sustainable agriculture.

The program worked to further distribute the marketing campaign created during Phase One funded under the 2009 Specialty Crop Block Grant Program (Project 59). Phase One was designed to increase the food safety knowledge of California's small specialty crop farmers through the research, development, evaluation, and production of a multilingual multimedia education and outreach program.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

As part of Phase Two of the program, an outline of the classroom curriculum and a PowerPoint presentation was created. A distribution of the multimedia educational materials to small specialty crop farmers was carried out and a series of workshops on food safety practices was given. To solicit participation in the workshops, information and flyers were sent to all Certified Farmers' Market (CFM) producers, CFM managers, County Farm Bureaus, University of California Farm Extensions, CDFA Inspection and Compliance Branch committees, and a variety of industry commissions and boards. A flyer was also posted on the CDFA's website.

Food safety courses were held from October 23 through November 15, 2012 in San Diego, Ventura, Goleta, Bakersfield, Morgan Hill, Stockton, Santa Rosa, Marysville, Red Bluff, and Eureka. Classes were held in English, Hmong, and Chinese with 193 people attending in total. The goal of the workshop series was to provide a set of tools and guidelines for farmers to build a foundational knowledge to increase their food safety practice standards through classroom presentation and the delivery of the California Small Farm Food Safety Guidelines booklet that was created in Phase One of this project.

In addition, a Cost Share program was created with applications available to all workshop attendees and other interested parties. This grant program was calibrated to encourage small specialty crop farmers in California to create a simple, yet effective, farm food safety plan that may include a USDA standardized GAP audit performed through CDFA or other approved third party audit providers. The program also provided cost share assistance, if needed. Costs that could be reimbursed through the program included first time GAP or Good Handling Practices (GHP) audits, informational assessments, water and/or soil testing, and educational training.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Though the goal was to have 200 small specialty crop farmers attend the workshops, the 193 attendees was close to that targeted number.

The exam which was created to measure the small specialty crop farmers' knowledge of food safety practices was written and translated into Spanish, Vietnamese, Hmong, Lao, Chinese, and Tagalog. The exam was given at the beginning and end of each workshop. Attendees were tested to gauge the overall effectiveness and delivery of the tools CDFA had provided. Tests given at the beginning of each class averaged a score of 64 percent, while the average score after taking the class was 85 percent. The 21 percent increase in scoring definitely showed an increase in knowledge gleaned from the course.

By the end of September 2013, the program received 47 applications totaling $7,958 for cost share assistance reimbursement for food safety programs. Only one of the 47 applications appeared to be from a small, socially disadvantaged or beginning farmer (as indicated by self-identification that a language other than English was spoken in the home). To further advertise the cost share program, reminders were sent via email to all those who had attended the food safety training. In addition, flyers were sent to the following organizations, trying to elicit responses from small and socially disadvantaged farmers: Nisei Farmers League, Central California Hispanic Chamber of Commerce, Southern California Hispanic Chamber of Commerce, California Women for Agriculture, the Hmong Farming Community Representative, California Native American Heritage Commission, and Asian American and Pacific Islander Philanthropy.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The project's aim was to enhance food safety practices for small, socially disadvantaged farmers. All the beneficiaries of this project were small specialty crop farmers.

It is not known what economic impact this program may have, but the small specialty crop farmers who participated in the workshops and/or the cost share program have a better understanding of the importance and use of a food safety program. Extra booklets were given to local County Agricultural Commissioners and University of California Cooperative Extensions so that those who did not come to the classes or participate in the cost share program will still have materials to help them with their food safety needs. Additionally, booklets in each language are available on the CDFA website. http://www.cdfa.ca.gov/is/i_&_c/sffsg.html

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

It was difficult to identify the target audience - small and socially disadvantaged farmers. The method used to identify this was to ask if something other than English was the primary language. Despite outreach efforts, only one application indicated that something other than English was the primary language spoken at home.

Though the goal of having at least 200 small specialty crop farmers educated on small farm food safety in a workshop setting was almost reached, the number of cost-share applications received was below expectations.

A reason some of the goals were not accomplished was the cultural and language barriers in the efforts to reach a multi-cultural audience. Although the booklets and tests were translated in the various languages, the outreach tools were not and that may have contributed to the lower than expected participation. Recommendation: Translate all materials in the various languages.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Attachment: Test questions with answers

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 71	Project Title: Public Relations: Consumer messaging and value added services for California specialty crop growers and stakeholders (Phase I)	
Grant Recipient: California Department of Food & Agriculture	**Grant Agreement No.:** SCB10071	**Date Submitted:** December 2013
Recipient Contact: Bob Maxie	**Telephone:** (916) 900-5018	**Email:** bob.maxie@cdfa.ca.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Consumer interest in the food supply has dramatically increased over the last five years. Consumers are interested in how their food is produced, where it is grown, and who is growing it. The recent consumer trends concerning organic, local, farmers markets and community supported agriculture have redefined retail marketing and sales. Traditional promotional activities by agricultural marketing programs (Cherry Board, Asparagus, etc.) are finding fewer acceptances within the marketplace. As a result, a sustainable and effective marketing connection between consumers and growers has become less effective.

The purpose of this project is to revitalize the promotional efforts of the California specialty crop industry through the development of a value-added marketing platform that provides growers, consumers and other stakeholders a messaging and "value-brand" that transcends traditional promotional sales marketing.

The value-added result is a marketing message/campaign that growers, retailers, and other stakeholders can use to complement and expand their own promotional activities. A value-added marketing platform uses a diversity of communication tools to motivate consumers to identify with products and brand messaging.

This project is important and timely because of increased consumer interest in the food supply and how these trends are impacting purchasing decisions by consumers. Improved marketing and messaging of specialty crop products improves the competitiveness and long-term sales of these products within retail sector.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

In order to test attitudes and perceptions of the CA Grown brand and program, consumer and stakeholder research was performed. Activities conducted included a qualitative survey and a quantitative survey of industry stakeholders and consumers. Research topics for the consumer surveys were as follows: Overall consumer trends i.e. defining locally grown; what is on their mind when shopping; CA Grown awareness (nationally and statewide); purchase influence, premium pricing; CA Grown attributes; value of being associated with CA Grown. The qualitative survey of the stakeholders was designed to test the perceived and actual value of the program to the industry and test the overall success and potential for future members as well as retention of current members.

The qualitative survey consisted of telephone interviews and a representative sample of 19 stakeholders including: 6 Specialty crop/agricultural organizations; 5 retailers; 4 trade organizations; 2 retail organizations; 1 Licensee of the CA Grown trademarked brand; and 1 specialty crop grower.

The quantitative survey consisted of a national survey of 1,000 consumers and a California Survey of 1,002 consumers. All consumers surveyed were 18 years or older, the primary shopper or had a shared responsibility in for the household shopping. Survey responses were obtained from all 50 states and the District of Colombia. In addition to the online survey, two online consumer focus groups were conducted to further test the consumer perception of the CA Grown brand and program.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The goal of the project was to establish baseline knowledge of consumer demands and industry needs through the completion of research and the development of a specialty crop value added messaging strategy.

In order to achieve this goal a strategy to perform qualitative and quantitative research and disseminate the findings of the research to the stakeholders was designated. The method to disseminate the findings was through group presentations in various locations within the state. Further, the number of groups expected to be reached through these efforts were approximately 10 agricultural programs; 50 specialty crop farmers; and 10 consumer groups.

The outcome of the research was the establishment of a marketing strategy platform that will be applied to Phase II of the grant project, which is a campaign designed to directly engage the consumer and pursue the opportunity for direct consumer support of the CA Grown programs as members. This strategy was based on the results of the surveys which are highlighted as the accomplishments of the project. The findings were presented to approximately 16 agricultural programs at the California Department of Food and Agriculture state agricultural programs CEO meeting on August 7, 2013.

Further dissemination of the findings to the targeted 50 specialty crop farmers and 10 consumer groups was not accomplished. The reason these outcomes were not achieved is that the execution of the surveys was delayed. Thus, the final results were not available until after the project expired. However, outreach continues as indicated above in the presentation of the findings to the state agricultural programs CEO meeting.

There were several questions that the qualitative and quantitative research addressed. Those questions were as follows:

- What is the current awareness and perceptions of the California Grown brand?
- What value does the California Grown brand have?
- Is there transactional value associated with the California Grown brand? (i.e., are consumers in California and nationally more inclined to buy the California Grown vs. non-the California Grown branded products?)
- Are consumers willing to pay a premium for the California Grown brand?
- What would the brand have to represent to command a preference or premium?
- Does the California Grown brand matter outside of California?
- Does the California Grown brand represent anything related to sustainability, food safety, quality and/or freshness?
- Is there an opportunity to make the connection between the California Grown brand and the attributes sustainability, safety, quality and freshness?
- Do consumers in the state and nationally recognize the California Grown logo?
- What does “locally grown” mean to you?
- Do you consider products grown in California “locally grown?”
- In your mind, does California Grown have the same meaning as “Made in the U.S.A?”

Do you associate California Grown with American-grown products? Do you regard them as one in the same or two different “sources” of agricultural products?

<u>Key Findings and Recommendations from Consumer Surveys</u>
There were several questions that the qualitative and quantitative research addressed. Those questions

were as follows:

- What is the current awareness and perceptions of the California Grown brand?
- What value does the California Grown brand have?
- Is there transactional value associated with the California Grown brand? (i.e., are consumers in California and nationally more inclined to buy the California Grown vs. non-the California Grown branded products?)
- Are consumers willing to pay a premium for the California Grown brand?
- What would the brand have to represent to command a preference or premium?
- Does the California Grown brand matter outside of California?
- Does the California Grown brand represent anything related to sustainability, food safety, quality and/or freshness?
- Is there an opportunity to make the connection between the California Grown brand and the attributes sustainability, safety, quality and freshness?
- Do consumers in the state and nationally recognize the California Grown logo?
- What does "locally grown" mean to you?
- Do you consider products grown in California "locally grown?"
- In your mind, does California Grown have the same meaning as "Made in the U.S.A?"

Both California and national consumers report that they prefer locally grown products to products grown elsewhere (75% national; 77% California).

Consumers have great respect for and want to support local farmers specifically, as well as agriculture in the state in general. They know that California produces a significant portion of the nation's food and is a major component of the state's economy. However, consumers don't understand how the brand helps local farmers. In fact, there is a misperception by some that CA Grown is only for the large, corporate producers. CA Grown needs to communicate to consumers how they are helping all famers and producers in the state and how that help translates into benefits for the local famer as well as agriculture in general in California.

California residents in the central part of the state are most interested in locally grown (68%) while those in the southern part of the state are least interested in locally grown products (60%). Women are significantly more likely than men to prefer locally grown products (68% vs. 55%).

Consumers have great faith in the food that is grown in the state, knowing it is of the highest quality and safety. They believe that consumers living outside the state have a positive perception of California-grown produce and that they seek it out. California consumers are proud of this. CA Grown should incorporate into their messaging the quality of locally produced products and the pride that all Californians should feel in supporting their local farmer and producer.

Any message about creating jobs and supporting the local and state economy resonated well with consumers. These words/phrases were consistently selected by consumers in the mission statement as being relevant or impactful to them. Overall, this is an important issue for Californians. CA Grown should also consider jobs and the economy as the central theme of their communication efforts.

Awareness of CA Grown was highest in northern California at 70% and the state as a whole at 59%. The awareness of CA grown was also most prominent among 35-44 year olds at 64%. Overall, consumers have a positive perception of the brand. Besides general positive comments about “CA Grown,” consumer perception of the brand is that it’s locally grown/grown in California. “CA Grown” matters most to residents in the San Joaquin Valley (95%) and least to residents of San Diego (78%).

Based on the focus groups conducted, some consumers were somewhat skeptical of the CA Grown brand because they are not that familiar with CA Grown, and they do not know what the benefits are to them as consumers. For some, CA Grown seems like marketing or PR. CA Grown should communicate to consumers what its purpose is as an organization, how the CA Grown campaign benefits farmers, producers and consumers, and that by getting the word out about the organization, they are actually helping those farmers and producers.

<u>Key Findings and Recommendations from Qualitative Interview of Stakeholders</u>
Members want to be shown that there is value in becoming or remaining a member. Conveying the benefits of membership is key to possibly stemming the exodus of current members.

Locally-grown is very important in the state, especially to consumers. Some retailers will advertise locally grown over California grown. Trying to incorporate “locally grown” into the messaging alongside the CA Grown brand may help increase awareness, preference and consumption of CA Grown products.

The CA Grown brand is thought to be non-existent in the minds of non-Californians. It has low awareness and many other states have similar programs, which will make it hard to compete for consumers in those states knowing that consumers in general prefer food that is locally grown. Focus on the consumers in California and strengthen the brand there before considering expansion or a national campaign

Some of the organizations felt the benefits of membership were not relative to the size of its contribution. Transparency on where and how membership contributions are spent may change this perception.

<u>Awareness and Perception of CA Grown</u>
Overall perception of CA Grown is positive. Close to 90% of interviewees do think statewide marketing campaigns, similar to CA Grown, are effective in promoting locally grown agricultural products. Almost 90% of interviewees rated the CA Grown program somewhat successful. The CA

Grown logo is appears to be widely used, recognized and memorable. Despite funding issues that have limited promotions, most have seen some form of advertising about CA Grown, and most have seen multiple forms of advertising.

Value of CA Grown
Even though most everyone who was interviewed is not a current member of the Buy California Marketing Agreement (BCMA), non-members do feel membership in BCMA can provide value to organizations. Three-fourths (75%) of those asked believe that CA Grown can command a premium price. Several respondents noted that the premium price would need to be small for consumers to be willing to pay it, and that for certain products, they do not feel consumers will pay a premium.

Respondents believe that the CA Grown brand does mean something to consumers in California, such as quality, freshness, pride, safety and locally grown, among others.

Effectiveness of CA Grown
More than half (58%) agree that the CA Grown campaign has succeeded in increasing awareness of CA Grown agricultural products. Respondents are more likely to believe the campaign has increased awareness than they are to believe it has increased consumption of CA Grown agricultural products. One-third (32%) agree that the CA Grown campaign has succeeded in increasing consumption of CA Grown agricultural products. Almost half (47%) don't know if the campaign has actually led to an increase in consumption.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

There are 15 marketing and promotions programs that can benefit from the results of the research completed as potential members of the Buy California Marketing Agreement. The current member marketing programs and agricultural organizations that directly benefited from the research were: the California Asparagus Commission, the California Pear Advisory Board, the California Cut Flower Commission, the California Avocado Commission, and the Agricultural Council of California. All California specialty crop growers are potential beneficiaries as the effectiveness of the CA Grown campaign is increased.

With pending new membership and current membership of agricultural organizations potentially thousands of agricultural organization growers/members could have access to the findings of the research completed through this project. Additionally, findings may be disseminated to major retailers including Target, WalMart, Costco, and Safeway as there has been interest in the project and in membership in the program.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The perception of CA Grown was positive with consumers and stakeholders due largely to a trend in preference to promote and purchase locally grown agricultural products. However, overall awareness of the program's promotion was not evident to consumers as there was expressed confusion as to whom and what CA Grown actually represents. Consumers want a more direct connection to their food than ever and they are seeking out any opportunity to interact and become educated about what they are eating.

The stakeholders' awareness of the program's promotion was more evident than that of consumers, but there is a need for activity levels to increase in order to create a greater presence in the marketplace.

As the targeted 50 specialty crop growers and 10 consumer groups were not reached due largely to the short timeline of this project, it may have been better to keep the focus on completing the research.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Attachment: Research results

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 72	**Project Title:** Acquisition of stereo and compound microscopy for specialty crop pest and disease identification training	
Grant Recipient: California Department of Food & Agriculture	**Grant Agreement No.:** SCB10072	**Date Submitted:** December 2013
Recipient Contact: Stephen Gaimari	**Telephone:** (916) 262-1131	**Email:** Stephen.gaimari@cdfa.ca.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The purpose of this project was to purchase equipment to enhance the ability of the Plant Pest Diagnostics Center (PPD) to provide requested training to various specialty crop constituencies by all labs (Plant Pathology, Nematology, Entomology, Seed Science, Botany). PPD routinely receives requests for training on diseases and pests of California's full array of specialty crops, from half-day workshops to larger, multiple-day sessions, for groups of varying sizes. These include training: (1) CDFA staff (e.g., border station, field, technical) to recognize or screen various pest groups to better focus detection and exclusion efforts and to promote more timely diagnostics of potential pests of all specialty crops; (2) scientific personnel from California counties to enhance their diagnostics ability, provide training in certain techniques or recognition of specific pest species and groups affecting specialty crops; (3) industry and commodity associations and groups (e.g., seed technologists, Citrus Research Board) to enhance abilities of professional diagnosticians as well as screeners and field personnel dealing with specialty crops.

The trainings are to (1) increase the knowledge base of trainees with respect to the pests and diseases that affect California's specialty crop industry; (2) raise awareness of the movement of new pests and diseases in the plant and nursery trade, in other agricultural commodities, and even on non-agricultural products to more quickly mitigate pest problems as they arise; (3) promote early detection and recognition of potential pests; (4) raise awareness of quarantine and plant health regulation requirements; and (5) interest students in the diagnostic aspect of agriculture science as a career choice.

The previous lack of the microscopic equipment necessary to offer these training sessions necessitated that PPD use other facilities at best, to provide training lacking in a clear demonstration component (with actual specimens), or to decline to provide requested training at worst. Hands-on training and clear demonstrations with actual samples provide practical experience and appreciation for the diseases and pests that cause problems in specialty crops. Pest and disease identification training is not widely available, largely due to lack of applicable courses in university programs. The ability to provide more frequent and enhanced training filled a need benefitting the California specialty crop industry.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Two microscopes were purchased, one stereo and one compound, each fitted with a camera attachment, and one dedicated digital camera setup, to facilitate the demonstration aspect of trainings and workshops by using real samples. Training is enhanced as diagnostic protocols can be demonstrated and real specialty crop pest samples displayed with the new equipment.

When trainings utilizing this equipment are conducted, survey data collection from each trainee at the beginning and end of each training session will be undertaken. Survey questions will examine the client comparison of past training opportunities and the enhanced training using the new equipment. Trainees will be asked to rate the differences in training on a percentage of improved efficiency scale. The population will be all clients trained under the proposed work plan. Project staff expect data analysis to display an efficiency improvement of at least 25% from complete survey respondents. If improvement is less than 25% training methodology will be analyzed for improvements including those providing the training.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Staff successfully acquired the microscopes fitted with camera attachments and a dedicated digital camera setup. During the grant period, there were no trainings requested, so the survey data collection will proceed from the next requested training sessions. Staff anticipated at least one or two requested trainings during this time from which they could collect data, but did not have any. However, training is ready to proceed when requested.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

PPD routinely receives requests for training from various client groups, including CDFA staff (including border station, lab and field), county staff, federal identifiers, industry and commodity groups (e.g., seed technologists, Citrus Research Board, Certified Nurserymen, horticulturalists, growers, farm advisors), scientific staff from other U.S. states and territories, scientific staff from other countries, students (typically college and graduate levels), and other professionals. These are the direct stakeholders in that they are the receivers of the training. The overarching stakeholder is the specialty crop agricultural industry in California, as it is the beneficiary of better trained people serving the industry. Acquisition of the equipment necessary for enhanced training from PPD staff makes the training better quality and more comprehensive.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

Nothing unexpected occurred, except for the lack of requested trainings in this short time period. Because trainings are "on demand," staff are prepared to provide the appropriate trainings when requested.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 73	Project Title: A Rural-Urban Connection Strategy for the Sacramento Region: Assisting communities in the planning for specialty crop agriculture	
Grant Recipient: California Department of Food & Agriculture	**Grant Agreement No.:** SCB10073	**Date Submitted:** December 2013
Recipient Contact: Josh Eddy David Shabazian	**Telephone:** (916) 653-0433 (916) 340-6231	**Email:** josh.eddy@cdfa.ca.gov dshabazian@sacog.org

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

On average, California loses approximately 55,000 acres of agricultural land per year or about one square mile every four days. The primary cause of agricultural land loss is urbanization resulting from rapid population growth, inefficient use of land to accommodate growth, and increased economic incentives for farmers to sell land to developers (e.g., reduced farm incomes, land sales as retirement funds, and increased land values). Most development of land occurs at the urban-rural edge. Lack of understanding of agriculture and rural economies is also a factor in this trend. SACOG has developed two analytical tools to evaluate land use scenarios within rural communities to assist urban and rural decision makers and communities in sustainable growth planning, which will protect and enhance specialty crop agriculture.

There is often limited access to good information to make land use decisions that affect agriculture at a regional scale. As part of the nationally recognized Rural-Urban Connections Strategy (RUCS) Project, SACOG has developed mapping and computer modeling tools that have produced an unprecedented level of data regarding the region's rural areas. The tools include several cutting-edge, yet practical, technical tools that expand the Sacramento region's understanding of the agricultural economy and assist in improving the economic and environmental sustainability of rural areas. As the Sacramento region and the rest of the California begin to emerge from the most recent recession, information about the value and needs of specialty crop production is needed to provide a way to balance choices about urban development with strategies that support and enhance agriculture.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

The California Department of Food and Agriculture partnered with the Sacramento Area Council of Governments (SACOG) to carry out this project.

SACOG developed the I-PLACE^{3}S web-based tool for land use modeling. The model includes a number of different rural and urban "place types." Typically, these represent the range of development products (e.g., residential, commercial, etc.). For the agricultural application of the model, place types are also referred to as "crop types."1 There are 30 different crop types that represent over 100 different crops. Each crop type is either a generalized category of crops or a specific crop, as needed. This reflects the agricultural diversity of the SACOG region. The crop types are assigned based on a crop map that details agriculture production at the field level across more than 2 million acres of farmland (Figure 1). Each crop type is assigned attribute data including transportation, employment, energy, input usage (e.g., fertilizer, seed and pesticide), input costs, yield, and price. The information is then used to calculate a number of infrastructural, economic and environmental indicators. These indicators include jobs, vehicle miles traveled, return on investment, water and energy consumption. The methodology and approach are transferable and scalable so any local, regional, state or federal organization may adapt them.

Because the model is specified for all crops, the analysis included in this report includes non-specialty crops as this provides a more complete and accurate illustration of the potential scenario outcomes. Including non-specialty crops better supported the purpose of this project, which is to promote and enhance specialty crop production. By including non-specialty crops results in the analysis, staff were able to demonstrate the model's ability to compare the economic viability and input needs of specialty crops to other crops. Staff time was closely monitored and only allowable charges involving work on specialty crops were charged to the grant.

While the I-PLACE^{3}S tool is very robust, it is a proprietary sole-source tool, with limited accessibility for outside organizations. As a result, SACOG, in collaboration with CalThorpe, the Strategic Growth Council and other Metropolitan Planning Organizations throughout the state has developed an open-source geo-spatial model called UrbanFootprint. It is a powerful dynamic scenario and modeling tool that has a web-based interface that requires no proprietary software to run and is designed to run on virtually all operating systems, desktops, and mobile environments. As its name suggests, most of the UrbanFootprint development has focused on urban landscapes. This grant allowed SACOG to work with CalThorpe to increase UrbanFootprint's rural analysis capacity.

[1] In cases where scenarios are run with both urban and rural land use change, we use the term "place type" generically for both rural and urban land use categories.

This project is a template for statewide application that can be used to provide a land use and economic feasibility framework for data analysis and scenario modeling, allowing local communities to evaluate current and future rural land use needs. SACOG's migration of its current urban and rural analysis model to the UrbanFootprint open-source platform not only improves a model that is already very sophisticated, but also makes it available to other regions in the state (or throughout the country) essentially for free. Coupled with crop and open space data from state-of-the-art remote sensing techniques, UrbanFootprint model development will improve upon the cutting-edge work of the RUCS project in the Sacramento region and beyond. The project also expands existing rural and agriculture metrics and allows users to compare and analyze scenarios for a range of variables and geographic scales.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Below is an illustration of UrbanFootprint's functionality. While the tool works in all six counties in the SACOG region, only Yolo County data will be used for the scenario comparison presented in this report for the sake of brevity. The report is broken into three parts:

1. Using I-PLACE3S: Developing a Base Case
2. Introduction to UrbanFootprint
3. Using UrbanFootprint: Testing Consistency and Developing Agricultural Scenarios

Using I-PLACE^{3}S: Developing a Base Case

I-PLACE^{3}S is a web-based land use scenario comparison tool. It enables users to create and evaluate multiple land use change scenarios against a set of base case conditions. It demonstrates how planning and design choices, made by a community, have impacts on development patterns, goods movement, job creation, economic development and infrastructure demands to name a few. By being aware of the consequences of different land use choices, citizens and decision makers can improve their economies, environments, and quality of life.

The I-PLACE^{3}S tool is used in the Rural-Urban Connection Strategy (RUCS) project to model agricultural land use changes. It is meant to identify various changes in infrastructural demand and economic revenues as a result in shifts in crop production. The current geographic scope of the tool includes the SACOG six counties of El Dorado, Placer, Sacramento, Sutter, Yolo and Yuba. The total value of agricultural production for these counties is more than $1.8 billion. The region has more than 7,000 farmers and nearly 2 million acres of crop and range land.

The I-PLACE^{3}S tool has the potential to support efforts to preserve agriculture land for specialty crop production by increasing the visibility and understanding of the economic and environment value of agriculture production. SACOG has already used to the tool to determine and present the economic impacts of agricultural land loss in rural communities and to develop strategies to increase the value of agricultural lands through increased support to agricultural infrastructure. The first step for the I-PLACE^{3}S model was to develop a base case scenario of land use using the crop map (Figure 1).

The crop map includes 30 different crop types, some of which are represented as rotations. Rotations are represented as Alfalfa, Grain/Other Vegetable and Tomato Rotation. They include a combination of alfalfa, beans, corn, safflower, sunflower, tomatoes and wheat. The blend is a weighted average of the six commodities based on the likelihood of being in the ground in a multi-year crop rotation (Table 1). The rotation name is given to the crop with the highest likelihood in any given year. SACOG met with stakeholders via four meetings with the Yolo County Farm Bureau, Yolo County Agricultural Commissioner, and Yolo County Farm Advisor. Staff from Yolo County Economic Development Department was also included in stakeholder meetings. On average 10 people attended the meetings to provide feedback on SACOG's work. The first meeting was a project overview presentation, while the remaining meetings focused on working with stakeholders to refine data and model design. The agriculture stakeholders (farmers, extension agents, and County Agricultural Commissioner's) vetted the composition of the rotations and the breakdown of the ratio. A similar methodology was used to develop the other blends used in the alternative scenarios, described later.

The base case scenario is a snapshot of current conditions. It represents how the study area would be expected to perform if current crops and development patterns were unchanged. All other alternative development scenarios are compared to the base case in order to assess alternatives.

The 30 crop types were assigned attribute data used to develop indicators to compare different scenarios. The attribute data are primarily based on the University of California Cooperative Extension's Cost to Produce studies (Table 2)[2]. These studies include estimates for transportation, employment, energy, input usage (e.g., fertilizer, seed, and pesticide), input costs, yield, and price. The indicators were also used to develop different scenarios.

Despite I-PLACE^{3}S many strengths the potential for application and utilization by other regions in the state was limited by its operating system. I-PLACE^{3}S is a sole source operating system. To overcome this challenge, SACOG is transitioning to UrbanFootprint.

[2] There are a number of crop types on the map that do not have corresponding Cost to Produce Studies. They include equine, fallow, habitat, and nursery. These crops were excluded from the indicator list. The crop list also includes some places that were not included in the base case like asparagus and blueberries.

Introduction to UrbanFootprint

Similar to I-PLACE^{3}S, UrbanFootprint is a web-based planning tool. Built by Calthorpe Associates on a base of open source software (i.e. Linux, PostGIS, and PostGreSQL), it is a powerful and dynamic scenario creation and modeling tool with full co-benefits analysis capacity. UrbanFootprint is a complete data, scenario, and analysis ecosystem, serving as a practical organizing vessel for large and varied data sets, future plan and scenario data, modeling engines, and results reporting. Its thin-client web-based interface requires no proprietary software to run and is designed to run on virtually all operating systems, desktop, and mobile environments. SACOG is in the process of transitioning into UrbanFootprint for the development of their urban and rural land use planning processes.

Although UrbanFootprint is still in development, the core functionality and logic for creating scenarios and testing different policies is in place (Figure 2). Project staff will continue to work with Calthorpe and other developers to further push the limits of the tool and incorporate new functionality as needed.

Using UrbanFootprint: Testing Agricultural Scenarios

Project staff worked with Calthorpe Associates to integrate the RUCS functionality within I-PLACE^{3}S into UrbanFootprint. As part of this work, two tests were conducted. The first test was conducted to input the base case scenario into UrbanFootprint and see if similar results were reported from the I-PLACE^{3}S tool and UrbanFootprint, the second test was to create scenarios from scratch and see if the results were in line with SACOG's expectations based on work with I-PLACE^{3}S.

The first test created a base case scenario in UrbanFootprint (Figure 3) and compared the return on investment for Yolo County by crop type estimated by I-PLACE^{3}S and UrbanFootprint. The results comparing return on investment are shown in Table 3.

The base case scenario was created in UrbanFootprint to best match the cropping patterns and metrics used in I-PLACE^{3}S base case. Figure 3 shows a similar cropping pattern as that shown in figure 1 for I-PLACE^{3}S. Some cartographic changes need to be made to UrbanFootprint to better represent the color patterns used in the RUCS project to date, but the results suggest that UrbanFootprint is performing as intended.

A slight difference between the two tools is due to rounding, and a difference in how gross area is calculated. Project staff will continue to explore this issue, but feels this difference is negligible. The return on investment comparison relies on an estimate of acres, production yield, return and cost. Since these numbers are within a less than 1% difference, it is assumed UrbanFootprint is conducting the calculation in a similar fashion to I-PLACE^{3}S, and therefore all calculations are correct relative to project staff research and findings.

The second test conducted was to model a set of scenarios in Yolo County to compare to the base case, and see if results seemed reasonable to project staff based on prior experience. Three scenarios for Yolo County were developed and maps of four indicators - return on investment, labor demand, truck trips, and water demand - were generated.

The three alternative scenarios were developed to test the model and to show drastic shifts in cropping patterns as a result of potential market and environmental changes. The changes in the market and environment are supported by regional stakeholders and agricultural experts. For the purposes of this exercise, the model was applied to Yolo County but the analysis could have been conducted on any of the six counties in the SACOG region. The three scenarios are:

1. Drastic rise in water cost, resulting in shifts in production to low water-use crops (Bishop, Curtis, and Emm 2010),
2. Drastic rise in labor cost, resulting in shifts in production to low labor-demanding crops (CA Farm Bureau 2012)
3. Increased demand for locally grown specialty crops met by small farms, resulting in shifts from export oriented commodity production towards more fresh consumed specialty crops (Martinez et al. 2010)

The scenarios were taken to the extreme, assuming that all production (excluding equine, fallow and pasture) would shift to crop types that exemplified the sought after characteristics. (These are example scenarios for illustrative purposes only and should not be construed as advocating for any of these land use changes.)

For the scenarios all relevant crop types were compared over a number of indicators to the base case. These indicators included water use, labor cost, return on investment, gross return (Table 4). As stated earlier the indicators are based on University of California Cooperative Extension Sample Cost to Produce studies.

To best reflect the scenarios used to test model functionality, crop blends were developed based on the different criteria. These blends were then applied to all of the acreage except for pasture and equine. It was assumed that these systems do not have readily available water and therefore changes in production type would require large infrastructure investments. The table below outlines the blends as identified in the research. The low-water scenario used grapes and the general field crop blend. The low-labor scenario used the alfalfa blend, and the specialty crop scenario used a blend of specialty crops as outlined in table 4.

The three scenarios were modeled within UrbanFootprint, and the results analyzed to see if results were as expected, based on the research conducted for the scenarios, as mentioned above. The maps (Figures 4-6) show the cropping patterns, labor demand, water demand, and truck trips generated for each scenario.

SACOG is currently using the model in two case studies for the counties of Yolo and Yuba. Stakeholders in these counties are seeking analysis to inform their understanding of and strategies for serving local market opportunities. In particular, the stakeholders need to better understand local demand for specialty crops and the amount of production needed to serve these markets. The Yolo

County case study has at least 15 stakeholders participating and they will generate at least 4 scenarios of possible cropping pattern changes and use indicators such as water demand, labor demand and return on investment to evaluate those scenarios. The model will help them understand which crops they should pursue given their limitations and cost with the supply of water, labor and land relative to the value of various crops. The Yuba County case study is less advanced to date, but will address similar questions and strategies as the Yolo County case study. Stakeholders in Sutter County have expressed interest in using the model; however, no work has started in that county to date. There is also interest in applying the model to the five Sacramento-San Joaquin Delta counties to assess the impact of the Bay-Delta Conservation Plan on agriculture in those counties. Stakeholders are seeking funding to develop data and modeling to develop strategies to maintain, if not increase, the viability of agriculture in the Delta in the face of losing potentially 100,000 or more acres of farmland for habitat purposes.

The Yolo model is expected to be completed next year and the Yuba model is expected to be completed within six months.

Outreach is ongoing with the entire SACOG region (6 counties and 22 cities) to work on food system economic development. The model is the cornerstone for this work since it provides an analytical foundation for analyses needed to guide strategies that better connect rural and urban economies and capitalize on opportunities in the food system. State-wide conversations are ongoing about deploying the model in other regions to help them with similar objectives. In particular, the USDA Rural Development State Director is seeking partnerships and funding to deploy RUCS in other parts of the state. Those conversations also include adding functionality to the model to better assess "working landscapes" opportunities via market analysis for environmental services.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The results of this project are available to the six counties (El Dorado, Placer, Sacramento, Sutter, Yolo and Yuba) and 22 cities within the region to help stakeholders understand ways to support and enhance specialty crop production in the Sacramento Valley. The region's six agriculture commissioner offices, five Farm Bureaus, five farm advisors, five county economic developments, nearly 1,000 specialty crop growers, and processors, distributors, and at least 39 agriculture advocacy groups will all benefit. At least 261,655 acres or $929 million of specialty crop production in the region will be affected by this work and will have the ability to use the tools that have been developed.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

Although the tool appears to work as needed, testing of scenarios will continue. The analysis comparing the results of the base case scenario from I-PLACE^{3}S to those of UrbanFootprint demonstrates that the new model is very closely replicating the functionality of the old model. The scenario comparison demonstrates that the model is capable of analyzing differences in possible futures for agriculture and provided reasonable results allowing users to compare indicators over a range of conditions. Extreme conditions were tested to evaluate the sensitivity of the model and found that key analysis indicators moved in the right direction and were appropriately relative to other scenarios. For example, in the diversified vegetable production scenario, the needs and impacts of small farm operations was tested. Such farms have much higher rates of manual labor and drive small loads of product to market multiple times a week. The model shows the substantial increase in labor needs and truck travel compared to other scenarios, if vegetable demand was served exclusively by small farm operations. If this were a realistic example, the region could use this information to address these challenges and opportunities through developing strategies with specialty crop stakeholders and local governments to reduce impacts and/or support these farm operations. If this were a realistic example, the region could use this information to address the labor, water and trucking challenges identified by the model results. This information could help assess market opportunities and assist in developing strategies with specialty crop stakeholders and local governments to reduce impacts and/or support these farm operations.

UrbanFootprint is an improvement over I-PLACE^{3}S in that it is open-source, it has more flexibility in its application and provides an opportunity for multiple organizations and regions to not only improve the model, but perhaps more importantly, use results to consider future policy and planning changes that support and enhance both urban and rural economic and environmental viability. The model provides this information in an easily understood format that is also approachable by the public at large.

The UrbanFootprint model provides a comprehensive modeling tool will enable stakeholders to quickly and easily see the trade-offs of land use decisions and highlight strategies that achieve multiple objectives.

To better serve its members, SACOG conducts the modeling rather than the members utilizing the modeling tool directly. Because of this, website analytics regarding the number of community stakeholders utilizing the tool are not available. In addition, because the tool is not available online, deployment for use by other regions is currently in discussion, as noted above. A lesson learned is to determine the best method of implementation for the intended beneficiaries.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Attachments

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 74	Project Title: Development of an Interactive Web-based Specialty Crop Nutrient Information Guidelines: Phase V	
Grant Recipient: California Department of Food & Agriculture	**Grant Agreement No.:** SCB10074	**Date Submitted:** December 2013
Recipient Contact: Eddie Hard William R. Horwath	**Telephone:** (916) 900-5022 (530) 754-6029	**Email:** edward.hard@cdfa.ca.gov wrhorwatch@ucdavis.edu

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The California Department of Food and Agriculture (CDFA) Fertilizer Research and Education Program (FREP) partnered with the University of California, Davis (UC Davis) to develop fertilization guidelines for major specialty crops grown in California. The guidelines are based on results of FREP-funded research projects, University of California published research, extension bulletins and other peer-reviewed research. The guidelines are becoming available to specialty crop growers, certified crop advisors and others through an interactive visual interface on the FREP homepage. This project provided additional resources, mainly providing research summaries of specialty crop soil fertility requirements to more quickly provide nutrient management guidelines on the FREP homepage.

The motivation for this project is two-fold. First to assemble one source of information that growers of specialty crops can access to determine the nutrient management needs of their crops as well as other factors that affect nutrient management such as soil type, irrigation practice, crop rotations, issues with diseases, etc. Secondly, additional information is provided on how to take soil and plant samples for nutrient management. Finally, though recommendations are site specific, the website provides growers to efficiently develop nutrient management plans to achieve the best economic performance and reduce offsite loss of nutrients. In summary, the website provides information on how develop nutrient management through information on soil and plant tissue sampling and using the results to assess the nutrient needs of specialty crops.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

This work entails constructing a searchable database of research specific to specialty crops and an interactive website that provides information on developing crop specific nutrient management plans.

The objectives for this project were as follows:

1. Enter key information of FREP-funded research projects or other scientific literature into the existing nutrient database to support the interactive visual nutrient guidelines interface.
2. Develop web-based interactive visual interface for nutrient (nitrogen, phosphorus, and potassium) and irrigation management guidelines for major specialty crops grown in California. By the end of the project, guidelines for at least ten major specialty crops shall be available online.

Objective 1. Includes the following sub-objectives:

1. Synthesizing full technical reports in relation to specialty crop/plant nutrient and water requirements, etc.
2. Assisting CDFA IT to develop a searchable database.
3. Researching additional data for each specialty crop report needed for databases (e.g., soil type using NRCS soil survey database).

The research results contained within the reports from the grants program of the CDFA Fertilizer Research and Education Program (FREP) for the past 20 years represents a vast store of knowledge. The results are not readily accessible to the public for a number of reasons because the results are not contained in a searchable database to allow the information to be mined by potential users. Second, the information contained in the reports is often too technical and difficult to interpret for practical applications required by growers of specialty crops. These reports were summarized and the pertinent information entered into a searchable web based database. In addition, crop information is located in an interactive web-based portal where specialty crop growers can access information for specific crops described in objective two.

Objective 2. Use the information summarized in objective one to create an interactive web-based information source for specialty crops. The webpage represents a one stop information source for specialty crop growers for information on crop nutrient requirements and management, a historical view of nutrient management over time and new approaches to nutrient management made possible by new technologies such as irrigation approaches (switch to micro-irrigation practices). The web site (http://apps.cdfa.ca.gov/frep/docs/Guidelines.html) is an interactive visual user interface for presenting the database information in a format that is easy to comprehend for the following crops (almonds, lettuce, broccoli, and tomatoes; with additional coming). Growers can peruse information on all the macronutrients and some micronutrient needs of crops by simply pointing to the nutrient or other factor of nutrient management such as soil and leaf tissue analysis. Where needed, other nutrients such as boron for almond production are included because they are vital to managing the macronutrients (nitrogen, phosphorus and potassium). In addition, the site provides additional information for specific soil types and region where specialty crops are grown. Each crop webpage contains all the citable resources used in creating the nutrient recommendations so that users can search for additional information if needed or desired. Staff time was monitored and only charged to the grant when work was performed on specialty crops.

The joint effort between FREP and the Department of Land, Air and Water Resources (LAWR) at the University of California, Davis provided the resources and expertise to make this project possible. The project utilized a Post Doctoral researcher to compile and summarize data from specialty crops from a variety of sources. The Information Technology resources of the CDFA were used to construct the interactive web-page with consultation with LAWR.

Although project staff was unable to attend the annual AAPFCO meeting to obtain feedback, presentations were made at an Environmental Protection Agency (EPA) workshop in June 2013, at a Certified Crop Advisors (CCA) training steering committee meeting in June 2013, and at the Annual FREP Conference in October 2013. Feedback from attendees was positive, as evidenced by the inclusion of the information into the CCA training program.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

The goals of the project were:

1. Enter key information of FREP-funded research projects or other scientific literature into the existing nutrient database to support the interactive visual nutrient guidelines interface.
2. Develop web-based interactive visual interface for nutrient (nitrogen, phosphorus, and potassium) and irrigation management guidelines for major specialty crops grown in California. By the end of the project, guidelines for at least ten major specialty crops shall be available online.

Key information of FREP-funded projects, extension materials and scientific literature was entered into a comprehensive nutrient database to support the interactive visual nutrient guidelines interface of the previously described nutrient management website

An interactive web-based visual interface for nutrient (nitrogen, phosphorus, and potassium) and irrigation management guidelines for major specialty crops grown in California was launched during the project period. The web site (http://apps.cdfa.ca.gov/frep/docs/Guidelines.html), an interactive visual user interface for presenting the database information in a format that is easy to comprehend for the following crops (almonds, lettuce, broccoli, and tomatoes) was established with additional specialty crops to be added (walnuts and wine grapes). In the near future guidelines for the major specialty crops will be available online.

The establishment of the website was the first step. The next outcome will be specialty crop growers, certified crop advisors and others using the site as a centralized information source. Presently, the website experiences considerable traffic amounting to one third of the total CDFA website hits registered over the grant period.

An interactive database was constructed where none previously existed. In addition, the construction of an interactive web-based nutrient management tool now exists where none previously existed. With the website garnering one third of the total CDFA web hits during the period, it can be viewed as a success where no website existed previously.

Methods are being developed to more effectively identify the database users. Delay to develop a survey is due in part to the mid summer release of the database. It is expected that the robustness (number of records) of the database content will increase with time, allowing both growers and Certified Crop Advisors to more effectively apply the guidelines.

Currently, methods involve:

- tracking the number of database website hits before and after public presentations of the database
- general survey of Certified Crop Advisors during CDFA sponsored nitrogen management training sessions being held January, February and March 2014
- With the use of Survey Monkey, developing an online survey with specific user questions for those Certified Crop Advisors who attended the CDFA sponsored nitrogen management training sessions. The responses over the course of the next three months will help gauge the overall grower and Certified Crop Advisor awareness of the database and identify to the extent practicable, the field application of guidelines contained in the database
- On January 15, 2014, at a CDFA sponsored nitrogen management training in Modesto, California, 20 percent of 120 participants acknowledged awareness and use of the CDFA guideline database.

All stated goals and outcomes were achieved during the grant period.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Specialty crop growers benefited from this project. The completion of this project represents the first ever database and interactive website dedicated to supplying information for nutrient management of specialty crops in California. This information previously existed in disparate sources, including reports from FREP projects, scientific literature, extension materials and commodity based publications. This project brings together all of these disparate sources of information into a searchable database and interactive website where growers of specialty crops, certified crop advisors and others can find information for crops in one specific source.

The database and interactive web-based nutrient management guidelines were created where none existed previously. During the period July 2012 to August of 2013 all of the CDFA websites experienced a total of 18,046 hits. The interactive nutrient management website had a total of 6,965 hits representing more than a third of the total hits of all CDFA websites combined. These data show that the website is being perused and it is expected that this will continue into the future.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The project represents the early phase of centralizing nutrient management data for specialty crops in California. The centralized product/tool will ensure growers, certified crop advisors and others have a common information resource to develop and prescribe nutrient management plans. The significant number of visits to the site is evidence users are interested in utilizing the nutrient management specific data.

The information provided in the website is general and does not specifically account for soil types and regions, though a base level of information is provided based on the richness of information contained within the reports for each specialty crop. Some information is provided to adjust nutrient management based on soil types and regions but more information would improve site-specific nutrient management plans. Ideally, the nutrient management guidelines should be linked to a GIS data, such as a soils database like STATSGO to provide site-specific information. For example, there is a rainfall gradient from north to south that likely result in greater potential for leaching in California's Sacramento Valley versus California's San Joaquin Valley. Breaking the current specialty crop nutrient management prescriptions into regions and merging with climate and soils databases would optimize nutrient management prescriptions. This would greatly increase the efficiency of nutrient applications and management across California specialty crops.

Peer reviewed journal articles were not written due to not enough available data existed to write such articles. The same reason prevented creation of outreach materials. Some publications are minor and concentrate on updates to provide information on the status of the website. These include http://plantingseedsblog.cdfa.ca.gov/wordpress/?p=4457 and http://ucdaviscaes.wordpress.com/2013/08/20/cdfa-posts-fertilizing-guidelines/. These represent initial efforts to advertise the nutrient management and nutrient database sites.

Publishing the guidelines online took more time than anticipated, and since the guidelines were not available, the survey could not be conducted. Two main reasons caused the delay in publishing the guidelines:

First, due to the dearth of peer-reviewed research on the nutrient requirements of specialty crops, compiling the information needed to write the guidelines was much more time consuming and took longer than anticipated.

Second, to ensure that the guidelines are relevant to growers and crop advisers, a draft of the guidelines was sent to scientists and farm advisors for a review. These professionals are very busy and getting a feedback took longer than expected. It seemed easier to get a feedback from people who were already aware of the project.

So the lesson learned is to contact potential reviewers early during the process of collecting data and writing the guidelines, and staying in contact with them. In some cases this helped speed up the review process considerably.

The most unexpected outcome is the dearth of peer-reviewed research on the nutrient requirements of specialty crops. Fortunately, other valuable sources such as final research reports submitted to FREP and commodity groups, University of California Cooperative Extension publications and newsletters provided abundant information to achieve the goals of this project. Site visits were also conducted with farmers of lettuce, almonds, tomatoes and grapes to discuss nutrient management plans for their crops were made instead. During these site visits, the farmers explained how they developed their nutrient management plans for specialty crops that are rotated with non-specialty crops. These discussions provided additional information on nutrient management for the nutrient management website.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

- Presentation at the EPA workshop 'Reactive Nitrogen Research for San Joaquin Valley' on June 4-5, 2013 in Fresno: Geisseler, D., Horwath, W.R. Nutrient Management Guidelines for Major Crops in California (http://www.epa.gov/region9/ag/workshop/nitrogen/index.html)

- Presentation at the meeting of the steering committee for the CCA training in Davis on June 7, 2013: Geisseler, D., Horwath, W.R. Nutrient Management Guidelines for Major Crops in California.
- Presentation at the Annual FREP Conference on October 29-30, 2013: Horwath, W.R., Geisseler, D. Assessment of Plant Fertility and Fertilizer Requirements for Agricultural Crops in California (www.cdfa.ca.gov/is/ffldrs/frep/pdfs/2013_Proceedings_FREP.pdf)

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 75	Project Title: Farm to Fork Website Development-Phase I	
Grant Recipient: California Department of Food & Agriculture	**Grant Agreement No.:** SCB10075	**Date Submitted:** December 2013
Recipient Contact: Elysia Fong	**Telephone:** (916) 900-5189	**Email:** Elysia.fong@cdfa.ca.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The California Department of Food and Agriculture (CDFA) Farm to Fork Office sought to create an innovative website to centralize the enormous amounts of farm to fork related data available. A vast amount of information regarding best practices, contact information, procurement methods, and a myriad of other resources exist but not in one centralized, easy to find location. This website allows specialty crop growers, food service institutions and local community organizations to forge new partnerships that will facilitate better service efforts in food access and the charge to put California specialty crops on every plate. The website focuses on visual media and tech savvy information about distribution channels related to specialty crops. It provides links to partner state agencies websites, such as California Department of Public Health's Harvest of the Month and California Department of Education's Team California for Healthy Kids.

Large food service institutions and California specialty crop growers often face barriers establishing sales relationships. These barriers include institutional procedures, local environmental health regulations, transportation logistics, and lack of awareness of specialty crop availability, both geographically and seasonally. Best practices information posted to the website inform specialty crop growers and food service institutions of methods by which other specialty crop growers and/or food services institutions have overcome these barriers. Such information will assist interested parties in developing methods and processes that will allow specialty crop growers to sell directly to the food service institutions and food service institutions to purchase locally grown, seasonal fruits and vegetables directly from the specialty crop growers.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Activity: Develop framework and content of website

- Overall Framework
  Project staff developed an overall framework for the website – designing it to appeal to the typical Californian consumer as well as specialty crop growers and institutional food service directors. The strategy included an artistic presentation of information, intended to draw in website users to explore the visually appealing, user-friendly site.

- Regional/Seasonal Page
  Project staff worked with the CDFA Certified Farmers' Market staff to gather information about when and where specialty crops are typically grown in California. Project staff decided to use the market manager handbook as our rough guide to when and where different specialty crops are grown. Project staff then worked with CDFA IT staff to visually represent this information in an easy-to-use way on the Regional/Seasonal map – dividing California into 5 regions (Northern, Central North, Central Coast, Central South, Southern) and listing which specialty crops are grown in those regions during which months. (See Screen Shots)

  Project staff also reached out to various specialty crop boards and commissions for permission to link to their websites and recipes, in order to provide users with more information about those specialty crops and examples of how to cook with them. For example, users can click on "Sweet Potato" and go directly to the Sweet Potato Council of California's website with over 50 sweet potato recipes.

- Best Practices (Explore Local Efforts Page)
  Project staff worked with 12 organizations to write up best practice descriptions. Project staff first compiled a list of model organizations, making sure to include a variety of different types of "Farm to Fork" work, including school lunch programs, gardens, food policy councils, specialty crop farmers, and community organizations. Project staff then interviewed these organizations and wrote up descriptions of their work for the website's best practices page (see screenshots).

- Blog Development "Tales from the Field"
  Project staff wrote blog posts, including introductory blog post (see screen shot), to help drive traffic to the site and update the site with relevant Farm to Fork news and information.

- Survey Development
  Project staff created a survey to gauge the effectiveness of the website and worked with IT staff to post it on the website.

- Project staff also worked with CDE's Team California for Healthy Kids and CDPH's Harvest of the Month to post links to their respective programs.

Activity: Design, create, and test website

- Working with Project staff, CDFA IT staff designed the overall CA Farm To Fork site, along with its navigation and interactive features. The designer hand drew the original artwork for the website and the blog, including the map, graphics, logos, and icons. He also created the format for Tales From The Field, the companion blog and the format of the online survey form. CDFA IT staff launched the "Tales from the Field" Blog and activated the WordPress data collection and reporting system for responses to the online survey form.

- CDFA IT staff tested features of the CA Farm To Fork website on multiple devices.

- CDFA IT staff posted monthly crop harvest information and related links on regional specialty crop pages.

- Project staff met regularly with CDFA IT staff to ensure that the design and content for the website were well coordinated and able to launch on time.

Activity: Post Best Practices on website

- Project staff and CDFA IT staff worked together to post the 12 best practices organizations on the website. (See screen shots, "Explore Local Efforts")

- Project staff also worked with CDFA Today to include video highlights of some of the featured organizations.

Activity: Publicize website

- In order to reach out to interested parties, Project staff created a flyer announcing the website that was handed out to visitors at the Sacramento Farm to Fork Festival on September 28, 2013 that drew thousands of people.

- Project staff also reached out to interested parties and networks (e.g. the California Farm to School Network) to publicize the website.

The project manager reviewed all the crops entered into the "regional and seasonal" database to ensure that only specialty crops were listed and made sure to exclude any non-specialty crops. In addition to reviewing the regional and seasonal data, the organizations and stories highlighted on the best practices/"Explore Local Success" page were also reviewed by the Project Manager to ensure those stories were solely about specialty crops.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Goal: to increase access to and awareness of best practices by specialty crop growers, food services institutions, and other local organizations.

Quantitative Outcomes:

The website was launched on September 30, 2013 and has been viewed by a variety of farmers, school food service directors, individuals, and restaurants. Specifically, the website has had:

- 1,914 views as of December 9, 2013
- 1,477 unique views as of December 9, 2013
- 78 % of survey respondents have reported that the website increased their awareness of regional and seasonal California specialty crops
- 36 survey responses

Qualitative Outcomes:

Qualitatively, the website has also received positive responses from many different stakeholders.

- "Your work on the Farm to Fork website is gorgeous and has attracted a lot of attention in the farmers' market community." (From a CFM Association)
- "This is a wonderful tool and resource for school food directors to utilize. It will make our jobs easier being able to see what's in season and can be acquired locally." (School Food Service Director)
- "What a great looking, user friendly site. We'll definitely share with our school friends." (Whole Kids Foundation)
- Inclusion in the CA Farm to School Networks' Newsletter
- Additionally, as a result of the website Project staff have been asked to present at the California Small Farm Conference.

Continuing

The website continues to run, and its survey, blog comments, and email are checked regularly by Project staff. Project staff will also continue to post new blogs, which will direct more traffic to the site. This continuing work will further connect specialty crop growers with consumers, including school food service and other institutional food service.

The survey includes questions about if users desire more information about where to purchase local produce (e.g. a map of farmers' markets), information about local farm to fork events, help selling to school districts (for specialty crop growers), help buying from local farmers (for institutional food service), and help developing recipes and menu planning. These responses will help Project staff plan for the next phase of the CA Farm to Fork Website.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

There are three main beneficiaries of the CA Farm to Fork website: Specialty Crop Growers, Institutional Consumers (with a particular focus on schools), and Individual Consumers.

Specialty Crop growers in California benefited by the increased awareness and promotion of their crops. By educating consumers about regional and seasonal produce and by including recipe links, the CA Farm to Fork Website makes it easier for consumers to purchase and use California specialty crops. Food service institutions, including schools, can use the regional and seasonal information to include more California grown specialty crops when menu-planning.

Both specialty crop growers and school districts benefit by learning about successful programs whose models they can follow in trying to include more California specialty crops in school meals. Additionally, as more school districts and specialty crop growers contact CDFA's Farm to Fork office through the website, Farm to Fork Staff are able to help connect growers and school districts with each other and provide other useful resources.

By providing information on the regions and seasons in which different specialty crops are grown, the CA Farm to Fork website has benefited both individual and institutional consumers. The guides help consumers understand when and where specialty crops are grown, and also provide links to recipes using those crops. As mentioned previously, 78 % of survey respondents have reported that the website increased their awareness of regional and seasonal California specialty crops.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The CA Farm to Fork Website is still being publicized; as we gather more data about visitors to the site we will have more information about the results of the project.

Going Forward

In the next phase of the website we hope to include a compass rose to help direct our three main target audiences (farmers, institutional food service, and individuals) to pages with more resources directly for them. The results from our current survey will help us determine what types of resources will be most useful to these different groups. For example, we were surprised by the number of requests from individual consumers wanting more information about how to cook with California specialty crops (e.g. recipes) and will work to include more recipes and other useful tips for the average consumer.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

Attachments: Screen shots from the website (www.cafarmtofork.com)

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 76	**Project Title:** Emergency Project to Eradicate the Asian Citrus Psyllid from the Porterville Area of Tulare County	
Grant Recipient: California Department of Food & Agriculture	**Grant Agreement No:** SCB10076	**Date Submitted:** December 2013
Recipient Contact: Victoria Hornbaker	**Telephone:** (916) 654-0317	**Email:** victoria.hornbaker@cdfa.ca.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

Background

On June 25 and 26, 2013, the Asian citrus psyllid, *Diaphorina citri* Kuwayama, was detected near the city of Porterville, in Tulare County. Based on the survey data, pest biology, information from California's Huanglongbing (HLB) Task Force, recommendations provided by the California Department of Food and Agriculture's (CDFA) Primary State Entomologist and Primary State Plant Pathologist, and experience gained from the United States Department of Agriculture's (USDA) control efforts in the southeastern United States, an infestation of ACP in the Porterville area was declared.

Female ACP may lay more than 800 eggs during their lives. The total life cycle has a range from 15 to 47 days, depending on environmental factors such as temperature and season. The adults may live for several months. There are nine to ten generations a year.

Compared to the rest of the world, California citrus is relatively free of diseases. This status is now in jeopardy due to the discovery of ACP. Eradicating ACP will prevent the possibility of HLB disease from infecting and killing citrus trees. Timely immediate action was needed to protect California from the negative environmental and economic impact this pest will cause, should it be allowed to remain in this area and spread.

The Need for Project Timeliness

The ACP is able to complete its lifecycle in 15 to 47 days. There are up to 10 generations per year. Due to the short lifecycle of the ACP, all life stages (eggs, nymphs, and adults) may be present at the same time. Because a breeding population existed in the Porterville area, a rapid response was necessary to prevent ACP from spreading throughout the Central Valley. The immediate need that was addressed by this project was to implement emergency eradication measures against the Asian citrus psyllid (ACP) to prevent the artificial spread over long distances to other citrus producing areas. Operations included insecticide applications, early detection methods and enforcing quarantine regulations. As ACP is the vector for the huanglongbing (HLB) disease, eradicating any incipient infestations will prevent HLB from becoming established in Tulare County.

Rapid implementation of the emergency project prevented the establishment of ACP/HLB. ACP/HLB will cause significant economic losses for the citrus production, nursery industries, urban landscapes, and for California's economy. Early detection of these pests is critical to the ability to eradicate or suppress incipient infestations. Detecting these pests at low population levels will allow for successful eradication. Additionally, enforcing quarantines will mitigate the spread of ACP.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

Activities and Tasks Performed

The project area encompass those portions of Porterville which fall within an approximate nine square-mile area around each property in which ACP has been detected. A map of the detection sites with the project boundaries and the proposed treatment work plan is attached. In summary form, the treatment plan consisted of the following elements:

1. Delimitation. Yellow panel traps were placed throughout the project areas to delimit the introduction and to monitor post-treatment ACP populations. Yellow panel traps were placed at a density of up to 100 traps in the core square mile and 50 traps per square mile in the surrounding eight square miles. Additional traps were added to further delimit the introduction and to determine the efficacy of treatments.

2. Visual survey. All host plants were inspected at all locations where traps are placed. Host plants were surveyed within an 800-meter radius around the detection sites.

3. Treatment. Properties within each treatment area were treated according to the following protocol: 1) Tempo® SC Ultra, containing the contact pyrethroid insecticide cyfluthrin, was applied to the foliage of host plants for controlling the adults and nymphs of ACP; 2) either Merit® 2F or CoreTect™, containing the systemic insecticide imidacloprid, was applied to the soil beneath the drip line of host plants for controlling developing nymphs and providing long term protection against re-introduction.

4. Quarantine Enforcement. The ACP quarantine prohibits host material from leaving the quarantine area. The ACP regulation prohibits the movement of ACP host nursery stock (citrus and citrus-related plants) from the ACP quarantined area, and allows movement within the quarantined area only if properly treated for ACP.
   a). Regulated Articles: All articles capable of harboring ACP and HLB shall be regulated in accordance with the most recent Federal Domestic Quarantine Order (USDA 2008) and state interior quarantine.
   b). Compliance agreements were issued to production nurseries, retail nurseries, growers, harvesters, haulers, nurseries, certified farmers markets vendors,

packinghouses, cut flower producers and green waste haulers and receivers located inside the ACP quarantine.

c). Staff monitored harvesting operations to assure packing bins/cartons are free from citrus plant parts.

d). Staff monitored treatment operations at citrus production nurseries.

Work Plan Activity	Accomplishment	
	Area	Quantity
Delimitation Trapping	9 square miles around each ACP detection site	830 traps in place. All traps are inspected weekly.
Visual Survey	800 meters around each detection site	167 sites were inspected. All sites were negative for ACP and HLB.
Treatment	800 meters around each detection site	67 properties treated. 100% compliance.
Quarantine Enforcement	178 square miles	-All nurseries were inspected, cataloged and host plants were placed on hold (not allowed to move out of the quarantine area). A total of 1,010,871 plants are on hold. -696 compliance agreements were signed. -Swap meets and farmers markets were inspected and prohibited from selling citrus plants. -Permits were issued to allow budwood to move out of the quarantine area.

Contributions and Role of Project Partners:

This was a cooperative program involving CDFA, the United States Department of Agriculture, Tulare County Agricultural Commissioners Office, and citrus industry stakeholders.

Agency	Role
CDFA	Deployment and inspection of delimitation traps, visual survey for all ACP life stages and plant tissue that is symptomatic for HLB, enforced quarantine regulations and applied eradicative treatments to control the ACP.

Agency	Role
USDA	Assistance in enforcing quarantine regulations, provided technical guidance.
Tulare County	Assistance in enforcing quarantine regulations, outreach to growers and homeowners, participation in grower and public meetings, inspected traps in the urban setting within Porterville.
Citrus Industry Stakeholders	Outreach to growers and provided technical guidance in industry practices. All citrus groves within 800 meters of an ACP detection site were treated with an approved pesticide.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Expected Measurable Outcomes:

Goal 1: Delimit the extent of the ACP infestation through intensive trapping and surveys in commercial and residential citrus trees (Attachment 1). Within the 27 square miles within the delimitation area, there are 830 traps that are inspected weekly.

Performance measure: There will be a reduction in pesticide use by growers and residents. Commercial and residential citrus trees will continue to bear quality fruit for consumption. Related industries, such as harvesters, packing houses, trucking companies will continue to work unabated.
Nursery stock will be able to be sold to commercial growers and residents. The general public will continue to enjoy California grown citrus at reasonable prices.

Benchmark: ACP detections in Tulare County in 2012 were detected before they spread beyond the eradication zone.

Target: Project staff will record all trapping and survey activity daily. Progress will be reported weekly for two years beyond the last ACP detected.

Outcome: Goal 1 was achieved. Delimitation traps were deployed and continue to be inspected on a weekly basis. Trapping and survey data is recorded in a weekly report. No additional ACP have been detected in the 27 square mile trapping area. Citrus was harvested as planned following two pesticide applications and compliance with quarantine regulations.

Goal 2: Timely application of insecticides to the residential properties within 800 meters of the detection sites (Attachment 2).

Performance measure: Eradicate all life stages of ACP before they reproduce and spread beyond the current eradication zone. There will be a reduction in pesticide use by growers and residents. Fewer applications of pesticides will allow beneficial insects to multiply and minimizes any negative impacts to the environment. Pesticide treatments for the psyllid would be instituted resulting in a direct cost of greatly increased pesticide use (3-6 treatments per year versus zero to two per year currently) and indirect costs due to disruption of the integrated pest management program.

Benchmark: ACP detections in Tulare County in 2012 were eradicated before they spread beyond the eradication zone.

Target: Project staff will record the addresses of all properties within 800-meters of the detection sites. The hosts treated, date of the application and the amount of insecticide applied at each property will be recorded. One insecticide treatment will be applied immediately after the detection of one ACP.

Outcome: Goal 2 was achieved. One hundred per cent of the properties with citrus trees that are within an 800-meter radius of the detection sites were treated with an approved pesticide. No additional ACP have been detected within the eradication treatment zones.

Goal 3: Establish and enforce quarantine regulations within a five-mile radius of each detection site (178 square miles) (Attachment 3).

Performance measure: The quarantine restrictions will be removed after two years of negative detections. Lifting of the quarantine restrictions will allow fruit and nursery stock to flow to the marketplace. Growers and the general public will benefit because citrus and nursery stock will be available at reasonable prices.

Benchmark: This is the first ACP quarantine area that is a five-mile radius around the detection sites. All other quarantine areas have been either a 20-mile radius around the detection sites or the entire county.

Target: Project staff will enforce the regulations daily. Activities such as number of compliance agreements signed, regulatory visits, violations issued, etc. will be recorded. The quarantine will be in effect for two years beyond the last ACP detected.

Outcome: Goal 3 was achieved and is ongoing. The quarantine regulations will remain in place for two years following the last ACP detected.

Progress of Desired Outcome:

Goal	Data Collected	Progress towards achieving goal
1 – Delimitation trapping	830 traps placed. Documentation for each trap includes: GPS points/address, date placed,	7,470 traps have been inspected. Quality control inspections are ongoing. Traps placed at locations where ACP

Goal	Data Collected	Progress towards achieving goal
	inspection record, and whether the traps are positive or negative for ACP.	were detected are negative for ACP. This goal has been achieved.
2 – Treatment	Addresses, amount of pesticide applied to each property, date of application, and hosts treated.	100% of the citrus trees within 800 meters of an ACP detection site were treated. This goal has been achieved.
3 – Quarantine Enforcement	Compliance agreements, location of all stakeholders with compliance agreements, number of host plants on hold, inspection dates, and dates of pesticide applications.	As the quarantine will be in place for two years past the last ACP detected, this goal is ongoing. To date, all quarantine protocols have been achieved.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The California citrus growers benefited from this project. California is one of the top citrus-producing states in the United States, with a total 2011 production valued at over $2.2 billion. Additionally, the establishment of ACP in California would increase the need for pesticide use by commercial and residential citrus producers, as well as require enforcement of quarantine restrictions. A 2012 study by the University of Florida showed that the presence of HLB in Florida has resulted in a loss of over $7 billion and 6,600 jobs over the previous five years. This eradication project against the ACP in the Porterville area is to prevent such devastation in California. This eradication project benefits all citrus industries (nursery, fruit for domestic use and exports, harvesters, citrus packing facilities, trucking companies and local businesses) and the environment (urban landscapes) by having a quarantine program to prevent the artificial spread of ACP over long distances.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

The ability to accomplish all of the proposed goals and objectives was due to the use of staff experienced in rapid response. Although this grant addressed the unanticipated detection of ACP in the Porterville area, the operations necessary to achieve the desired outcomes were based on emergency responses to other exotic pests.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
FINAL PERFORMANCE REPORT

USDA Project No.: 77	**Project Title:** Improving the Capability and Data Defensibility of Specialty Crop Pesticide Residues Analysis	
Grant Recipient: California Department of Food & Agriculture	**Grant Agreement No.:** SCB10077	**Date Submitted:** December 2013
Recipient Contact: Tiffany Tu	**Telephone:** 916-228-6830	**Email:** tiffany.tu@cdfa.ca.gov

Project Summary

- Provide a background for the initial purpose of the project, which includes the specific issue, problem, or need that was addressed by this project.
- Establish the motivation for this project by presenting the importance and timeliness of the project.
- If the project built on a previously funded SCBGP project, describe how this project complimented and enhanced previously completed work.

The California Department of Food and Agriculture's Food Safety (FS) laboratories at the Center for Analytical Chemistry (CAC) screen domestic and imported specialty crop produce for all classes of pesticides and herbicides to assure the quality and safety of California's food supply. The Pesticide Residue laboratories (PR) laboratories have a 24 hour turnaround obligation to submit analytical results of the specialty crop samples to Enforcement agencies so they can quarantine crops that contain tolerance violations or would pose a health risk for consumers. PR laboratories rely on rugged and sophisticated instrumentation to be effective in providing timely, accurate and relevant results. Currently the Sacramento PR laboratory utilizes the Gas and Liquid Chromatograph-Tandem Mass Spectrometer (GC and LC-MS/MS) instruments to screen for over 300 pesticides on specialty crops almost daily. These new type of instruments have expanded the laboratory's capability to detect many chemicals that were not possible to detect with traditional equipment. The Sacramento lab reported many tolerance violations on specialty crops imported to California. This information enhances the value of California's specialty crops as our data clearly demonstrate that California grown produce are the safest in the world.

The primary focus of this proposal is to enhance the efficiency and capacity of the PR laboratories in Anaheim so that the PR laboratories will better serve the California specialty crop industry. The Anaheim laboratory did not have the capability of fully implementing the large analytical screen because it did not have a GC-MS/MS instrument. Supplying the Anaheim PR laboratory with a MS/MS instrument would enable the team to detect more agro chemicals in specialty crop samples and reduce the turn-around time for effective surveillance work. Secondly, the addition of the latest generation of LC-MS/MS system for the Sacramento PR laboratory allowed the expansion of the current screening method to detect more pesticides, and for the development of faster screening and confirmation methods.

Project Approach

- Briefly summarize activities performed and tasks performed during the grant period. Whenever possible, describe the work accomplished in both quantitative and qualitative terms. Include the significant results, accomplishments, conclusions and recommendations. Include favorable or unusual developments.
- Present the significant contributions and role of project partners in the project.

The procurement process of the instruments was completed in September 2013, with delivery of the instruments in November 2013. Prior to installation of the GC-MS/MS system on December 9, 2013, the Anaheim PR laboratory staff travelled to the Sacramento PR laboratory for preliminary trainings conducted by the Senior Environmental Scientists at the Sacramento PR laboratory. Concurrently, the Sacramento PR team began the method expansion process pending installation of the LC-MS/MS system. The new generation of LC-MS/MS system will enable the team to add another 55 agrochemicals to the screen list which translates to 17% increase in detection capability. Most impressively, for the first time in the PR program, the new LC-MS/MS will provide the ability to detect the acid herbicides concurrently with daily work. Traditionally, the acid herbicide screen requires separate extraction and detection procedures that take days to complete. The new technology will benefit the California specialty crop industry, as well as consumers of California specialty crops, by enhancing the speed and efficiency of both laboratories' ability to screen specialty crops.

Goals and Outcomes Achieved

- Supply the activities that were completed in order to achieve the performance goals and measurable outcomes for the project.
- If outcome measures were long term, summarize the progress that has been made towards achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets.

Anaheim: Since the GC-MS/MS was installed in December 2013, analysis of routine samples has not begun, but is expected to begin in January 2014. Based on past success the Sacramento PR laboratory had with the same GC-MS/MS, Anaheim PR laboratory is expected to increase its capacity to monitor for pesticides in produce and decrease sample turnaround time by 30% for a more favorable time frame for enforcement and surveillance agencies to take action.

Sacramento: It is expected that the new LC-MS/MS instrument will provide the capability to screen for a class of acid herbicides and pesticides used by foreign countries. Having this detection ability enhances the ability of the PR program to detect more herbicides and pesticides on imported specialty crops, increasing the competitiveness of California's specialty crop industry by scientifically demonstrating that California's specialty crops are cleaner and safer than imported specialty crops.

Beneficiaries

- Provide a description of the groups and other operations that benefited from the completion of this project's accomplishments.
- Clearly state the quantitative data that concerns the beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The California specialty crop industry will benefit greatly from the project as laboratories' surveillance data clearly demonstrate that California products are safe. The majority of the tolerance violations are on imported specialty crops. This information enhances the value of California's specialty crops as data clearly demonstrates that California grown produce are the safest in the world. The California consumers also benefit from this project as they can be assured their food supply is being monitored for harmful agrochemicals.

Lessons Learned

- Offer insights into the lessons learned by the project staff as a result of completing this project. This section is meant to illustrate the positive and negative results and conclusions for the project.
- Provide unexpected outcomes or results that were an effect of implementing this project.
- If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

One obstacle was the delay in purchasing and installing the instruments; installation is dependent on the manufacturer's schedule. The goals were set realistically based on past success and it is expected that those goals will be achieved once the new methods are fully implemented in both laboratories.

Additional Information

- Provide additional information available (i.e. publications, websites, photographs) that is not applicable to any of the prior sections.

None.

2010
Specialty Crop Block Grant Program – Farm Bill (SCBGP-FB)
FINAL PERFORMANCE REPORT ATTACHMENTS

USDA, AMS Agreement No:
Specialty Crop Agreement No. 12-25-B-1055

State of California
Department of Food and Agriculture
1220 N Street
Sacramento, CA 95814

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Date Submitted:
December 20, 2013

California Department of Food and Agriculture
2010 Specialty Crop Block Grant Program – Farm Bill
Final Performance Report Attachments
CFDA # 10.170

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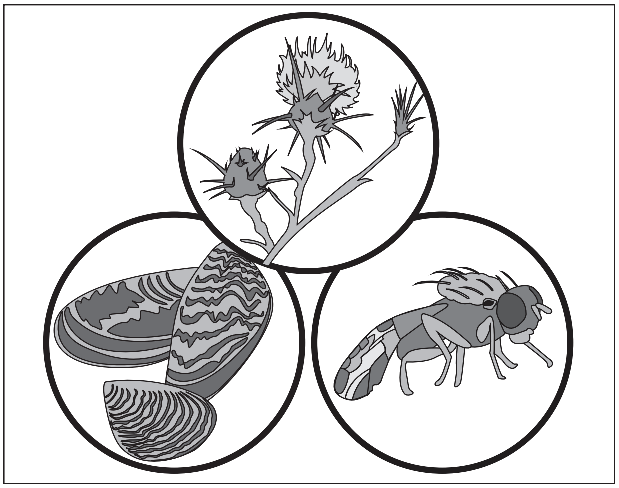
Natural Resource Fact Sheet

Invasive Species

Information compiled by the Invasive Species Council of California

Background – Invasive species are organisms that are moved by nature, people, or animals into an ecosystem where they have not been previously found. Some of these organisms are introduced naturally or accidentally by people, while others are introduced intentionally, without understanding the harm they might cause. Although most of the organisms brought into our state cause no harm, a few are able to thrive in California to the detriment of native ecosystems, recreation, agriculture, infrastructure, and public or animal health. These invasive species include plants and animals, insects and other arthropods, and pathogens.



Plants – California is home to 4,200 native plant species; approximately 1,800 non-native plants also grow wild in the state. A relatively small number of these non-native plants, approximately 200, are considered invasive. Invasive plants damage ecosystems by displacing native plants, changing the structure of the plant community, and reducing the value of habitat for wildlife and other animals. Medusahead, an annual grass found in California, is an example of an invasive plant that crowds out native grass species, reducing forage for livestock. Water hyacinth is a floating aquatic plant that has invaded the Sacramento Delta and can quickly cover the surface of open water.

Animals – Invasive animals can be divided into two major groups—vertebrates, or those animals with backbones, like mammals, and invertebrates, or those without backbones, like snails. They may cause a decrease of native animals by out-competing them for resources such as food and habitat, by preying on them, or by introducing new diseases. The Norway rat is an example of an invasive vertebrate. These rodents can spread diseases affecting humans and other animals. The quagga mussel is an example of an invasive invertebrate that clogs water systems, crowding out native wildlife and damaging water supply infrastructure.

Insects and Other Arthropods – Insect and other arthropod introductions into the U.S. have increased rapidly over the past century, largely because of increased trade and travel. Invasive insects or arthropods such as mites and spiders, often sneak onto airplanes and into shipping containers. When the containers arrive and the cargo is unloaded, pests can enter our environment unnoticed, despite government inspectors monitoring shipments. Pests can also cross state lines, "hitchhiking" as unintended passengers on produce, firewood, and other items packed in cars or planes. For example, the Mediterranean fruit fly, or Medfly, is constantly entering the state through fruit smuggling, package shipments, and tourists' carry-on luggage. The Medfly can infest a wide range of commercial and garden fruits, nuts and vegetables, and is considered the most damaging agricultural pest in the world. In California, when Medfly is found, regulators impose quarantines on the movement of fresh fruits and vegetables, and this may cause economic hardship for those producing and selling the produce.

Diseases – Viruses, bacteria, fungi, and other pathogens can cause invasive diseases which typically enter the U.S. in infected imported plants, soil, equipment, or firewood. Invasive diseases sometimes need a carrier, or vector, to further the spread of disease in an area or to a new location. For example, the Asian citrus psyllid is a newly arrived insect pest that acts as a vector spreading the bacteria thought to cause huanglongbing, a devastating disease of citrus trees. This bacterial disease is transmitted to healthy trees by the psyllid after it has fed on infected plant tissue.

Prevention and Control – Preventing the introduction of invasive species is preferred since eradication is not always successful. Travelers play an essential role in invasive species prevention. Not transporting food, animals, plants, firewood, or other materials that might harbor an invasive species will help protect our agriculture, forests, and natural and urban areas.

Economic Impact – Invasive species present a significant risk to California's agricultural economy, valued at $36 billion. Natural resources also face ecological, economic, and aesthetic impacts. Nationally, the damage resulting from invasive species is estimated at more than $100 billion annually.

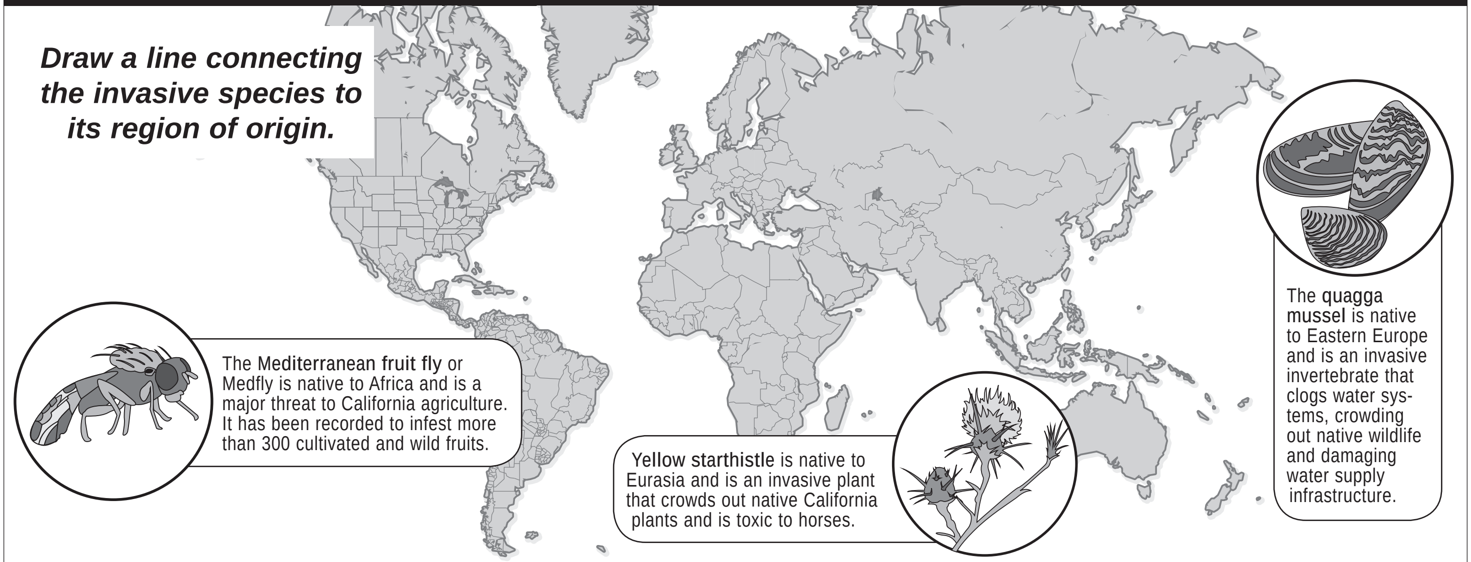
For additional information:
Invasive Species Council of California
1220 N Street, Suite 221
Sacramento, CA 95814
(888) 922-4722
Fax: (916) 651-2900
Email: info@iscc.ca.gov
Website: www.iscc.ca.gov

01/13

This is one in a series of fact sheets composed by the California Foundation for Agriculture in the Classroom (CFAITC). For additional educational materials: CFAITC, 2300 River Plaza Drive, Sacramento, CA 95833-3293 (916) 561-5625 ✤ (800) 700-AITC ✤ Fax: (916) 561-5697
Email: info@learnaboutag.org ✤ Website: www.LearnAboutAg.org ✤

Invasive Species Activity Sheet

Draw a line connecting the invasive species to its region of origin.



Lesson Ideas

- Plan and build traps to detect invasive insects. Place the traps and monitor insect populations. Display data in graph form.
- Examine firewood in a natural area for signs of beetle activity. Discuss how moving firewood increases the risk of spreading invasive species.
- Create a public service announcement that will encourage Californians to protect our agricultural supply from invasive species. Share the PSAs online via podcasts.
- Select an agricultural commodity that is sold and shipped around the world. Investigate potential pests that may "hitchhike" with the commodity.
- Take a field trip to a California port or airport. Have a state or federal regulator explain inspection procedures.
- Research native plants and plant a native garden. Label each plant appropriately.
- Draw a cartoon that teaches other students how to report invasive species to the proper authorities.
- Canines have an important role in detecting invasive species. Follow Hawkeye, a parcel inspection dog, via his blog at *hawkeye.detection-dog.com*.

Fantastic Facts

1. What is the total cost of invasive species damage nationwide?
2. Which invasive insect is thought to spread the disease huanglongbing?
3. Which invasive pest is considered the most damaging agricultural pest in the world?
4. What is the name of a mussel that clogs waterways and crowds out native wildlife?
5. What are the two subcategories of invasive animals?
6. How many native plant species can be found in California?
7. What is an invasive aquatic plant that has invaded the Sacramento Delta?
8. What is the best way to combat the introduction of invasive species?

1) $100 billion 2) Asian citrus psyllid 3) Mediterranean fruit fly 4) Quagga mussel 5) Vertebrates & invertebrates 6) 4,200 7) Water hyacinth 8) Prevention

Lesson Plan: Invasive Weed Seed Walk

Introduction: The best way to protect natural and agricultural areas from invasive species is to prevent the spread of new invasive species to those areas. Students can help prevent the spread. Invasive weed seeds can be spread through movement of soil. When we walk or hike through muddy areas, we often carry soil with us, moving debris, which may include invasive weed seeds, to new locations. In this lesson, students will examine the material that may attach to their shoes, and identify methods that reduce the risk of spreading invasive weed species.

Materials: Newspaper, magnifying glass, tweezers, shoes that can get dirty

Procedures:

1. Introduce students to a variety of invasive weeds, and what their seeds look like. Have students recognize different ways the seeds can be transported. Explain that some invasive weed seeds are transported by unsuspecting hikers, as they move through natural environments.
2. Take students on a walk around campus. Lead them through various areas, some dry and some wet, on pavement and on grassy areas.
3. Have students remove their shoes over a sheet of newspaper. Using tweezers and a hand lens, instruct students to identify, categorize, and analyze the plant material and soil that has adhered to the soles of their shoes.
4. Lead a class discussion to highlight their findings. Discuss how wet soil (mud), like glue, causes plant material to stick as students move through different environments. Remind students that invasive species can also be part of the plant material. Have students retrace their steps and predict how an invasive weed seed could have been moved.
5. Have students create a brochure to advise hikers, bikers, or off-road motorists on best practices to prevent the spread of invasive weed species.

This is one in a series of fact sheets composed by the California Foundation for Agriculture in the Classroom (CFAITC). For additional educational materials: CFAITC, 2300 River Plaza Drive, Sacramento, CA 95833-3293 (916) 561-5625 ✤ (800) 700-AITC ✤ Fax: (916) 561-5697
Email: info@learnaboutag.org ✤ Website: www.LearnAboutAg.org ✤

HELLO INVASIVE SPECIES, GOODBYE CALIFORNIA

Some invasive species destroy crops, damage natural water systems and limit our fresh fruit and vegetable choices. Others can ruin recreation areas, scenic waterways and forests. Have you seen any of the particularly harmful pests shown below?

Yellow Starthistle

This spiny, noxious weed grows abundantly and is a pest in pastures, croplands and natural areas. It crowds out native plants and is toxic to horses. If you hike through them, don't spread the seeds with you—dust off to prevent hitchhikers on your clothes or boots.

photo: CDFA

Asian Citrus Psyllid

Oranges, lemons, grapefruit—this aphid-sized insect carries the huanglongbing disease that threatens all of California's backyard and commercial citrus crops. Check your citrus trees often, and if you think you may have seen a psyllid, report it immediately to the pest hotline, **800-491-1899**.

photo: David Hall

Brown Marmorated Stinkbug

This trouble-maker feeds on fruit trees and some crops. Very difficult to control, they can be a serious problem for backyard gardeners and organic growers. If you see them near your house, vacuum them up and freeze the bag to exterminate.

photo: Gary Bernon

Endangered: FRUIT – VEGETABLES – ECONOMY – FIELDS – FORESTS – LAKES

Water Hyacinth

A popular addition to water gardens, this aquatic nuisance damages lakes, streams, irrigation and aqueducts and costs millions to control in the Sacramento-San Joaquin River Delta. Please don't plant it or release it to the wild.

photo: Willey Durden

European Grapevine Moth

This pest may have entered California on illegally imported produce or nursery stock and threatens our world famous wine industry. The ongoing eradication project is now a successful model for collaboration and effectiveness.

Gold-Spotted Oak Borer

Responsible for destroying massive numbers of oak trees in San Diego County, these beetles are headed north. They lurk under bark, so please don't move firewood: Buy It Where You Burn It.

photo: Mike Lewis

Quagga Mussels

They reproduce often and in the billions, completely clogging water supply channels and damaging recreational boating areas. They spread by hitchhiking on boats, so always clean, drain and dry your vessel.

Asian Long-Horned Beetle

A black and white beetle with a big impact—they decimate entire forests and may damage orchards. Currently found in New England and the Midwest, California's hardwoods are now vulnerable. Be mindful, they hitchhike on wooden packing materials and firewood.

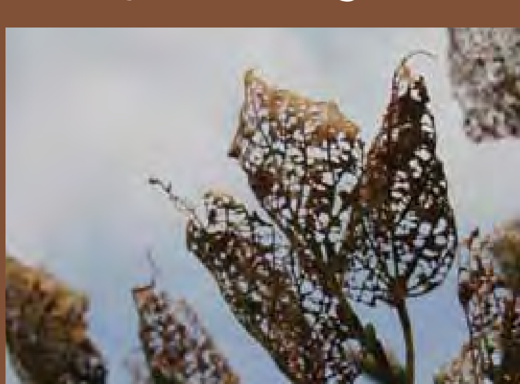
photo: Karen Snover-Clift

Brown Tree Snake

Death to birds! Because birds do so much to control crop pests, this snake harms agriculture as well as the environment. Thanks to vigilance by U. S. Customs and Border Protection, it's not in California – yet.

photo: Gordon Rodda, Bugwood.org

PRESERVEOUR BEAUTIFUL SCENERY • PROTECT OUR FRESH LOCAL PRODUCE



YOU CAN HELP

Here's how you can help protect California's bounty.

* **Keep A Lookout.** Learn to identify the invasive plants and animals that affect your favorite farm, hiking trail or boating area. Learn more at ***CaliforniaInvasives.info***
* **Buy It Where You Burn It.** Use local firewood to avoid giving bugs a free ride.
* **Plant Carefully.** Buy non-invasive home and garden plants from a reputable local source.
* **Travel Safely.** Please be sure to declare produce and plants at borders.
* **Keep It Clean.** Before returning home from fishing, hunting and camping trips wash outdoor gear, boats and vehicles to keep hitch-hikers from damaging other areas.
* **Treat Pets Wisely.** Always acquire pets from legal sources and *never* release any pet into the wild.
* **Report Sightings.** Being a "citizen scientist" is fun and easy. There are many ways to make a difference.
  - **Call California's Pest Hotline** at **800-491-1899.**
  - **Contact your local county Agricultural Commissioner, *www.cacasa.org***
  - **Visit *whatisthisbug.org* and download the *Report a Pest* app.**

INVASIVE SPECIES COUNCIL OF CALIFORNIA

Funded by a grant from the Department of Food and Agriculture's Specialty Crop Block grant program

PRESERVE

OUR BEAUTIFUL SCENERY

YOU CAN HELP

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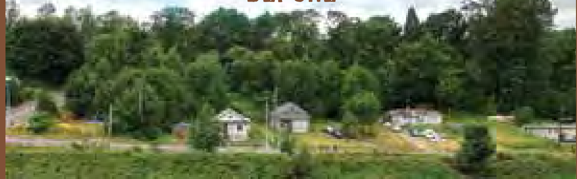
A striking example of invasive species impact! In this case, tree removal in Massachusetts to stop the spread of the Asian Long-Horned Beetle.:

BEFORE



AFTER

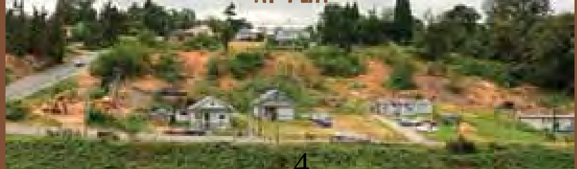


photo: Center for Invasive Species Research

PROTECT

OUR FRESH LOCAL PRODUCE

HELLO INVASIVE SPECIES, GOODBYE CALIFORNIA

Some invasive species destroy crops, damage natural water systems and limit our fresh fruit and vegetable choices. Others can ruin recreation areas, scenic waterways and forests. Have you seen any of the particularly harmful pests shown below?

Yellow Starthistle

This spiny, noxious weed grows abundantly and is a pest in pastures, croplands and natural areas. It crowds out native plants and is toxic to horses. If you hike through them, don't spread the seeds with you—dust off to prevent hitchhikers on your clothes or boots.

photo: CDFA

Asian Citrus Psyllid

Oranges, lemons, grapefruit—this aphid-sized insect carries the huanglongbing disease that threatens all of California's backyard and commercial citrus crops. Check your citrus trees often, and if you think you may have seen a psyllid, report it immediately to the pest hotline, **800-491-1899**.

photo: David Hall

Brown Marmorated Stinkbug

This trouble-maker feeds on fruit trees and some crops. Very difficult to control, they can be a serious problem for backyard gardeners and organic growers. If you see them near your house, vacuum them up and freeze the bag to exterminate.

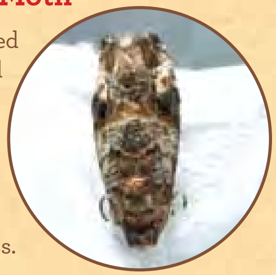
photo: Gary Bernon

Water Hyacinth

A popular addition to water gardens, this aquatic nuisance damages lakes, streams, irrigation and aqueducts and costs millions to control in the Sacramento-San Joaquin River Delta. Please don't plant it or release it to the wild.

photo: Willey Durden

European Grapevine Moth



This pest may have entered California on illegally imported produce or nursery stock and threatens our world famous wine industry. The ongoing eradication project is now a successful model for collaboration and effectiveness.

Gold-Spotted Oak Borer

Responsible for destroying massive numbers of oak trees in San Diego County, these beetles are headed north. They lurk under bark, so please don't move firewood: Buy It Where You Burn It.

photo: Mike Lewis

Quagga Mussels

They reproduce often and in the billions, completely clogging water supply channels and damaging recreational boating areas. They spread by hitchhiking on boats, so always clean, drain and dry your vessel.

Asian Long-Horned Beetle

A black and white beetle with a big impact—they decimate entire forests and may damage orchards. Currently found in New England and the Midwest, California's hardwoods are now vulnerable. Be mindful, they hitchhike on wooden packing materials and firewood.

photo: Karen Snover-Clift

Brown Tree Snake

Death to birds! Because birds do so much to control crop pests, this snake harms agriculture as well as the environment. Thanks to vigilance by U. S. Customs and Border Protection, it's not in California – yet.

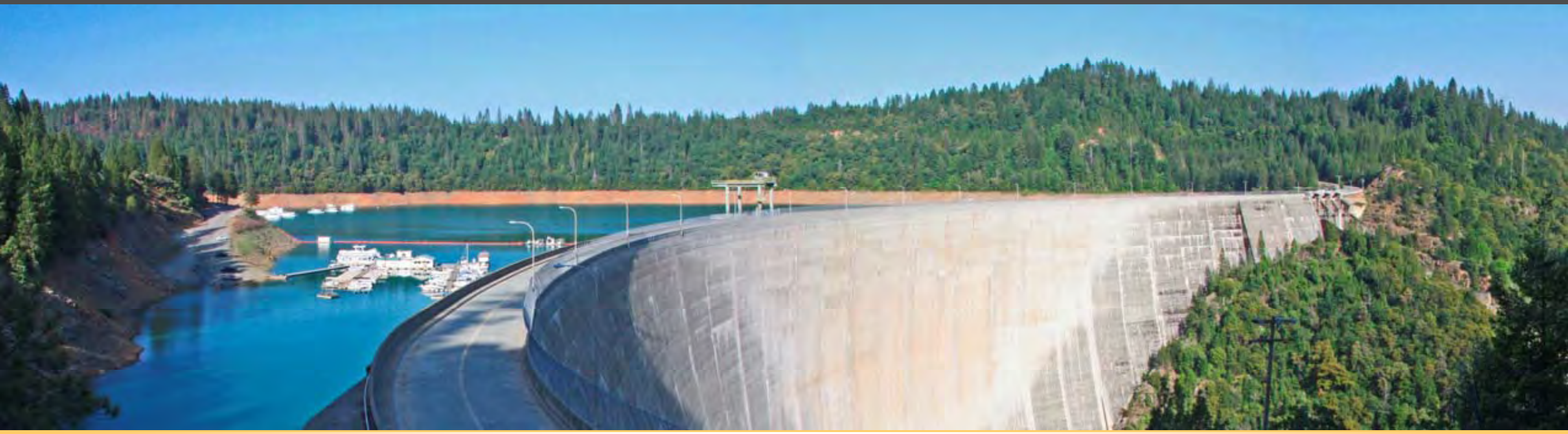
photo: Gordon Rodda, Bugwood.org

Endangered:

FRUIT - VEGETABLES - ECONOMY - FIELDS - FORESTS - LAKES

INVASIVE SPECIES COUNCIL OF CALIFORNIA

Funded by a grant from the Department of Food and Agriculture's Specialty Crop Block grant program



Invasive Species Pathway Risk Analysis for California

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PURPOSE

The purpose of this invasive species pathway risk analysis is to provide a scientific analysis and policy recommendations in support of the ***CISAC Strategic Framework*** for ***Prevention and Exclusion,*** which is to *"Identify and address new and existing pathways for entry and movement of invasive species"*.

The first line of defense and the most cost-effective strategy against the establishment of new invasive species is exclusion to prevent their entry into California (CISAC 2011). Likewise, with invasive species already in California, it is critical to employ effective prevention practices to keep from spreading them to new areas. Both efforts require intervention into an extensive network of activities that can spread invasive species into and around the state. These "pathways" range from aquatic organisms carried on boat hulls to food items and plants smuggled into the state, and programs to address these pathways require significant sophistication and resources to be effective.

Experts in invasive species detection continue to identify new and previously unrecognized pathways associated with the movement of people and trade; such as interstate and intrastate transport of firewood and express parcel shipments. Internet sales represent a rapidly expanding potential source of invasions. California needs a comprehensive study of entry and spread pathways for invasive species, including the most effective options for addressing each pathway. Research is needed to identify novel pathways, and to determine which pathways pose the greatest risk for new introductions. A range of disciplines, including anthropology and sociology, can make contributions to developing effective approaches to address each pathway. Researchers should work in partnership with public and private land managers to develop Best Management Practices for identifying new potential pathways and preventing the introduction and spread of invasive species.

INTRODUCTION

Invasive species (IS) can be transported into California via a variety of different manmade pathways, many as a result of trade. The volume of imports is forecasted to grow exponentially at an average rate of 6% per year (Levine and D'Antonio 2003). Understanding which pathways are at a high risk to introduce IS that could be potentially devastating to CA agriculture or native species is key in a successful prevention strategy.

DEFINITIONS

Invasive Species

An invasive species is legally defined by Executive Order (1999) as "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health".

Pathways

Pathways are the means by which invasive species are transported from one location to another. Natural pathways can include wind or water dispersal. Man-made pathways are those pathways "which are enhanced or created by human activity" (NISC 2007). There are two types of man-made pathways: intentional and unintentional. Intentional pathways are the result of deliberate actions that result in the translocation of organisms. Unintentional pathways are those man-made pathways that unintentionally move organisms such as ballast water discharge (e.g. red-tide organisms), soil associated with the trade of nursery stock (e.g. imported red fire ant), importation of fruits and vegetables (eg. plant pests), and the international movement of people (e.g. pathogens). With unintentional pathways, the movement of species is an indirect byproduct of human activity. This focus of this analysis is on man-made, unintentional pathways.

OVERVIEW

California Invasive Species Advisory Committee (CISAC)

In 2009, state agencies created the Invasive Species Council of California (ISCC), following the lead of the federal government (National Invasive Species Council) and more than a dozen other states. The ISCC is led by Secretary Karen Ross from California Department of Food and Agriculture (CDFA), along with Secretary John Laird from California Natural Resource Agency, Matthew Rodriguez from California Environmental Protection Agency, Acting Secretary Tracy Stevens from Business, Transportation and Housing Agency, Secretary Diana S. Dooley from Health and Human Services, and Acting Secretary Mike Dayton from California Emergency Management Agency.

The ISCC appointed 24 stakeholder representatives to the California Invasive Species Advisory Committee (CISAC). The purpose of the ISCC and CISAC is to bring relevant agencies—state, federal and local—together with external stakeholders to develop and implement effective measures to forestall the harm caused by invasive species. In 2010, these collaborative bodies produced the state's first comprehensive list of invasive species (online at *www.ice.ucdavis.edu/invasives*).

CISAC Strategic Framework

In 2008, the National Invasive Species Council generated a revised federal management plan, laying out a blueprint for action. Increasingly, states are following this lead, seeking the benefits of a coherent plan to coordinate the many agencies whose missions touch on the problem. Our plan for California builds on two existing plans, the California Noxious & Invasive Weed Action Plan (2005) and the California Aquatic Invasive Species Management Plan (2008). These plans provide extensive and detailed recommendations for improving particular aspects of the state's invasive species response infrastructure. This current plan consolidates important themes from those plans and fills gaps.

CISAC Invasive Species List

A Recommended Action in the CISAC Strategic Framework is to develop and maintain a list of invasive species that harm or could harm California. In 2009, the CISAC formed five taxonomic working groups (arthropod, disease, invertebrate, plant, and vertebrate) tasked with developing the first comprehensive invasive species list for California. This effort commenced with the compilation of the California Invasive Species List, a living document released in April 2010. Using a numerical grading system based on a standard list of analytical criteria, the list provides a common foundation for assessing the full range of species and impacts. This will serve as a baseline with which to measure future trends and progress. The list for California is compiled from a range of authoritative sources and covers all taxonomic areas. Scorecards rate each species' detrimental impacts (and any beneficial impacts) to California's environment, agriculture, infrastructure, culture, and public health. Scorecards also rate the difficulty of addressing the impacts of the species, and what level of tools are already in place to do so. The list is set up to accept and display online comments from expert reviewers, and over 100 reviewers are currently signed up to contribute information. This is an essential aspect in that the information evolves rapidly, and the range of expertise on diverse taxa is difficult to assemble. This listing effort should continue and be further refined. Though no list can be truly comprehensive, this resource is a key foundation for work on invasive species in California.

METHODOLOGY

We adapted the pathway definitions and methodology from the *Training and Implementation Guide for Pathway Definition, Risk Analysis and Risk Prioritization* developed jointly by the Aquatic Nuisance Species Task Force (ANSTF) and National Invasive Species Council (NISC) Prevention Committee via the Pathways Work Team to conduct the CISAC invasive species pathway analysis. The CISAC developed a list of pathways relevant to invasive species entering California and used the coding system from the NISC (2007) guide to code each pathway. We organized the pathways analysis into three main types of pathways that invasive species can enter in California: transportation, plant-related living industries and animal-related living industries (Figure 1). Each main pathway was divided into subcategories and each were given a unique code (Tables 1-3).

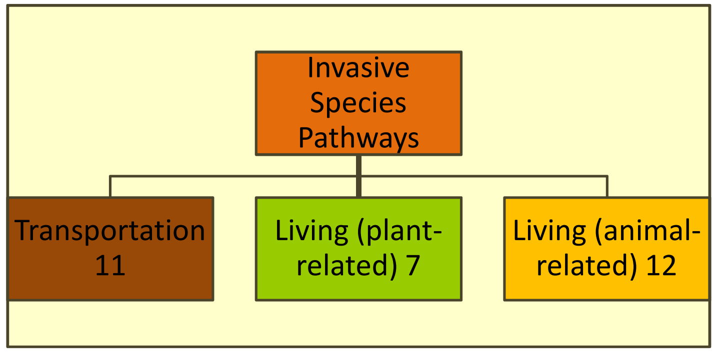


Figure 1. Invasive species pathways and the number of subcategories

Table 1. Transportation pathway codes

(T) Transportation Pathways	
T 1	**Modes of Transportation**
T 1.1	Air
T 1.2	Water/Aquatic
T 1.2.1	Ship Ballast Water
T 1.2.2	Hull/Surface Fouling (i.e., Recreational Boats and Vessels)
T1.2.3	Stowaways in Holds
T 1.2.4	Superstructres/Structures Above Water Line
T 1.2.5	Transportation of Dredge Spoil Material
T 1.3	Land Terrestrial
T 1.3.1	Cars, Buses, Trucks,ATVs, Trailers for recreational boats
T 1.3.2	Trains, Subways, Metros, Monorails
T 1.3.3	Construction/Firefighting Vehicles
T 1.3.4	Hikers, Horses, Pets
T 2	**Military Travel and Transportation of Military Vehicles**
T 2.1	Baggage/Gear
T 2.2	Equipment
T 3	**Items used in the Shipping Process**
T3.1	Containers
T 3.2	Packing Materials
T3.2.1	Wood Packing Materials

T 3.2.2	Seaweed
T 3.2.3	Other Plant Materials
T 3.2.4	Sand/Earth
T 4	**Mail/Internet Overnight Shipping**
T 5	**Travel Tourism/Relocation**
T 5.1	Travelers Themselves
T 5.2	Baggage/Gear
T 5.3	Pets/Plants and Animals Transported for Entertainment
T 5.4	Travel Consumables
T 5.5	Service Industries

Table 2. Living industry pathway codes

(L) Living Industry Pathways	
L 1	**Plant Pathways**
L 1.1	Importation of Plants for Research
L 1.2	Potting Soils, Growing Mediums, Sods, etc.
L 1.3	Plant Trade (agricultural, nursery, landscape, floral, logs)
L 1.3.1	Plant Parts
L 1.3.1.1	Above-Ground Plant Parts
L 1.3.1.2	Below-Ground Plant Parts
L 1.3.1.3	Seeds and the Seed Trade
L 1.3.1.4	Aquatic Propagules
L 1.3.1.5	Hay
L 1.3.1.6	Seed contaminant
L1.3.1.7	Nursery stock contaminant
L1.3.1.8	Firewood
L 1.3.2	Whole Plants
L 1.4	Illegal entry
L 1.5	Accidental introduction
L 2	**Food Pathways**
L 2.1	Live Seafood
L 2.2	Other Live Food Animals
L 2.3	Plants and Plant Parts as Food or Medicine
L 2.4	Illegal entry
L 3	**Non-Food Animal Pathways**
L 3.1	Bait
L 3.2	Pet/Aquarium Trade
L 3.3	Aquaculture
L 3.4	Non-Pet Animals
L 3.5	Release of Organisms for Religious, Cultural or Other Reasons
L 3.6	Medicinal uses
L 3.7	Farm or crop protection
L 3.8	Stocking species for recreation (fishing, hunting)

L 3.9	Biological research
L 3.10	Accidental escape from zoos or aquariums
L3.11	Intentional release
L 4	**Nonliving Animal and Plant-Related Pathways**
L 4.1	Processed and Partially Process Meat and Meat Processing Waste
L 4.2	Frozen Seafood
L 4.3	Minimally Processed Animal Products
L 4.4	Minimally Processed Plant Products

Table 3. Miscellaneous pathway codes

(M) Miscellaneous Pathways	
M 1	**Biocontrol**
M 2	**Other Aquatic Pathways**
M 2.1	Interconnected Waterways
M 2.1.1	Freshwater Canals
M 2.1.2	Marine/Estuarine Canals
M 2.1.3	Domestic Waste Streams
M 2.2	Interbasin Transfers
M 3	**Natural Spread of Established Populations**
M 3.1	Wind Dispersal
M 3.2	Water Dispersal
M 3.3	Animal movement (seed dispersal, disease)
M3.4	Migration of vertebrate and invertebrate pests
M3.5	Native plants serve as host for pest/disease
M 4	**Ecosystem Disturbance**
M 4.1	Long-Term (highway and utility rights-of-way, clearing, logging)
M 4.2	Short-Term (habitat restoration, enhancement, prescribed burning)
M 4.2.1	Phytomining
M 4.2.2	Gravel contaminant
M 5	**Garbage**
M 5.1	Garbage Transport
M 5.2	Garbage Landfill
M 6	**Ecoterrorism**
M 7	**Biofuel**
M 8	**Unknown Pathway**

The CISAC Invasive Species list was divided into five taxonomic categories: Arthropods, Diseases, Invertebrates, Plants, and Vertebrates. We sorted each taxonomic group into two groups of invasive species: currently in California and not yet found in California. For the pathway analysis we used only the invasive species not yet found in California. Each invasive species was ranked for the risk of introduction (high, medium or low) by the CISAC taxonomic working groups. For each species (not in CA) we conducted a brief internet and literature search (search terms included the Latin taxonomic name, common name and each name + pathway or invasive species) and recorded all pathways in which that species could enter California. Pathways were ranked as primary, secondary or tertiary. We documented all references and recorded any relevant notes describing the specifics about the pathway, specific commodities impacted, or country of origin for the invasive species. The data was compiled by taxonomic group, species, and pathway.

RESULTS

Invasive Species Pathway Risk Analysis by Taxonomic Group

Arthropods

Table 4. Results of Arthropod invasive species pathway risk analysis. Species are listed by taxonomic subcategories and ranked by risk of introduction. Species considered to be a threat to biosecurity were not included in the report. Refer to Tables 1-3 for invasive species pathway codes.

Scientific name	*Common Name*	*Extent*	*Primary Pathways*	*Notes for Primary Pathways*
Bees and Wasps				
High Risk				
Apis mellifera capensis	Cape honeybee	not present	L 2.2, L3.4	beekeeping, honey, parasite of African honeybee
Diprion similis	introduced pine sawfly	not present	T3.2.1, L1.3.1.7	wood packing material, nursery stock
Dryocosmus kuriphilus	chestnut gall wasp	not present	L2.3, L1.3	attacks Castanea crenata (Japanese chestnut), Castanea dentata (American chestnut), Castanea mollissima (Chinese chestnut) and Castanea sativa (European chestnut) and their hybrids
Fenusa pusilla	birch leafminer	not present	L1.3	pest of birch (gray, paper, yellow, black, European white, and river)
Leptocybe invasa	Blue gum chalcid	not present	L2.3, L1.3, L1.3.1.7	attacks eucalyptus spp.
Quadrastichus erythrinae	Erythrnia gall wasp	not present	L1.3	pest of Erythrina variegata
Solenopsis geminata	tropical fire ant	not present	L1.3, L 1.3.1.3	pest of grass seed & granaries
Solenopsis richteri X Solenopsis invicta hybrid	hybrid fire ant	not present	M3.4	hybrid population spreading northward from MS & AL
Moderate Risk				
Chrysis spp.	cuckoo wasps	not present		

Diastrophus radicum	raspberry root gall wasp	not present	L1.3, L1.3.1.7	pest of raspberry
Sirex noctilio	sirex woodwasp	not present	T3.2.1	wood packing material
Solenopsis saevissima	red imported fire ant	not present	L2.3, L1.3	pest of ornamental plants
Low Risk				
Coelioxys spp.	cuckoo bees	not present		
Beetles				
High Risk				
Acalymma vittatum	striped cucumber beetle	not present	L2.3, L1.3	pest of cucumber fruit
Adoretus sinicus	chinese rose beetle	not present	L1.2, L1.3.1.7	nursery stock from Asia
Adoretus spp.	Adoretus spp.	not present	L1.2, L1.3.1.7	nursery stock from Asia
Agrilus planipennis	emerald ashborer	not present	L1.3.1.8, L1.3.1.3, L1.3., L1.3.1, T3.1, T3.2,	firewood of all hardwood (non-coniferous) species; nursery stock, green lumber, and other material living, dead, cut, or fallen, including logs, stumps, roots, branches, and composted and uncomposted chips of the genus Fraxinus.
Agrilus ruficollis	rednecked cane borer	not present	L1.3, L1.3.1.7	pest of raspberry, blackberry, dewberry
Anoplophora chinensis	citrus longhorned beetle	not present	L1.3, L1.3.1.7, L1.3.1.8	pest of citrus, trifoliate orange, apple, Australian pine, poplar, willow. Potential pest of maple, silk tree, alder, birch, camellia, hickory/pecan, chestnut, Japanese cedar, wild olive, loquat, beech, fig, 'Nagami' kumquat, ash, mallow, holly, walnut, spicebush, amur, mulberry, sycamore/plane tree, cherry/peach/apricot/plum, firethorn, pear, oak, sumac, locust, rose, blackberry/raspberry, pagoda tree, Stransvaesia, snowbell tree, elm

Anoplophora glabripennis	Asian longhorned beetle	not present	L1.3, L1.3.1.8, T3.2.1	firewood, wood packing material. Host plants include maple, horsechestnut, birch, plan-tree, poplar, willow, elm
Anthonomus grandis grandis	boll weevil	not present	L 1.3.1	pest of cotton
Anthonomus signatus	strawberry bud weevil	not present	L1.3.1.7	pest of strawberry
Atrichonotus taeniatulus	small lucerne weevil	not present	L1.3, L1.3.1.5, L1.3.1.6	pest of lucerne seed and hay
Cathartus quadricollis	squarenecked grain beetle	not present	L2.3, L1.3, , L1.3.1.7	pest of coffee, cereals, dried fruit and cacao
Cerotoma trifurcata	bean leaf beetle	not present	L2.3, L1.3, L1.3.1.7	pest of soybean
Chalcodermus aeneus	cowpea curculio	not present	L2.3, L1.3, L1.3.1.7	pest of southern peas
Conoderus rufangulus	Conoderus rufangulus	not present		
Conotrachelus aguacatae	small avocado seed weevil	not present	L2.3, L1.3, L1.3.1.6, L1.3.1.7	pest of avocado seed
Conotrachelus nenuphar	plum curculio	not present	L2.3, L1.3, L1.3.1.7	pest of Amelanchier arborea, A.canadensis, cherries (Prunus avium and P. cerasus), Crataegus spp., Malus domestica, Malus spp., peaches, pears, plums, Prunus alleghaniensis, P. americana, P. maritima, P. pensylvanica, P. pumila, P. salicina, P. serotina, P. virginiana and Sorbus aucuparia. Also found on Ribes spp. and Vaccinium spp.
Conotrachelus perseae	small seed weevil	not present	L2.3, L1.3, L1.3.1.7	pest of avocado
Copturus aguacatae	avocado stem weevil	not present	L2.3, L1.3, L1.3.1.7	pest of avocado
Curculio elephas	chestnut weevil	not present	L2.3, L1.3, L1.3.1.6	pest of chestnut & oak
Curculio nucum	hazelnut weevil	not present	L2.3, L1.3	pest of hazelnut
Cylas formicarius elegantulus	sweetpotato weevil	not present	L2.3, L1.3, L1.3.1.7	pest of sweet potato

Diabrotica barberi	northern corn rootworm	not present	L2.3, L1.3, L1.3.1.7	pest of corn (roots)
Diabrotica undecimpunctata howardi	spotted cucumber beetle	not present	L2.3, L1.3, L1.3.1.7	pest of cucumbers, soybeans, cotton, beans and many others
Diabrotica virgifera virgifera	western corn rootworm	not present	L2.3, L1.3, L1.3.1.7	larvae are a pest of corn; adults may also feed on other Poaceae, Asteraceae, Fabaceae & Cucurbitaceae
Diaprepes sp.	exotic weevil	not present	L2.3, L1.3, L1.3.1.7	pest of ~2700 spp.from 59 plant families incl. citrus, peanut, sorghum, guinea corn, corn, Surinam cherry, dragon tree, sweet potato, sugarcane, panicum grasses, coffee weed (sesbania), Brazilian pepper & other ornamental plants
Epilachna borealis	squash beetle	not present	L2.3, L1.3	
Epilachna tridecimnotata	ladybird beetle	not present	L1.3	
Epilachna varivestis	Mexican bean beetle	not present	L2.3, L1.3, M3.5	pest of snap beans, lima beans, soybeans, beggars ticks
Euscepes postfasciatus	Indian sweetpotato weevil	not present	L2.3, L1.3	pest of sweet potato
Exosoma lusitanica	leaf beetle	not present	L1.3	
Harmonia axyridis	Multicolored asian ladybeetle	not present	M1, L1.3, L1.5	IPM, hitchhikes on nursery plants, accidental introduction
Heilipus lauri	avocado seed weevil	not present	L2.3, L1.3	pest of avocado
Hylobius pales	pales weevil	not present	L1.3, L1.3.1.8	pest of pines
Hylotrupes bajulus	old house borer	not present	L1.3, L1.3.1.8	larvae are a pest of softwoods particularly pine. Infects timber for new home building.
Hylurgus ligniperda	redhaired pine bark beetle	not present	L1.3, L1.3.1.8	larvae are a pest of pine species, spruce, true firs, Douglas fir, and larch
Leptinotarsa decemlineata	Colorado potato beetle	not present	L2.3, L1.3	attacks potatoes and various other cultivated and wild solanaceous plants

Listroderes subcinctus	Chilean vegetable weevil	not present	L2.3, L1.3	
Macrodactylus subspinosus	rose chafer	not present	L1.3	
Maladera castanea	Asiatic garden beetle	not present	L1.3, L1.3.1.7	pest of pasture and landscaping grasses
Orthotomicus erosus	Mediterranean pine engraver	not present	L1.3, L1.3.1.8	pest of pine trees
Oulema melanopus	cereal leaf beetle	not present	L2.3, L1.3, L1.3.1.3	feeds on all cereals; barley (Hordeum spp.), wheat (Triticum spp.), oats (Avenea spp.) rye (Secale spp.), corn (Zea mays) and wild grasses.
Phloeotribus liminarius	peach bark beetle	not present	L2.3, L1.3, L1.3.1.7	pest of peach & black cherry
Pissodes nemorensis	eastern pine weevil	not present	L1.3, L1.3.1.8	pest of pine and cedar
Popillia japonica	Japanese beetle	not present	L1.3	pest of more than 300 species of turf-grass, landscape & ornamental plants
Popillia lewisi	scarab beetle	not present	T1.1, T2, L1.3	presumably arrived in Guam via an airforce flight from Okinawa, Japan
Rhynchophorus ferrugineus	red palm weevil	not present	L1.3	pest of palm species
Sinoxylon anale	dunnage beetle	not present	T3.2.1	wooden pallets
Tomicus piniperda	pine shoot beetle	not present	L1.3, L1.3.1, L1.3.1.8	pest of Scots pine and other Pinus spp. Transported via firewood.
Xyleborinus andrewesi	Asian ambrosia beetle	not present		
Xyleborus glabratus	Redbay ambrosia beetle	not present	L2.3, L1.3	pest of avocado (Persea americana), California bay laurel (Umbellularia californica), northern spicebush (Lindera benzoin), redbay (Persea borbonia), sassafras (Sassafras albidum) swampbay (Persea palustris)
Moderate Risk				

Anomala orientalis	Oriental beetle	not present	L2.3, L1.3, L1.3.1.7	pest of lawn grass, maize, pineapple, sugarcane (larvae) and Alcea rosea, Dahlia spp. Iris spp. Phlox spp. and roses (adults)
Anomala sulcatula	Anomala sulcatula	not present	L1.3, L1.3.1.7	pest of bamboo
Brachycerus spp.	garlic beetles	not present	L2.3, L1.3, L1.3.1.7	pest of garlic
Coccotorus scutellaris	plum gouger	not present	L2.3, L1.3, L1.3.1.7	pest of peaches and plums
Conotrachelus juglandis	butternut curculio	not present	L2.3, L1.3,, L1.3, L1.3.1.7	pest of butternut (Juglans cinera) and vector of butternut cankor caused by fungus Sirococcoc clavigignenti-juglandacearum
Conotrachelus retentus	black walnut curculio	not present	L2.3, L1.3, L1.3.1.7	pest of walnut
Conotrachelus spp.	hidden snout weevils	not present		
Curculio caryae	pecan weevil	not present	L2.3, L1.3, L1.3.1.6	pest of pecans
Cylas spp.	exotic weevil	not present	L2.3, L1.3, L1.3.1.7	
Diabrotica virgifera zea	Mexican corn rootworm	not present	L2.3, L1.3, L1.3.1.7	larvae are a pest of corn; adults may also feed on other Poaceae, Asteraceae, Fabaceae & Cucurbitaceae
Diocalandra spp.	coconut weevils	not present	L2.3, L1.3	
Diocalandra taitensis	Tahitian coconut weevil	not present	L2.3, L1.3	
Elytroteinus subtruncatus	Fijian ginger weevil	not present	L2.3, L1.3	pest of white ginger root, avocado seed, bird-of-paradise tubers, cycad trunk, lemons, Marrattia fern, sugarcane, taro roots, and ti cuttings
Gerstaeckeria nobilis	weevil	not present		
Holotrichia mindanaona	white grub	not present		
Hypothenemus hampei	coffee berry borer	not present	L2.3, L1.3	pest of coffee
Lophocateres pusillus	Siamese grain borer	not present	L2.3, L1.3, L1.3.1.3	pest of rice

Megalometis chilensis	Megalometis chilensis	not present		
Metamasius spp.	bromeliad weevils	not present		
Myllocerus undecimpustulatus undatus	Sri Lanka weevil	not present		
Naupactus xanthographus	South American fruit tree weevil	not present	L2.3, L1.3	pest of Actinidia chinensis (Chinese gooseberry), Annona cherimola (cherimoya), Citrus, Eriobotrya japonica (loquat), Glycine max (soyabean), Malus domestica (apple), Medicago sativa (lucerne), Mespilus germanica (medlar), Olea europaea subsp. europaea (olive), Persea americana (avocado), Prunus armeniaca (apricot), Prunus avium (sweet cherry), Prunus domestica (plum), Prunus dulcis (almond), Prunus persica (peach), Prunus salicina (Japanese plum), Pyrus (pears), Pyrus communis (European pear), Solanum tuberosum (potato), Vitis vinifera (grapevine)
Omphisa anastomosalis	sweetpotato vine borer	not present	L2.3, L1.3	pest of sweet potato and other species of Ipomoea
Phyllophaga congrua	May beetle	not present	L2.3, L1.3, L1.3.1.7	pest of turf-grass, forage grass, corn, small grains, sugar cane, strawberries, potatos, and young nursery trees
Prostephanus truncatus	larger grain borer	not present	L2.3, L1.3	pest of maize, cassava
Protaetia fusca	mango flower beetle	not present	L2.3, L1.3	adults feed on tree sap, a wide variety of ripening fruits, corn, and the flowers of apple, thistle, mock orange, milkweed, dogwood, sumac, yarrow, daisies, and goldenrod
Protaetia orientalis	oriental flower beetle	not present	L2.3, L1.3	pest of ornamental trees
Rhabdoscelus obscurus	New Guinea sugarcane weevil	not present	L2.3, L1.3	pest of sugarcane and coconut
Rhizotrogus majalis	European chafer	not present	L1.3	pest of turf-grass

Sphenophorus maidis	maize billbug	not present	L2.3, L1.3	pest of maize
Sternochetus mangiferae	mango seed weevil	not present	L2.3, L1.3	pest of mango
Trogoderma granarium	khapra beetle	not present		
Trogoderma granarium	khapra beetle	not present		
Typophorus nigritus viridicyaneus	sweetpotato leaf beetle	not present	L2.3, L1.3	pest of sweet potato
Xyleborus spp.	ambrosia beetles	not present		
Zygogramma exclamationis	sunflower beetle	not present	L2.3, L1.3	pest of sunflower
Low Risk				
Agrilus biguttatus	Oak splendour beetle	not present	L1.3.1.8,, T3.1, T3.2, L1.3, L1.3.1	dunnage, crating, grape leaves, unspecific cargo
Anomala foraminosa	scarab beetle	not present	L2.3, L1.3, L1.3.1.7	pest of sugarcane
Anomala insitiva	scarab beetle	not present	L2.3, L1.3, L1.3.1.7	pest of sugarcane
Anomala luteipennis	scarab beetle	not present		
Anomala undulata	scarab beetle	unknown		
Cryptorhynchus mangiferae	mango seed weevil	not present	L1.3, L2.3	pest of mango
Risk Unknown				
Callidiellum rufipenne	Lesser Japanese cedar longhorned beetle	not present	L1.3, L 1.3.1.1, L1.3.1.8	pest of timber from Taxodiaceae and Cupressaceae, also some firs and pines
Chlorophorous annularis	Bamboo longhorned beetle	MISSING	L2.3, L1.3, L1.3.1.7	pest of bamboo
Hesperophanes campestris	Chinese longhorned beetle	MISSING	L2.3, L1.3	pest of apple and mulberry
Hylurgus palliatus	A bark beetle	MISSING	L1.3, L1.3.1.8	larvae are a pest of fir, true cedar, larch, spruce, and pine
Ips sexdentatus	Six-toothed bark beetle	MISSING		

Ips typographus	European spruce bark beetle	MISSING		
Mononychellus alternatus	Japanese pine sawyer	MISSING	L1.3, L1.3.1.8	
Mononychellus sutor	Small white-marmorated longhorned beetle	MISSING		
Pityogenes chalcographus	Spruce engraver	MISSING	L1.3, L1.3.1.8	pest of Norway spruce, fir, Douglas-fir, pine and other spruce species
Platypus quercivorus	Oak ambrosia beetle	MISSING	L1.3, L1.3.1.8	pest of oak, chestnut, cypress, holly, Lauraceae, ash, Prunus sp.
Tetropium castaneum	A longhorned beetle	MISSING	L1.3, L1.3.1.8	pest of Norway spruce, Scots pine
Tetropium fuscum	Brown spruce longhorned beetle	MISSING		
Tomicus destruens	Pine shoot beetle	MISSING	L1.3, L1.3.1, L1.3.1.8	pest of Pinus spp. Transported via firewood.
Tomicus minor	Lesser pine shoot beetle	MISSING	L1.3, L1.3.1, L1.3.1.8	pest of Scots pine and other Pinus spp. Transported via firewood.
Trypodendron domesticus	An ambrosia beetle	MISSING		
Urocerus gigas	A horntail	MISSING	L1.3, L1.3.1, L1.3.1.8	pest of Norway spruce and common fir
Butterflies and Moths				
High Risk				
Acrobasis nuxvorella	pecan nut casebearer	not present	L2.3, L1.3	pest of pecan, peach fruit
Acrolepiopsis assectella	leek moth	not present	L2.3, L1.3	pest of leek, onion, garlic, chives & shallot
Adoxophyes orana	summer Fruit Tortrix Moth	not present	L2.3, L1.3, L1.3.1.7	pest of apple & pear fruit (incl asian pear)
Alabama argillacea	cotton leafworm	not present	L1.3, L1.3.1	pest of cotton
Argyrotaenia velutinana	redbanded leafroller	not present	L2.3, L1.3, L1.3.1.7	pest of cherry, peach, plum, grape and other small fruits, and ornamental crops. This species has a broad host range, tying leaves of most plant species except conifers.

Cactoblasis cactorum	cactus moth	not present	M1, M3.4	biological control for invasive Opuntia spp.
Chilo suppressalis	Asiatic rice borer	not present	L2.3, L1.3, L1.3.1.3, L1.3.1.7	pest of rice, maize, sorghum
Cryptophlebia leucotreta	false codling moth	not present	L2.3, L1.3, L1.3.1.7	pest of ~70 plants, including: avocado (Persea americana), banana (Musa paradisiaca) bur weed (Triumfeta spp.), bean (Phaseolus spp.), bloubos (Royena pallens), boerboon (Schotia afra), buffalo thorn (Zizyphus mucronata), cacao (Theobroma cacao), carambola (Averrhoa carambola), castorbean (Ricinus communis), chayote (Sechium edule), citrus (Citrus sinensis, Citrus spp.), coffee (Coffea arabica, Coffea spp.), cola (Cola nitida), corn (Zea mays), cotton (Gossypium hirsutum, Gossypium spp.), cowpea (Vigna unguiculata, Vigna spp.), custard apple (Annona reticulata), elephant grass (Pennisetum purpureum), English walnut (Juglans regia), grape (Vitis spp.), guava (Psidium guajava), governor's plum (Flacourtia indica), Indian mallow (Abutilon hybridum), jakkalsbessie (Diospyros mespiliformis), jujube (Zizyphus jujuba), jute (Abutilon spp.), kaffir plum (Harpephyllum caffum), kapok/copal (Ceiba pentranda), khat (Catha edulis), kudu-berry (Pseudolachnostylis maprouneifolia), lima bean (Phaseolus lunatus), litchi (Litchi chinensis), loquat (Eriobotrya japonica), macadamia nut (Macadamia

				ternifolia), mallow (Hibiscus)
Cydia funebrana	red plum maggot	not present	L2.3, L1.3, L1.3.1.7	pest of plum, cherry, peach & other Rosaceae
Cydia splendana	chestnut moth	not present	L2.3, L1.3	
Darna pallivitta	limacodid moth	not present	L2.3, L1.3, L1.3.1.7	Observed completing its life cycle on Arecaceae: Areca, Caryota (fishtail palm), Cocos (coconut palm), Phoenix (Phoenix palm), Rhapsis (Rhapsis palm), Veitchia merrillii (Manila palm); Asteraceae: Adenostemma; Commelinaceae: Commelina diffusa (honohono grass); Euphorbiaceae: Breynia; Fabaceae: Vigna marina (beach pea); Liliaceae: Cordyline terminalis (ti plant), Dracaena (cane plant, ‘Compacta’ & ‘Massangeana’ varieties), Iris; Moraceae: Ficus; Oxalidaceae: Averrhoa carambola (starfruit); Rubiaceae: Coffea arabica (coffee) and Urticaceae: Pipturus albidus (mamaki).
Endopiza viteana	grape berry moth	not present	L2.3, L1.3	pest of grapes (cultivated and wild)

Harrisina americana	grapeleaf skeletonizer	not present	L2.3, L1.3	pest of grapes (cultivated and wild) & Virginia creeper
Heliocoverpa armigera	cotton bollworm	not present	L2.3, L1.3	pest of cotton, corn, tomato, legumes and tobacco
Laspeyresia spp.	Laspeyresia spp.	not present	L3.4	sold as "Mexican jumping beans"-a seed capsule of Sebastiana pavoniana with a live larvae inside
Malacosoma americanum	eastern tent caterpillar	not present	L2.3, L1.3	pest of cherry, plum, peach, apple, hawthorn and related plants
Maruca testulalis	bean pod borer	not present	L2.3, L1.3	pest of mung beans
Maruca vitrata	bean pod borer	not present	L1.3	pest of cowpea
Opogona sacchari	banana moth	not present	L2.3, L1.3	pest of bananas, pineapples, bamboo, maize, sugarcane, Cactaceae, Dracaena, Strelitzia and Yucca
Ostrinia nubilalis	European corn borer	not present	L2.3, L1.3	pest of maize, millet, hemp, hops, peppers, sorghum, soybean, cotton.
Pectinophora scutigera	pink-spotted bollworm	not present	L2.3, L1.3	pest of cotton
Rhyacionia buoliana	European pine shoot moth	not present	L1.3, L1.3.1.8	pest of pine trees (red, mugho, Scots & Austrian)
Spodoptera dolichos	armyworm	not present		
Spodoptera eridania	southern armyworm	not present	L2.3, L1.3	pest of beet, cabbage, carrot, collard, cowpea, eggplant, okra, pepper, potato, sweet potato, tomato, and watermelon. Other crops damaged include avocado, citrus, peanut, sunflower, velvet bean, tobacco and various flowers. Many weeds are consumed, but pigweed, Amaranthus spp.; and pokeweed, Phytolacca americana; are especially favored. Grasses are rarely eaten. There are numerous reports of armyworm infestations beginning with pigweed and pokeweed, with adjacent crops damaged only after the more favored weeds

				are consumed.
Spodoptera exempta	nutgrass armyworm	not present	L1.3	
Spodoptera latifascia	lateral lined armyworm	not present	L1.3	
Spodoptera littoralis	Egyptian cottonworm	not present	L1.3	
Spodoptera mauritia	lawn armyworm	not present	L1.3	
Spodoptera sunia	Costa Rican armyworm	not present	L1.3	
Stenoma catenifer	avocado seed moth	not present	L2.3, L1.3	pest of avocado and other plants in the Lauraceae
Thyridopteryx ephemeraeformis	bagworm	not present	L1.3	pest of arborvitae, juniper, pine, spruce, and many other evergreen species. It also attacks certain deciduous trees such as black locust, honeylocust, and sycamore.
Zeuzera pyrina	leopard moth	not present	L2.3, L1.3	hosts are trees and shrubs of the genera Malus, Tilia, Pyrus, Acer, Rhododendron, Ulmus, Castanea, Populus, Fraxinus, Quercus, and Juglans.
Moderate Risk				
Acrobasis juglandis	pecan leaf casebearer	not present	L2.3, L1.3	pest of pecan, walnut fruit
Acrolepia assectella	leek moth	not present	L2.3, L1.3	pest of leek, onion, garlic, chives & shallot
Antaeotricha leucillana	stenomine oecophorid	not present	L1.3, L1.3.1, L1.3.1.8, L2.3	pest of ash, basswood, birch, elm, maple, oak, poplar, willow

Apamea apamiformis	riceworm	not present	L2.3, L1.3, L1.3.1.7	pest of rice (esp. wild rice)
Attacus atlas	atlas silk moth	not present	L1.3, L3.4	cocoons used to make Fagara silk
Celama sorghiella	sorghum webworm	not present	L2.3, L1.3, L1.3.1.3, L1.3.1.7	pest of grain sorghum, Sudan grass, Johnson grass, corn, rye & timothy
Chilo plejadellus	rice stalk borer	not present	L2.3, L1.3, L1.3.1.3, L1.3.1.7	pest of rice
Choristoneura fumiferana	spruce budworm	not present	L1.3, L1.3.1.3, L1.3.1.7, L1.3.1.8	pest of spruce
Chrysodeixis chalcites	golden twin spot moth	not present	L2.3, L1.3, L1.3.1.7	pest of tobacco, tomato, cotton, Cruciferae, legumes, corn, soybeans, potatoes, artichokes, greenhouse crops, and cauliflower
Conogethes punctiferalis	yellow peach moth	not present	L2.3, L1.3, L1.3.1.7	pest of peaches, durian, citrus trees, papaya, eggplant and castor.
Corcyra cephalonica	rice moth	not present	L2.3, L1.3, L1.3.1.6, L1.3.1.7, M1	pest of rice,used for IPM research
Cydia caryana	hickory shuckworm	not present	L2.3, L1.3, L1.3.1.6	pest of pecan & hickory
Diaphania hyalinata	melonworm	not present	L2.3, L1.3, L1.3.1.7	pest of Cucurbitaceae: summer squash, winter squash, pumpkin.
Diatraea crambidoides	southern corn stalk borer	not present	L2.3, L1.3	pest of corn and eastern gamagrass (Tripsacum dactyloides)
Diatraea grandiosella	southwestern corn borer	not present	L2.3, L1.3	pest of corn, sorghum & other Poaceae
Diatraea saccharalis	sugarcane borer	not present	L2.3, L1.3	pest of sugarcane, corn, rice, sorghum, sudangrass, Johnsongrass, Paspalum spp., Panicum spp., Holcus spp., Adropogon spp. and other Poaceae
Dyspessa ulula	onion carpenter worm	not present	L1.3, L2.3	
Earias fabia	spotted bollworm	not present	L2.3, L1.3	pest of cotton

Gonodonta pyrgo	citrus fruitpiercing moth	not present	L2.3, L1.3	
Halysidota tessellaris	pale tussock moth	not present		
Helicoverpa hawaiiensis	Hawaiian bud moth	not present	L1.3	
Lampides boeticus	bean butterfly	not present	L2.3, L1.3	attacks the flowers, seeds and pods of many Fabaceae spp., incl. Medicago, Crotalaria, Polygala, Sutherlandia, Dolichos, Cytisus, Spartium & Lathyrus spp.
Lampides boeticus	bean butterfly	not present	L2.3, L1.3	
Leucinodes orbonalis	eggplant fruit borer	not present	L2.3, L1.3	pest of eggplant, potato, black nightshade, tomato, sweet pepper, and other Solanum spp, Cucurbita spp. & pea
Leucoptera malifoliella	pear leaf blister moth	not present	L2.3, L1.3	pest of Betula (birches), Chaenomeles (flowering quinces), Cotoneaster, Crataegus (hawthorns), Cydonia oblonga (quince), Malus domestica (apple), Malus sylvestris (crab-apple tree), Mespilus germanica (medlar), Pistacia vera (pistachio), Prunus armeniaca (apricot), Prunus avium (sweet cherry), Prunus cerasus (sour cherry), Prunus domestica (plum), Prunus persica (peach), Prunus salicina (Japanese plum), Prunus spinosa (blackthorn), Pyrus (pears), Pyrus bretschneideri (yali pear), Pyrus communis (European pear), Rhamnus frangula (alder buckthorn), Sorbus aucuparia (mountain ash)
Lymantria dispar	Gypsy moth	not present	T 1.2.3, T3.1, T3.2.1, L3.1, L1.3.1.8	egg masses can infest cargo ships, cargo containers, wood packing materials, firewood
Lymantria spp.	exotic moth	not present		

Mamestra brassicae	cabbage moth	not present	L1.3	
Melittia calabaza	southwestern squash vine borer	not present	L2.3, L1.3	caterpillars attack squash and wild cucurbits
Melittia cucurbitae	squash vine borer	not present	L2.3, L1.3	caterpillars attack cultivated and wild cucurbits
Orgyia leucostigma	whitemarked tussock moth	not present	L1.3	pest of sycamore and a cariety of other trees
Papaipema nebris	stalk borer	not present	L2.3, L1.3	pest of small grains, grasses, corn and ragweed
Papilio demoleus	lime swallowtail	not present	L2.3, L1.3	pest of citrus & Fabaceae
Plathypena scabra	green cloverworm	not present	L2.3, L1.3	pest of soy beans
Sannina uroceriformis	persimmon borer	not present	L2.3, L1.3	pest of persimmon
Sesamia cretica	durra stalk borer	not present	L2.3, L1.3	pest of maize, sugarcane, sorghum
Syngrapha epigaea	inscribed looper moth	not present		
Thaumatotibia leucotreta	False codling moth	not present	L2.3, L1.3	pest of ~70 plants, including: avocado (Persea americana), banana (Musa paradisiaca) bur weed (Triumfeta spp.), bean (Phaseolus spp.), bloubos (Royena pallens), boerboon (Schotia afra), buffalo thorn (Zizyphus mucronata), cacao (Theobroma cacao), carambola (Averrhoa carambola), castorbean (Ricinus communis), chayote (Sechium edule), citrus (Citrus sinensis, Citrus spp.), coffee (Coffea arabica, Coffea spp.), cola (Cola nitida), corn (Zea mays), cotton (Gossypium hirsutum, Gossypium spp.), cowpea (Vigna unguiculata, Vigna spp.), custard apple (Annona reticulata), elephant grass (Pennisetum purpureum), English walnut (Juglans regia), grape (Vitis spp.), guava (Psidium guajava), governor's plum (Flacourtia indica), Indian mallow

				(Abutilon hybridum), jakkalsbessie (Diospyros mespiliformis), jujube Zizyphus jujuba), jute (Abutilon spp.), kaffir plum (Harpephyllum caffum), kapok/copal (Ceiba pentranda), khat (Catha edulis), kudu-berry (Pseudolachnostylis maprouneifolia), lima bean (Phaseolus lunatus), litchi (Litchi chinensis), loquat (Eriobotrya japonica), macadamia nut (Macadamia ternifolia), mallow (Hibiscus)
Tildenia gudmannella	pepper flower bud moth	not present	L1.3	
Zeiraphera canadensis	spruce budworm	not present	L1.3	pest of white spruce
Zophodia convolutella	gooseberry fruitworm	not present	L2.3, L1.3	pest of current & gooseberry
Low Risk				
Argyrotaenia pulchellana	grey red-barred twist	not present	L2.3, L1.3, L1.3.1.7	major pest of grapes, apricot, citrus crops, kenaf
Capua tortrix	Capua tortrix	not present		
Carposina niponensis	peach fruit moth	not present	L2.3, L1.3, L1.3.1.7	pest of apples, peaches, pears
Chrysodeixis eriosoma	green garden looper	not present	L2.3, L1.3, L1.3.1.7	pest of basil, cabbage, celery, Chinese pea, corn, eggplant, green beans, lettuce, mint, parsley, peas, potato, spinach, sweet potato, and tomato. Ornamental crops attacked are chrysanthemum, orchid, ti and tropical foliages such as Aglaonema, Diffenbachia, Ficus and Syngonium.

Conopomorpha cramerella	cocoa pod borer	not present	L2.3, L1.3, L1.3.1.7	pest of cocoa
Conopomorpha litchiella	lychee leaf miner	not present	L2.3, L1.3, L1.3.1.7	pest of lychee fruit
Euproctis chrysorrhoea	browntail moth	not present	L2.3, L1.3	pest of apple, black cherry, northern red oak & black oak
Hemimene juliana	nut fruit tortrix	not present	L2.3, L1.3.1.6	pest of chestnut seeds
Lymire edwardsii	Edwards' wasp moth	not present	L2.3, L1.3	pest of Ficus spp. including F. altissima, F. aurea, F. auriculata, F. benghalensis, F. benjamina, F. continifolia, F. elastica, F. lyrata, F. retusa and F. rubiginosa
Megalopyge opercularis	puss caterpillar	not present		
Pammene fasciana	chestnut leaf roller	not present	L2.3, L1.3	pest of Quercus, Fagus sylvatica, Castanea sativa acorns/nuts
Prays endocarpa	citrus pock caterpillar	not present	L2.3, L1.3	pest of citrus and other Rutaceae
Proeulia spp.	Proeulia spp.	not present	L2.3, L1.3	pest of Acer pseudoplatanus (sycamore), Actinidia deliciosa (kiwifruit), Citrus sinensis (navel orange), Diospyros (malabar ebony), Malus domestica (apple), Mespilus germanica (medlar), Platanus orientalis (plane), Prunus armeniaca (apricot), Prunus domestica (plum), Prunus persica (peach), Pyrus communis (European pear), Simmondsia chinensis (jojoba), Vitis vinifera (grapevine)
Scrobipalpa ocellatella	surgarbeet crown borer	not present	L2.3, L1.3	pest of sugarbeet, table beet and fodder beet.
Tischeria marginata	moth	not present		
Risk Unknown				
Dendrolimus superans sibiricus	Siberian silk moth	MISSING	L1.3, L1.3.1.7, L1.3.1.8	pest of confer species incl. Abies, Pinus,Larix, Picea & Tsuga
Lymantria mathura	pink gypsy moth		L1.3, L1.3.1.8	attacks many species of Betula, Castanea, Juglans, Malus, Quercus, Salix, Tilia, Ulmus and other deciduous

				trees
Lymantria monacha	nun moth		L1.3, L1.3.1.8	attacks Scots pine and Norway spruce.
Phyllocnistis citrella	Citrus leafminer	MISSING	L2.3, L1.3	pest of citrus and other Rutaceae
Flies				
High Risk				
Anastrepha fraterculus	South American fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of citrus, apple
Anastrepha grandis	South American cucurbit fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of cucumber fruit
Anastrepha sp.	exotic fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of fruit
Moderate Risk				
Anastrepha ludens complex	Mexican fruit fly complex	not present	L2.3, L1.3, L1.3.1.7	pest of grapefruit, oranges, pear, peach, and apple
Anastrepha obliqua	West Indian fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of mango (Mangifera indica L.), guava (Psidium guajava L.), hog plums (Spondias sp.), Anacardium occidentale (cashew), Annona hayesii, Averrrhoa carambola (carambola), Citrus aurantium (sour orange), Citrus grandis (pumelo), Citrus x paradisi (grapefruit), Dovyalis hebecarpa (kitambilla or Ceylon gooseberry), Eriobotrya japonica (loquat), Eugenia jambos (jambos, rose-apple, or pomarosa), Eugenia malaccensis (Malay-apple or pomerack), Eugenia nesiotica, Mangifera indica (mango), Diospyros digyna (black sapote), Pouteria mammosa (sapote), Prunus amygdalus (bitter almond), Prunus dulcis (almond), Psidium guajava (guava), Spondias dulcis (vi-apple or Otaheite-apple), Spondias mombin (yellow

				mombin), Spondias nigrescens, Spondias purpurea (purple or red mombin), Coffea arabica (arabica coffee)). The species also has been reared experimentally from Achras sapota (sapodilla), Annona glabra (pond-apple), Chrysobalanus icaco (coco-plum), Passiflora quadrangularis (a passion-flower, the giant granadilla), Prunus persica var. nectarina (nectarine), and Vitis vinifera (California grape).
Anastrepha suspensa	Caribbean fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of guava, citrus, mango, and various other cultivated fruits
Bactrocera correcta	Guava fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of guava, mango, oranges, sweet almond, peaches (occasionally nectarine), plums
Bactrocera dorsalis	Oriental fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of Tropical Fruits: Guava, persimmon, banana, papaya, mango, pomegranate, quince, kumquat, avocado; Date palms, Figs; Citrus: Oranges, grapefruit, lemons, limes, tangerines; Cashew, walnut, sweet almond; Cucurbits: Cucumbers, watermelon; Other Fruits/Vegetables: Tomatoes, bell peppers, chili peppers, gooseberries.
Bactrocera facialis	Tongan fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of Tropical Fruits: Guava, pineapple, avocado; Citrus: lemons, Tree Nuts: Cashew, sweet almond; Temperate Tree & Vine Fruits: peaches (occasionally nectarine); Cucurbits: watermelon; bell peppers
Bactrocera latifrons	solanaceous fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of Tropical Fruits: Guava, banana, mango, Citrus: Oranges, grapefruit, lemons, Cucurbits: cucumbers, tomatoes, chili peppers, eggplant

Bactrocera tryoni	Queensland fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of Tropical Fruits: Guava, persimmon, banana, papaya, mango, pomegranate, quince, kumquat, avocado; Citrus: Oranges, grapefruit, lemons, limes, mandarin oranges, citrons; Datepalms; Figs; Olives; Tree Nuts: Cashew, walnut, sweet almond; Temperate Tree and Vine Fruits: Apples, peaches (occasionally nectarine), pears, plums, apricots, cherries, mulberries, grapes (esp. wine grapes); blackberries gooseberries, cauliflower, okra.
Bactrocera zonata	Peach fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of Tropical Fruits: Guava, papaya, mango, pomegranate, quince; Date palms; Citrus: Oranges; Tree Nuts: sweet almond; emperate Tree and Vine Fruits: Apples, peaches (occasionally nectarine); Cucurbits: Gourds, watermelon, other melons. Other Fruits/Vegetables: Tomatoes
Ceratitis capitata	Mediterranean fruit fly	not present	L2.3, L1.3, L1.3.1.7	wide range of hosts including coffee, Solanum pseudocapsicum, apples, avocados, citrus, figs. Kiwifruits, magoes, medlars, pears, Prunus sp.
Ceratitis rosa	Natal fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of apples, apricots, avocados, Citrus, Fortunella, guavas, figs, grapes, litchis, mangoes, pawpaws, peaches, pears, plums, quinces & tomatoes
Cerodontha iridophora	leafminer fly	not present		
Dacus bivittatus	African pumpkin fly	not present	L2.3, L1.3	
Dacus sp.	exotic fruit fly	not present	L2.3, L1.3	
Rhagoletis boycei	walnut husk fly	not present	L2.3, L1.3	pest of walnut
Rhagoletis cingulata	cherry fruit fly	not present	L2.3, L1.3	pest of cherry

Rhagoletis fausta	black cherry fruit fly	not present	L2.3, L1.3	pest of cherry
Rhagoletis juglandis	walnut husk fly	not present	L2.3, L1.3	pest of walnut
Rhagoletis mendax	blueberry maggot	not present	L2.3, L1.3	pest of blueberry
Rhagoletis spp.	exotic fruit fly	unknown	L2.3, L1.3	
Rhagoletis suavis	walnut husk fly	not present	L2.3, L1.3	pest of walnut
Toxotrypana curvicauda	papaya fruit fly	not present	L2.3, L1.3	pest of papaya, mango, milkweed. May attack other species.
Toxotrypana curvicauda	papaya fruit fly	not present	n/a	n/a
Zonosemata electa	pepper maggot	not present	L2.3, L1.3	pest of pepper & eggplant
Low Risk				
Anastrepha striata	guava fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of guava (and other myrtaceous fruits), mango, mombins, orange, peach
Bactrocera albistrigata	White Striped Fruit Fly	not present	L2.3, L1.3, L1.3.1.7	pest of sweet almond
Bactrocera cucurbitae	melon fly	not present	L2.3, L1.3, L1.3.1.7	pest of Tropical Fruits: Guava, papaya, mango, quince, avocado; Date palms, Figs; Citrus: Oranges, grapefruit, lemons; Tree Nuts: walnut, sweet almond; Temperate Tree and Vine Fruits: Apples, peaches (occasionally nectarine), pears, apricots; Other Fruits/Vegetables: Tomatoes, bell peppers, eggplant, garden beans, lima beans, cauliflower, okra.
Bactrocera irvingiae	irvinge fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of mango (Mangifera indica), guava (Psidium guajava), citrus fruits (Citrus spp.) (Photo 4), papaya (Carica papaya), bush mango (Irvingia gabonensis), avocado (Persea Americana), star apple (Chrysophyllum albidum), badamier (Terminalia catappa) and other wild species such as Sclerocarya birrea, Vitellaria paradoxa

Bactrocera scutellata	Striped fruit fly	not present	L2.3, L1.3, L1.3.1.7	pest of pumpkin
Cochliomyia hominivorax	screwworm	not present	L3.4	parasitic pest of livestock
Contarinia johnsoni	grape blossum midge	not present	L2.3, L1.3, L1.3.1.7	pest of grapes
Dacus cucurbitae	Melon fruit fly	not present	L2.3, L1.3	
Horidiplosis ficifolii	Ornamental fig pest	not present	L2.3, L1.3	pest of Ficus, incl. F. benjamina & F. microcarpa
Ophiomyia phaseoli	bean fly	not present	L2.3, L1.3	pest of Cajanus cajan (pigeon pea), Crotalaria juncea (sunn hemp), Crotalaria pallida (smooth crotalaria), Cyamopsis tetragonoloba (guar), Fabaceae (leguminous plants), Glycine max (soyabean), Lablab purpureus (hyacinth bean), Macrotyloma uniflorum (horsegram), Medicago sativa (lucerne), Mucuna pruriens (Buffalobean), Phaseolus (beans), Phaseolus coccineus (runner bean), Phaseolus lathyroides (Phasey bean), Phaseolus lunatus (lima bean), Phaseolus vulgaris (common bean), Pisum sativum (pea), Psophocarpus tetragonolobus (winged bean), Vigna aconitifolia (moth beans), Vigna angularis (adzuki bean), Vigna mungo (black gram), Vigna radiata (mung bean), Vigna sinensis ssp. sesquipedalis (asparagus bean), Vigna unguiculata (cowpea)
Rhagoletis cerasi	European cherry fruit fly	not present	L2.3, L1.3	pest of sweet cherry and cherry
Tipula oleracea	common crane fly	not present	L1.3	pest of turf-grass
Risk Unknown				
Dasineura leguminicola	clover seed midge	unknown	L1.3	pest of clover
Eumerus aurifrons	exotic bulb fly	unknown	L1.3	

Mites				
High Risk				
Amphitetranychus viennensis	fruit tree spider mite	not present	L2.3, L1.3, L1.3.1.7	pest of apple
Brevipalpus chilensis	false grape mite	not present	L2.3, L1.3, L1.3.1.7	pest of grapes, lemons, kiwifruit, persimmons, privet and other ornamentals.
Eriophyes gossypii	cotton blister mite	not present	L1.3	
Euvarroa sinhai	Euvarroa sinhai	not present	L3.4, L2.3	parasitic pest of honeybees
Raoiella indica	Red Palm Mite	not present	L2.3, L1.3	pest of palm species
Steneotarsonemus spinki	panicle rice mite	not present	L2.3, L1.3	pest of rice
Tropilaelaps clareae	honeybee mite	not present	L3.4, L2.3	attacks honeybees
Moderate Risk				
Eriophyes litchii	lychee erinose mite	not present	L2.3, L1.3	pest of lychee fruit
Mononychellus tanajoa	green spider mite	not present		
Scales and Aphids				
High Risk				
Abgrallaspis aguacatae	armored scale	not present	L2.3, L1.3	pest of avocado fruit from Mexico
Abgrallaspis palmae	tropical palm scale	not present	L2.3, L1.3	pest of banana, coconut palm, manihot, oil palm, cocoa & orchids
Acutaspis albopicta	albopicta scale	not present	L2.3, L1.3	pest of avocado fruit from Mexico
Acutaspis tingi	ting scale	not present	L2.3, L1.3, L1.3.1.7	pest of coconut palm
Aleurocanthus spiniferus	orange spiny whitefly	not present	L2.3, L1.3, L1.3.1.7	pest of citrus, rose, grape, peach, pear, guava
Aleurocanthus woglumi	citrus blackfly	not present	L2.3, L1.3, L1.3.1.7	pest of citrus, avocado, banana, cashew, coffee, ginger, grape, guava, lychee, mango, pawpaw, pear, pomegranate, quince, rose

Aonidiella orientalis	oriental scale	not present	L1.3, L1.3.1.7	pest of citrus, ficus, mango, papaya, bananas and other fruits; tea (Camellia sinensis); and palm trees, including coconut and arecanut (Areca catechu). Host records include species of: Acacia, Aegle, Agave sisalana, Albizia, Annona spp., Areca catechu, Azadirachta, Bauhinia, Bombax, Calotropis, Camellia sinensis, Camellia spp., Carica papaya, Cassia, Citrus spp., Cocos nucifera, Codiaeum, Cucurbita, Cycas, Dalbergia, Diospyros, Elaeis guineensis, Eugenia spp., Feijoa, Ficus spp., Ficus carica, Gossypium hirsutum, Hedera, Hibiscus, Jasminum, Laelia, Litchi chinensis, Litsea, Mangifera indica, Manilkara, Melia, Metroxylon, Morus, Musa sapientum, Myrrhinium, Myrtaceae, Nerium, Olea europaea, Orchidaceae, Osbeckia, Palmae, Persea americana, Phoenix dactylifera, Pistacia, Podocarpus, Polyalthea, Poncirus, Prunus persica, Prunus spp., Psidium guajava, Punica granatum, Ricinus communis, Ricinus, Rosa, Roystonea, Salix, Santalum, Schleichera, Solanum melongena, Solanum spp., Spondias, Tamarindus, Vitis vinifera, Weinmannia, Ziziphus spp.
Aphis glycines	soybean aphid	not present	L2.3, L1.3, L1.3.1.7	pest of soybean
Aspidiotus destructor	coconut scale	not present	L2.3, L1.3, L1.3.1.7	pest of coconut & banana
Asterolecanium epidendri	orchard scale	not present	L1.3, L1.3.1.7	pest of orchids, bromeliads and tropical indoor plants
Aulacaspis yasumatsui	cycad aulacaspis scale	not present	L1.3, L1.3.1.7	pest of cycads

Ceroplastes ceriferus	Indian wax scale	not present	L2.3, L1.3, L1.3.1.7	pest of mostly fruit crops (e.g. apple, avocado, citrus, fig, pear, plum, quince, Vaccinium and many tropical fruit crops) and ornamentals (e.g. Acer, Berberis, Buxus, Cornus, Deutzia, Euonymus, Ficus, Ilex, Lagerstroemia, Laurus, Magnolia, Platanus, Populus, Pyracantha, Rhododendron, Salix, Viburnum
Ceroplastes floridensis	Florida wax scale	not present	L2.3, L1.3, L1.3.1.7	
Ceroplastes rubens	red wax scale	not present	L2.3, L1.3, L1.3.1.7	
Ceroplastes rusci	fig wax scale	not present	L2.3, L1.3, L1.3.1.7	
Chionaspis furfura	scurfy scale	not present	L1.3, L1.3.1.7	pest of aspen, cottonwood and willow
Clavaspis herculeana	herculeana scale	not present	L1.3	
Coccus viridis	Green scale	not present	L2.3, L1.3, L1.3.1.7	pest of citrus, Annona (cherimoya, atemoya, sugar apple), anthurium, avocado, cacao, celery, coffee, flowering ginger, guava, lime, macadamia, orange, orchid and plumeria.
Fiorinia theae	tea scale	not present	L2.3, L1.3, L1.3.1.7	pest of camellias, tea, olives, citrus
Furcaspis biformis	red orchard scale	not present	L1.3	pest of orchids (including cattleya, oncidium, and vanda) and philodendron
Furcaspis oceanica	coconut red scale	not present	L2.3, L1.3	pest of coconut
Gymnaspis aechmeae	aechmea scale	not present	L1.3	
Hemiberlesia palmae	tropical palm scale	not present	L1.3	
Howardia biclavis	mining scale	not present	L2.3, L1.3	pest of acacia, allamanda, bougainvillea, cassia, ficus, ebony, gardenia, hibiscus, ixora, jasmine, kelumpang, lantana, lychee, mango, papaya, plumeria, poinsettia, pulasan, sapodilla, and sapote

Ischnaspis longirostris	black thread scale	not present	L2.3, L1.3	pest of Agavaceae: Agave americana (century plant), Anacardiaceae: Mangifera spp. (mango), Apocynaceae: Nerium oleander (oleander), Plumeria acutifolia (frangipani tree, temple tree), Araceae: Anthurium scandens, Dieffenbachia seguine, Philodendron spp. and Monstera deliciosa (ceriman, swiss cheese plant, fruit salad plant, Mexican breadfruit)Arecaceae: Chamaedorea elegans (parlor palm), and Elaeis spp. (oil palms), Bromeliaceae: Bromelia sp., Cyperaceae: Cyperus sp., Fabaceae: Acacia spp., Lauraceae: Cinnamomum spp., Persea americana (avocado), Liliaceae: Aloe spp., Magnoliaceae: Magnolia sp., Malvaceae: Gossypium sp. (cotton), Hibiscus sp.Moraceae: Ficus spp., Myrtaceae: Eucalyptus sp., Eugenia sp.,Oleaceae: Jasminum spp., Ligustrum japonicum (Japanese privet), Orchidaceae: Cattleya sp., Oncidium sp., Rosaceae: Prunus armeniaca (apricot), Rubus sp., Rubiaceae: Coffea spp. (coffee), Ixora sp., Gardenia sp., Rutaceae: Citrus spp., Litchi spp.Theaceae Camellia spp., Verbenaceae: Duranta sp., Lantana sp.
Kilifia acuminata	acuminate scale	not present	L2.3, L1.3	pest of Gardenia jasminoides; Bay laurel (Laurus nobilis); Ilex vomitoria; Eugenia sp; Anthurium sp.; Guava; Lemon; Mango (Mangifera indica); Brazilian pepper (Schinus terebinthifolius).
Lopholeucaspis cockerelli	Cockerell scale	not present		
Massileurodes chittendeni	rhodendron whitefly	not present	L1.3	

Morganella longispina	plumose scale	not present	L2.3, L1.3	pest of Alectryon connatus, Artocarpus integrifolia, Averrhoa carambola (carambola), Bauhinia variegata (butterfly tree), Broussonetia papyrifera (paper mulberry), Camellia japonica (camellia), Cananga odoratum, Carica papaya (papaya), Cedrela toona, Cinnamomum zeylanica, Citrus aurantium (sour orange), Citrus limon (lemon), Citrus maxima (shaddock), Citrus paradisi (grapefruit), Citrus reticulata (tangerine), Cupania supida, Ficus carica (piku), Ficus macrophylla, Fraxinus berlandieri, Gleditsia delavayi, Hibiscus rosa-sinensis (chinese hibiscus), Hibiscus syruacus,Jasminum sambac (Arabian jasmine), Lagerstroemia flos-reginae, Ligustrum sinense (Chinese privet), Macadamia integrifolia (macadamia nut), Mangifera indica (mango), Michelia champeca, Michelia flava, Nerium oleander, (oleander), Olea europaea (olive), Psidium cattleianum, Psidium guajava, Tecoma stans (trumpetbush)
Mycetaspis spaerioides	armored scale	not present		
Myndus crudus	American palm cixiid	not present	L2.3, L1.3	pest of coconuts, dates, and Canary Island date palm; grasses: St. Augustine grass, Paspalum notatum, Cynodon dactylon
Neomaskellia bergii	sugarcane whitefly	not present	L1.3	
Nilotaspis halli	Hall scale	not present		
Oebalus pugnax	rice stink bug	not present	L2.3, L1.3	pest of rice
Paratachardina pseudolobata	Lobate lac scale	not present	L1.3	

Parlatoria blanchardi	parlatoria date scale	not present	L2.3, L1.3	
Parlatoria proteus	sanseveria scale	not present	L1.3	
Parlatoria pseudaspidiotus	vand orchid scale	not present	L1.3	
Parlatoria theae complex	tea paralatoria scale - species complex	not present	L1.3	
Parlatoria vandae	vanda paralatoria scale	not present	L1.3	
Parlatoria ziziphi	black citrus scale	not present	L2.3, L1.3	
Phenococcus aceris	apple mealybug	not present	L2.3, L1.3	pest
Pinnaspis buxi	boxwood scale	not present	L2.3, L1.3	pest of anthurium, banana, coconut palm, dendrobium, hala, hibiscus, monstera, orchids, persimmon, philodendron
Pinnaspis strachani	lesser snow scale	not present	L2.3, L1.3	pest of asparagus, avocado, bird of paradise, carambola, cherimoya, chinaberry, citrus, coconut palm, croton, cycads, dracaena, ferns, geranium, hala, hi'aloa, hibiscus, jacaranda, lychee, mango. Mexican creeper, native cotton, oleander, pikake, plumeria, poinciana, red pepper, sweet potato, ti and wisteria
Planococcus lilacinus	coffee mealybug	not present	L2.3, L1.3	
Planococcus minor (Maskell)	Passionvine mealybug	not present	L2.3, L1.3	pest of more than 250 host plants (see ref for list)
Poliaspis cycadis	Poliaspis cycad scale	not present	L1.3	pest of Cruciferae; Microsemia sp. Cycadaceae; Cycas circinalis L., Cycas revoluta, Dioon edule Ericaceae; Gaultheria depressa Hook.f, Gaultheria rupestris (G. Forst.) R.Br.
Pseudaonidia paeoniae	peony scale	not present	L1.3	pest of camellias and azaleas
Pseudaulacaspis pentagona	white peach scale	not present	L2.3, L1.3	pest of peach, privet, mulberry, paper mulberry,

				catalpa, and chinaberry
Pseudococcus cryptus	citriculus mealybug	not present	L2.3, L1.3	pest of citrus and species from 20 different families
Pseudococcus dendrobiorum	Orchid mealybug	not present	L1.3	pest of orchids: Ascoglossum sp., Cymbidium sp., Dendrobium sp., Phalaenopsis sp., Pholidota sp. and Promatocalpum species.
Pseudoparlatoria parlatoriodes	false paralatoria scale	not present		
Quadraspidiotus ostreaeformis	European fruit scale	not present	L2.3, L1.3	
Scotinophara lurida	rice stinkbug	not present	L2.3, L1.3	pest of rice
Toxoptera citricida	Brown citrus aphid	not present	L2.3, L1.3	pest of citrus
Trialeurodes floridensis	avocado whitefly	not present	L2.3, L1.3	pest of citrus
Moderate Risk				
Crisicoccus azaleae	azalea mealybug	not present	L1.3, L1.3.1.7	
Dinaspis aculeata	armored scale	not present	L1.3	
Dysmicoccus alazon	alazon mealybug	not present	L2.3, L1.3, L1.3.1.7	pest of pineapple, Andrea inermis, sugar apple, papaya, seagrape, Arabian coffee, calabash tree, Dasylirion longissimum, Eupatorium odoratum, weeping fig, Guazuma tomentosa, mango, banana, passionflower, pomegranate, chayote, teak, india almond, cacao
Icerya aegyptiaca	Egyptian fluted scale	not present	L1.3, L1.3.1.6	pest of seed grasses used for erosion control
Leptocorisa acuta	rice seed bug	not present	L2.3, L1.3	pest of rice and Echinochloa sp.
Leptoglossus chilensis	brown Chilean leaf-footed bug	not present		
Mesolecanium nigrofasciatum	terrapin scale	not present	L2.3, L1.3	attacks maple, oak, birch, elm and flowering fruit trees

Phenococcus manihoti	cassava mealybug	not present	L2.3, L1.3	pest of cassava, red spiderling, bell peppers, citrus, flatsedge, poinsettia, soyabean, sweet potato, ceara rubber
Phylloxera devastatrix	pecan phylloxera	not present	L2.3, L1.3	pest of pecans
Pseudococcus importatus	imported mealybug	not present	L1.3	pest of Bromeliaceae, Orchidaceae & Sapindaceae
Saccharicoccus sacchari	pink sugarcane mealybug	not present	L2.3, L1.3	pest of sugarcane and other Poaceae
Selenaspidus articulatus	rufous scale	not present		
Singhiella simplex	Fig whitefly	not present	L2.3, L1.3	pest of ficus benjamina
Sogatodes orizicola	rice delphacid	not present	L2.3, L1.3	pest of rice and vector of virus that causes 'hoja'blanca' disease
Trioza tripunctata	blackberry psyllid	not present	L2.3, L1.3	pest of blueberry
Unaspis citri	citrus snow scale	not present	L2.3, L1.3	pest of citrus
Velataspis dentata	dentate scale	not present	L1.3	
Low Risk				
Magicicada septendecim	periodical cicada	not present		
Pseudococcus elisae	banana mealybug	not present	L2.3, L1.3	pest of banana and other tropical fruits
Springtails				
Low Risk				
Sminthurus viridus	lucerne flea	not present	L2.3, L1.3	pest of lucerne (alfalfa) and other Fabaceae
Thrips				
High Risk				
Danothrips trifasciatus	thrips	not present	L2.3, L1.3.1.7	pest of citrus
Frankliniella tritici	flower thrips	not present	L1.3	
Haplothrips chinensis	thrips	not present	L1.3	

Scirtothrips dorsalis (Hood)	Chilli thrips	not present	L2.3, L1.3	pest of bananas, beans, chrysanthemums, citrus, corn, cotton, cocoa, eggplant, ficus, grape, grasses, holly, jasmine, kiwi, litchi, longan, mango, onion, peach, peanut, pepper, rose, soybean, strawberry, tea, tobacco, tomato, viburnum, among others
Selenothrips rubrocinctus	redbanded thrips	not present	L2.3, L1.3	pest of avocado, cacao mango & sweetgum tree; numerous tropical fruit, ornamental and shade trees.
Thrips angusticeps	cabbage thrips	not present	L2.3, L1.3	pest of Allium, horseradish, oats, sugarbeet, cabbage, broccoli, caraway, daisy, carnation, Barbeton daisy, barley, flax, lupine, Lucerne, tobacco, beans, peas, peaches, radish, willow, rye, potato, clover, wheat, broad bean
Thrips florum	banana flower thrips	not present	L2.3, L1.3	pest of gardenia
Thrips palmi	melon thrips	not present	L2.3, L1.3	pest of avocado, beans, cabbage, cantaloupe, carnation, chili, Chinese cabbage, chrysanthemum, citrus, cotton, cowpea, cucumber, bean, eggplant, hibiscus, lettuce, mango, melon, okra, onion, pea, peach, pepper, plum, potato, pumpkin, soybean, squash, tobacco and watermelon.
Moderate Risk				
Liothrips oleae	olive thrips	not present	L2.3, L1.3	attacks olives

Diseases

Table 5. Results of Disease invasive species pathway risk analysis. Species are listed by taxonomic subcategories and ranked by risk of introduction. Species considered to be a threat to biosecurity were not included in the report. Refer to Tables 1-3 for invasive species pathway codes.

Scientific name	*Common Name*	*Extent*	*Primary Pathways*	*Notes for Primary Pathways*
Bacteria				
High Risk				

Candidatus Liberibacter asiaticus	Huanglongbing disease of Citrus-Asian Strain	not present	M6; L1.3; L1.3.1.7; L1.3.2; L1.4; L1.3.1.1	
Candidatus Liberibacter sp.	Huanglongbing Disease of Citrus	not present	M6; L1.3; L1.3.1.7; L1.3.2; L1.4; L1.3.1.1	
Xanthomonas anoxopodis pv. citri	Citrus Canker	not present	M6 ; T2.1; L1.3; L1.3.1.1; L1.3.1.7; L2.3; M5	
Moderate Risk				
Candidatus Liberibacter americanus	Huanglongbing disease of Citrus-Americas Strain	not present	M6; L1.3; L1.3.1.7; L1.3.2; L1.4; L1.3.1.1	
Dickeya solani	Black leg disease of potato	not present	L1.3.1.2; L1.3.1.3	
Ehrlichia ruminantium	Heartwater; cowdriosis	not present	L2.2; L3.2; L2.4; T1.3.4	
Xylophilus ampelinus (Xanthomonas ampelina)	Grapevine Bacterial Blight	not present	L1.3; L1.3.1; L1.3.1.1; L1.3.1.7; L1.3.2; L1.4	
Low Risk				
Candidatus Liberibacter africanus	Huanglongbing disease of citrus-African strain	not present	M6; L1.3.1.7; L1.3.2; L1.4	
Mycoplasma capricolum capripneumoniae	Contagious Bovine Caprine Pleuropneumonia	not present	L2.2	
Mycoplasma mycoides mycoides	Bovine pleuropneumonia	not present	L2.2	
Xylella fastidiosa CVC	Citrus/Select Agent (citrus variegated chlorosis strain)	not present	L1.3; L1.3.1; L1.3.1.1; L1.3.1.3; L1.3.1.7; L1.3.2; L1.4	
Risk Unknown				
Brenneria salicis	Willow Watermark Disease	VALUE REQUIRED		
Candidatus australiense	Phytoplasma Yellows	VALUE REQUIRED		

Candidatus fragariae	Marginal chlororsis	VALUE REQUIRED		
Candidatus Liberibacter solanacearum	potato zebra chip	not present		
Candidatus Lieberobacter asiaticum	Apple Brown Ringspot Agent	VALUE REQUIRED		
Candidatus Phlomobacter fragariae	Marginal chlororsis	VALUE REQUIRED		
Erwinia salicis	Watermark Disease	VALUE REQUIRED		
Pseudomonas avellanae	Bacterial Canker of Hazelnut	VALUE REQUIRED		
Pseudomonas celebensis	Blood disease bacterium of banana	VALUE REQUIRED		
Pseudomonas celebensis	Freckle	VALUE REQUIRED		
Pseudomonas lignicola	Bacterial Stain	VALUE REQUIRED		
Pseudomonas lignicola	Potato Leaflet Stunt	VALUE REQUIRED		
Ralstonia solanacearum	Bacterial wilt	not present		
Ralstonia solanacearum race 3 biovar 2	Geranium Bacterial Wilt/Select Agent	not present		
Unknown pathogenic bacterium	Wheat Yellowing Stripe Bacterium	VALUE REQUIRED		
Xanthomonas acernea	Cotton small leaf agent	VALUE REQUIRED		
Xanthomonas albilineans	Sugarcane Wilt	VALUE REQUIRED		
Xanthomonas axonopodis manihotis	Cassava Bacterial Blight	VALUE REQUIRED		
Xanthomonas axonopodis pv. Dieffenbachiae	Anthurium Blight	VALUE REQUIRED		
Xanthomonas axonopodis vasculorum	Sugarcane Gumming Disease	VALUE REQUIRED		
Xanthomonas campestris pv vasculorum	Sugarcane Gumming Disease	VALUE REQUIRED		

Xanthomonas oryzae pv. oryzae	Bacterial Leaf Blight of Rice/Select agent	VALUE REQUIRED		
Xanthomonas oryzae pv. oryzicola	Bacterial Leaf Streak of Rice/Select Agent	VALUE REQUIRED		
Xanthomonas populi	Grapevine Infectious Necrosis Bacterium	VALUE REQUIRED		
Xanthomonas populi	Poplar Canker	VALUE REQUIRED		
Xanthomonas vasculorum	Bacterial Blight of Sugarcane	VALUE REQUIRED		
Fungi				
High Risk				
Cryphonectria parasitica	Chestnut blight	not present	L1.3; L1.3.1; L1.3.1.1; L1.3.1.7; L1.3.2	
Geosmithia sp.	Thousand Cankers Disease Complex	unknown		
Phakopsora meibomiae	soybean rust	not present	L1.3; L1.3.1; L1.3.1.6	
Moderate Risk				
Acremonium (Cephalosporium) diospyri	Persimmon Wilt	not present	L1.2; L1.3; L1.3.1.1; L1.3.1.7; L1.3.2	
Ceratocystis fagacearum	Oak wilt	not present	L1.3; L1.3.1; L1.3.1.4; L1.4	
Ceratocystis (Ophiostoma) ulmi	Dutch elm disease	Limited	M3; L1.3.1.4	
Discula destructiva	Dogwood Anthracnose	not present	L1.3; L1.3.1.7; L1.3.2	
Ophiostoma valdivianum	Blue Stain of Beech	not present	L1.3; L1.3.1; L1.3.1.4	
Phomopsis vaccinii	Phomopsis soft rot	not present	L1.3; L1.3.1; L1.3.1.1; L1.3.1.7; L1.3.2	
Puccinia graminis f. sp. tritici	Wheat stem rust (Uganda 99 strain)/Black rust	not present	L1.3; L1.3.1; L1.3.2; L1.3.1.1; L1.3.1.7; L1.3.1.3; M6	

Raffaelea lauricola	Laurel Wilt Disease	not present	L1.3; L1.3.1.4; L1.4	
Sclerophthora rayssiae var. zeae	Brown Stripe Downy Mildew of Maize	not present	L1.2; L1.3.1.3	
Tilletia tritici (caries)	Wheat smut	not present	T5; L1.2; L1.3; L1.3.1; L1.3.1.3	
Low Risk				
Armillaria novae-zelandiae	Armillaria Root Disease	not present	T3.2.4; T4; L1.3; L1.4	
Colletotrichum coffeanum	Brown Blight	not present	L1.3; L1.3.1.3; L4.4	
Cronartium flaccidum	Scotch Pine Blister Rust	not present	L1.3; L1.3.1; L1.3.1.1; L1.3.1.7; L1.3.2	
Entyloma oryzae	Leaf Smut of rice	not present	L1.3; L1.3.1.3	
Geomyces sp.	White-Nose Syndrome of bats	not present	M3	
Gymnosporangium asiaticum	Rust: Pear and Juniper	Limited	M3	
Microcyclus ulei	South American Leaf Blight	not present	L1.3; L1.3.1; L1.3.1.1; L1.3.1.6; L1.3.2	
Peronosclerospora sacchari (philippinensis)	Sugarcane Downy Mildew	not present	L1.3; L1.3.1.3	
Phakopsora pachyrhizi	Asian soybean Rust	not present	L1.3; L1.3.1; L1.3.1.6	
Phytophthora alni	Alder Phytophthora	not present	L1.3; L1.3.1; L1.3.1.1; L1.3.1.2; L1.3.1.7; L1.3.2	
Sirococcus clavigignenti-juglandacearum	Butternut Canker	not present	L1.3; L1.3.1; L1.3.1.3; L1.3.1.4	
Synchytrium endobioticum	Potato Wart/Select Agent	not present	T1.3; L1.2; L1.3; L1.3.1; L1.3.1.2	

Thecaphora (Angiosorus) solani	Potato smut	not present	L1.2; L1.3; L1.3.1.2; L1.3.1.3; L1.3.2	
Risk Unknown				
Aecidium hydrangeae-paniculatae	alt: Puccinia glyceriae/ rust on Hydrangea spp. and Glyceria spp.	VALUE REQUIRED		
Aecidium mori	Mulberry Rust	VALUE REQUIRED		
Armillaria limonea	Armillaria Root Disease	VALUE REQUIRED		
Ceratocystis fimbriata	black rot	VALUE REQUIRED		
Ceratocystis moniliformis	Cocoa ceratocystis wilt	VALUE REQUIRED		
Ceratocystis nothogafi	Blue Stain Fungus	VALUE REQUIRED		
Ceratocystis novae-zelandiae	wood-staining	VALUE REQUIRED		
Ceratocystis tenella	Blue Stain	VALUE REQUIRED		
Cercospora pini-densiflorae	Needle blight	VALUE REQUIRED		
Chalara australis	Vascular stain fungus	VALUE REQUIRED		
Chrysomyxa abietis	Spruce Needle Rust	VALUE REQUIRED		
Chrysomyxa himalensis	Spruce Needle Rust	VALUE REQUIRED		
Chrysomyxa ledi var. rhododendri	Rhododendron-spruce Needle Rust	VALUE REQUIRED		
Cochliobolus miyabeanus	Brown Spot of Rice	VALUE REQUIRED		
Coniothyrium spp.	canker in elm	VALUE REQUIRED		
Cordyceps spp.	Fungal Disease of Bees	VALUE REQUIRED		
Cornuvesica falcata	New Zealand wood rot	VALUE REQUIRED		
Crinipellis perniciosa	Witches Broom Fungus in cocoa	VALUE REQUIRED		

Cyclaneusma minus	Cyclaneusma Needle Cast	VALUE REQUIRED		
Diaporthe mali	Leaf, Branch, and Fruit Disease	VALUE REQUIRED		
Elsinoe australis	Sweet Orange Scab	VALUE REQUIRED		
Elsinoe batatas	sweet potato scab	VALUE REQUIRED		
Erythricium salmonicolor	Pink Disease	VALUE REQUIRED		
Fusarium fuliginosporum	Seeding Disease/seedling rot of Deodar cedar	VALUE REQUIRED		
Fusarium oxysporum f.sp. fragariae	Fusarium wilt of strawberry	VALUE REQUIRED		
Ganoderma mastoporum	Artist Conk	VALUE REQUIRED		
Gremmeniella abietina	Scleroderris Canker	VALUE REQUIRED		
Guignardia citricarpa	Citrus Black Spot	VALUE REQUIRED		
Guignardia musae	Freckle disease of Banana	VALUE REQUIRED		
Guignardia piricola	Leaf, Branch, and Fruit Disease	VALUE REQUIRED		
Hemileia vastatrix	Coffee Rust	VALUE REQUIRED		
Ischnoderma rosulata	Wood decay	VALUE REQUIRED		
Junghuhnia vincta	Corm dry rot	VALUE REQUIRED		
Lachnellula willkommii	Eurpoean larch canker	VALUE REQUIRED		
Leptographium procerum	Leptographium root disease	VALUE REQUIRED		
Leptographium truncatum	Root Disease	VALUE REQUIRED		
Melampsora pinitorqua	Twist Rust	VALUE REQUIRED		
Melanomma glumarum	Glume Blotch	VALUE REQUIRED		

Monilinia fructigena	Brown Rot of Fruit	VALUE REQUIRED		
Moniliophthora roreri	Watery Pod Rot	VALUE REQUIRED		
Mycosphaerella dearnesii	Brown Spot Needle Blight	VALUE REQUIRED		
Mycosphaerella pini	Red Band Needle Blight	VALUE REQUIRED		
Oncobasidium theobromae	Vascular Streak Die-back of cocoa	VALUE REQUIRED		
Oospora oryzetorum	Blight	VALUE REQUIRED		
Ophiostoma (Ceratocystis) ulmi	Dutch elm disease	VALUE REQUIRED		
Ophiostoma huntii	Blue Stain	VALUE REQUIRED		
Ophiostoma ips	Blue Stain Fungus	VALUE REQUIRED		
Ophiostoma piceae	Blue stain	VALUE REQUIRED		
Ophiostoma piceaperdum	Laural Wilt	VALUE REQUIRED		
Ophiostoma piliferum	Blue stain	VALUE REQUIRED		
Ophiostoma pluriannulatum	Wood stain	VALUE REQUIRED		
Pestalotiopsis disseminata	Parasitic Leaf Fungus	VALUE REQUIRED		
Phacidiopycnis pseudotsuga	Douglas Fir Canker	VALUE REQUIRED		
Phaeoramularia angolensis	Phaeoramularia Fruit and Leaf Spot	VALUE REQUIRED		
Phellinus noxius	Brown root rot	VALUE REQUIRED		
Phellinus senex	Stem decay	VALUE REQUIRED		
Phialophora cinerescens	Phialophora wilt of carnations and strawberries	VALUE REQUIRED		

Phlebia chrysocrea	Wood decay	VALUE REQUIRED		
Phoma tracheiphila	Mal Secco	VALUE REQUIRED		
Phyllosticta colocasiophila	Phyllosticta Leafspot	VALUE REQUIRED		
Physoderma zeae-maydis	Brown Spot of Corn	VALUE REQUIRED		
Pseudocercospora timorensis	Sweet Potato leaf spot	VALUE REQUIRED		
Pseudopezicula tracheiphila	Rotbrenner	VALUE REQUIRED		
Puccinia mccleanii	Rust	VALUE REQUIRED		
Pucciniastrum actinidae	Rust	VALUE REQUIRED		
Pucciniastrum areolatum	Cherry-Spruce Rust	VALUE REQUIRED		
Rhacodiella vitis	Chestnut rot	VALUE REQUIRED		
Rhacodiella vitis	Sterenberg fungus	VALUE REQUIRED		
Rosellinia necratrix	Dematophora Root Rot	VALUE REQUIRED		
Septoria melanosa	Elenk fungus	VALUE REQUIRED		
Sphaeropsis sapinea	Diplodia Shoot Blight	VALUE REQUIRED		
Stephanoderes hampei	Coffee fungus	VALUE REQUIRED		
Stereum hiugense	White Rot	VALUE REQUIRED		
Stigmina deflectans	Needlecast Disease	VALUE REQUIRED		
Trachysphaera fructigena	Mealy Pod Diseases of Cushy Gall Disease	VALUE REQUIRED		
Trametes versicolor	Wood decay	VALUE REQUIRED		
Triphragmiopsis laricinum	Brown Needle Rust	VALUE REQUIRED		
Uredo dioscoreae-alatae	Graminicolous Rust	VALUE REQUIRED		

Uredo gladioli-buettneri	Graminicolous Rust	VALUE REQUIRED		
Urocystis agropyri	Flag Smut	VALUE REQUIRED		
Urocystis tritici	Flag Smut Agent	VALUE REQUIRED		
Uromyces gladioli	Rust	VALUE REQUIRED		
Uromyces nyikensis	Rust	VALUE REQUIRED		
Uromycladium tepperianum	Rust	VALUE REQUIRED		
Oomycete				
Risk Unknown				
Peronosclerospora maydis	Downy Mildew of Corn/ Select agent	VALUE REQUIRED		
Peronosclerospora philippinensis (aka, sacchari)	Philippine Downy mildew of sorghum/Select Agent	not present		
Phytophthora cinnamomi	Root Rot	VALUE REQUIRED		
Phytophthora fragariae	Red Stele	VALUE REQUIRED		
Phytophthora infestans	Late Blight	VALUE REQUIRED		
Phytophthora kernoviae	Rhododendron Phytopthora disease	VALUE REQUIRED		
Phytophthora quercina	Oak disease	VALUE REQUIRED		
Schlerophthora rayssiae var zeae	Brown Stripe Downy mildew of corn/Select Agent	not present		
Phytoplasma				
Risk Unknown				
Candidatus phytoplasma	Witches broom disease of lime	not present		

Candidatus Phytoplasma australiense	Australian grapevine yellows/Phytoplasma yellows	VALUE REQUIRED		
Candidatus Phytoplasma mali	Apple proliferation	VALUE REQUIRED		
Candidatus phytoplasma spp.	Grapevine Yellows Disease	VALUE REQUIRED		
Phytoplasma bn	Black wood	VALUE REQUIRED		
Phytoplasma eay	European Aster Yellows	VALUE REQUIRED		
Phytoplasma esfy	European Stone Fruit Yellows	VALUE REQUIRED		
Phytoplasma fd	Flavescence doree	VALUE REQUIRED		
Phytoplasma md	Mulberry Dwarf	VALUE REQUIRED		
Phytoplasma parastolbur-mlo	Parastolbur	VALUE REQUIRED		
Phytoplasma rus	Rubus stunt	VALUE REQUIRED		
Phytoplasma ryd-mlo	Rice Yellow Dwarf	VALUE REQUIRED		
Phytoplasma scwl	Sugarcane White Leaf Phytoplasma	VALUE REQUIRED		
Phytoplasma ulmi	Elm yellows	VALUE REQUIRED		
Unknown pathogenic phytoplasma 1	Apple Rubbery Wood Phytoplasma	VALUE REQUIRED		
Unknown pathogenic phytoplasma 10	Sweetpotato witches broom (little leaf)	VALUE REQUIRED		
Unknown pathogenic phytoplasma 11	Texas phoenix palm phytoplasma	not present		
Unknown pathogenic phytoplasma 2	Cotton virescence	VALUE REQUIRED		
Unknown pathogenic phytoplasma 3	Grapevine Vergelbungskrankheit	VALUE REQUIRED		
Unknown pathogenic phytoplasma 4	Groundnut witches broom	VALUE REQUIRED		
Unknown pathogenic phytoplasma 5	Palm Lethal Yellowing Phytoplasma	VALUE REQUIRED		

Unknown pathogenic phytoplasma 6	Potato Marginal Flavescence	VALUE REQUIRED		
Unknown pathogenic phytoplasma 7	Potato Purple Top Roll	VALUE REQUIRED		
Unknown pathogenic phytoplasma 8	Potato witches broom	VALUE REQUIRED		
Unknown pathogenic phytoplasma 9	Stolbur	VALUE REQUIRED		
Protists				
Risk Unknown				
Plasmodium falciparum	Malaria	VALUE REQUIRED		
Plasmodium knowlesi	Malaria	VALUE REQUIRED		
Plasmodium malariae	Malaria	VALUE REQUIRED		
Plasmodium ovale	Malaria	VALUE REQUIRED		
Plasmodium relictum	Avian malaria	VALUE REQUIRED		
Plasmodium vivax	Malaria	VALUE REQUIRED		
Unknown Diseases				
High Risk				
Cilivirus cilv-c	Citrus leprosis virus C	not present	L1.3; L1.3.1.7; L1.4	
Potyvirus ppv	Plum Pox Virus	not present	L1.3; L1.3.1; L1.3.1.1; L1.3.1.7; L1.3.2	
Moderate Risk				
Begomovirus (ToTV)	Tomato Torrado Virus (ToTV)	not present	L1.3; L1.3.2	
Carlavirus	Blueberry Scorch carlavirus	not present	L1.3; L1.3.2; T4; L1.3.1.1	
Novirhadovirus Viral Hemorrhagic Septicemia Virus (VHSV)	Viral Hemorragic septicemia	not present	L3.1; L3.3	

Potyviruses: Potyviridae	Plum pox	not present	L1.3; L1.3.1; L1.3.1.1; L1.3.1.7; L1.3.2	
Low Risk				
Alphavirus eeev	Eastern Equine Encephalitis Virus	not present	M6; T1.3.4; T5.3; L3.2; L3.4	
Alphavirus veev	Venezuelan Equine Encephalitis Virus	not present	M6	
Badnavirus cymvr	Citrus yellow mosaic virus	not present	M6; T1.3.4; T5.1	
Birnaviridae fam: unknown	Citrus Chlorotic Dwarf Virus	not present	L1.3.2; L1.3; L1.3.1.1	
Bunyavirus (TZSV)	Tomato zonate spot virus (TZSV)	not present	L1.3.2; L1.3	
Mandarivirus icrsv	Indian citrus ringspot virus	not present	L1.3; L1.3.1; L1.3.1.1; L1.3.1.2; L1.3.2	
Nepovirus gtrsv	Grapevine Tunisian Ringspot Virus	not present	L1.3; L1.3.1; L1.3.1.1; L1.3.1.2; L1.3.1.7; L.1.3.2	
Risk Unknown				
Alfamovirus pyv	Potato Yellowing Virus	VALUE REQUIRED		
Apscaviroid 1	Apple scar skin viroid	VALUE REQUIRED		
Apscaviroid 2	Citrus bent leaf viroid	VALUE REQUIRED		
Apscaviroid 3	Grapevine yellow speckle viroid	VALUE REQUIRED		
Apscaviroid pbcvd	Pear Blister Canker Viroid	VALUE REQUIRED		
Asfivirus asfv	African Swine Fever Virus	VALUE REQUIRED		
Avipoxvirus	Bird pox	VALUE REQUIRED		
Babuvirus bbtv	Banana Bunchy Top Virus	VALUE REQUIRED		

Baculovirus BMNV (PjNOB1)	Baculoviral Midgut Gland Necrosis Virus (BMNV) of fish	VALUE REQUIRED		
Baculovirus complex WSBV	White Spot Syndrome Baculovirus Complex of fish	VALUE REQUIRED		
Baculovirus PmSNPV	Mbv-Type Virus of fish	VALUE REQUIRED		
Badnavirus bsv	Banana Streak Virus	VALUE REQUIRED		
Badnavirus cssv	Cocoa Mottle Leaf Virus	VALUE REQUIRED		
Begomovirus bgmv	Bean Golden Mosaic Virus	VALUE REQUIRED		
Begomovirus byvmv	Bhendi Yellow Vein Mosaic Virus	VALUE REQUIRED		
Begomovirus clcuv	Cotton Leaf Curl Virus	VALUE REQUIRED		
Begomovirus lgmv	Lima Bean Golden Mosaic Virus	VALUE REQUIRED		
Begomovius hgymv	Horsegram Yellow Mosaic Virus	VALUE REQUIRED		
Benyovirus bnyvv	Beet necrotic yellow vein virus (BNYVV)	VALUE REQUIRED		
Bigeminivirus lgmv	Lima Bean Golden Mosaic Virus	VALUE REQUIRED		
Bigeminvirus acmv	Cassava African Mosaic Virus	VALUE REQUIRED		
Bigeminvirus mymv	Mung Bean Yellow Mosaic Virus	VALUE REQUIRED		
Birnaviridae	Groundnut Chlorotic Leaf Streak Virus	VALUE REQUIRED		
Brevidensovirus IHHNV	Infectious Hypodermal and Hematopoietic Necrosis Virus of fish	VALUE REQUIRED		
Bymovirus baymv	Barley Yellow Mosaic Virus	VALUE REQUIRED		

Capillovirus of unknown genus	Apple stem grooving virus	not present		
Capripoxvirus lsd	Lumpy Skin Disease of Cattle	VALUE REQUIRED		
Capripoxvirus sppv	Sheep pox virus	VALUE REQUIRED		
Carlavirus casmmv	Cassava Common Mosaic Virus	VALUE REQUIRED		
Carlavirus cpmmv	Cowpea Mild Mottle Virus	VALUE REQUIRED		
Carlavirus pvm	Potato Mop Top Virus	VALUE REQUIRED		
Closteroviridae byvd	Blackberry Yellow Vein Disease	VALUE REQUIRED		
Closterovirus wylv or Prosopis fiebrigii ?	Wheat Yellow Leaf Virus	VALUE REQUIRED		
Cocadviroid cccvd	Coconut Cadang-Cadang Viroid	VALUE REQUIRED		
Cocoa Swollen Shoot Virus	Cocoa Swollen Shoot Virus	VALUE REQUIRED		
Comovirus of unknown genus	Andean Potato Mottle Virus	VALUE REQUIRED		
Comovirus rcmv	Red Clover Mottle Virus	VALUE REQUIRED		
Crinivirus pyvv	Potato Yellow Vein Virus	VALUE REQUIRED		
Crinivirus spcsv	Sweetpotato Chlorotic Stunt Virus	VALUE REQUIRED		
Cytorhabdovirus bysmv	Barley Yellow Striate Mosaic Virus	VALUE REQUIRED		
Cytorhabdovirus ncmv	Northern Cereal Mosaic Virus	VALUE REQUIRED		
Dicistroviridae TSV	Taura syndrome of shrimp; Infectious cuticular epithelial necrosis virus (ICENV)	VALUE REQUIRED		
Enterovirus cv-b5	Swine Vesicular Disease	VALUE REQUIRED		
Fijivirus mrdv	Maize Rough Dwarf Virus	VALUE REQUIRED		
Fijivirus osdv	Oat Sterile Dwarf Virus	VALUE REQUIRED		

Flavivirus 3	Yellow Fever	VALUE REQUIRED		
Flavivirus jev	Japanese Encephalitis Virus	VALUE REQUIRED		
Geminivirus bgmv	Bean Golden Mosaic Virus	VALUE REQUIRED		
Geminiviruses	Misc. viral diseases of cotton, pepper, etc.	VALUE REQUIRED		
Hemileia vastatrix	Yellow ring mosaic agent (assoc. with Jasminum)	VALUE REQUIRED		
Ilarvirus apmv	Apple mosaic virus	VALUE REQUIRED		
Influenzavirus hpav	Highly Pathogenic Avian Influenza	VALUE REQUIRED		
Ipomovirus cbsv	Cassava Brown Streak Virus	VALUE REQUIRED		
Isavirus isa	Infectious Salmon Isavirus Anemia (ISA)	VALUE REQUIRED		
Jasmine Variegation Agents	Jasmine Variegation Agents	VALUE REQUIRED		
Ligustrum Mosaic Agents	Ligustrum Mosaic Agents	VALUE REQUIRED		
Llarvirus emov	Elm Mottle Virus	VALUE REQUIRED		
Luteovirus cav	Cotton Anthocyanosis Agent	VALUE REQUIRED		
Luteovirus isdv	Indonesian Soybean Dwarf Virus	VALUE REQUIRED		
Luteovirus of unassigned genus	African Soybean Dwarf Agent	VALUE REQUIRED		
Luteovirus sbdv	Soybean dwarf virus	VALUE REQUIRED		
Maple Mosaic Agent	Maple Mosaic Agent	VALUE REQUIRED		
Maple Variegation Agent	Maple Variegation Agent	VALUE REQUIRED		
Monogeminivirus msv	Maize Streak Virus	VALUE REQUIRED		
Morbillivirus ppr	Peste des Petits Ruminants;	VALUE REQUIRED		
Morbillivirus RBOK	Rinderpest virus	not present		

Mountain Ash Ringspot Mosaic Agent	Mountain Ash Ringspot Mosaic Agent	VALUE REQUIRED		
Mountain Ash Variegation Agent	Mountain Ash Variegation Agent	VALUE REQUIRED		
Mulberry Mosaic Agent	Mulberry Mosaic Agent	VALUE REQUIRED		
n/a Citrus chlorotic dwarf	n/a Citrus chlorotic dwarf	not present		
n/a Citrus leaf blotch virus	n/a Citrus leaf blotch virus	not present		
n/a Citrus vein-enation virus probably Luteovirus	n/a Citrus vein-enation virus probably Luteovirus	not present		
n/a Citrus viroids	n/a Citrus viroids	not present		
n/a Indian citrus ringspot virus	n/a Indian citrus ringspot virus	not present		
Nepovirus ailv	Artichoke Italian Latent Virus	VALUE REQUIRED		
Nepovirus armv	Arabis mosaic virus and its strains	VALUE REQUIRED		
Nepovirus avb	Arracacha Virus B	VALUE REQUIRED		
Nepovirus brv	Black Currant Reversion Virus	VALUE REQUIRED		
Nepovirus cnv	Cocoa Necrosis Virus	VALUE REQUIRED		
Nepovirus csalv	Cassava Latent Virus	VALUE REQUIRED		
Nepovirus gblv	Grapevine Bulgarian Latent Virus	VALUE REQUIRED		
Nepovirus gcmv	Grapevine Chrome Mosaic Virus	VALUE REQUIRED		
Nepovirus lalv	Lucerne Vein Yellowing Virus	VALUE REQUIRED		
Nepovirus lasv	Lucerne Australian Symptomless Virus	VALUE REQUIRED		
Nepovirus pvu	Potato Virus U	VALUE REQUIRED		
Nepovirus rprsv	Raspberry ringspot virus and its strains	VALUE REQUIRED		

Nepovirus slrsv	Strawberry Latent Ringspot Virus	VALUE REQUIRED		
Nepovirus tbrv	Tomato Black Ring Virus	VALUE REQUIRED		
Nepovirus trsv	Tobacco Ringspot Virus	VALUE REQUIRED		
Nucleorhabdovirus ccmv	Cereal Chlorotic Mosaic Virus	VALUE REQUIRED		
Nucleorhabdovirus ccsv	Cynodon Chlorotic Streak Virus	VALUE REQUIRED		
Nucleorhabdovirus immv	Iranian Maize Mosaic Virus	VALUE REQUIRED		
Nucleorhabdovirus lev	Lucerne enation virus	VALUE REQUIRED		
Oat Red Streak Mosaic Virus	Oat Red Streak Mosaic Virus	VALUE REQUIRED		
Okra Mosaic Agents	Okra Mosaic Agents	VALUE REQUIRED		
Okra Yellow Leaf Curl Agent	Okra Yellow Leaf Curl Agent	VALUE REQUIRED		
Orbivirus ahsv	African Horse Sickness Virus	VALUE REQUIRED		
Orthobunyavirus akav	Akabane Virus	VALUE REQUIRED		
Orthopoxvirus cmlv	Camel Pox Virus	VALUE REQUIRED		
Oryzavirus ersv	Echinochloa Ragged Stunt Virus	VALUE REQUIRED		
Paramyxovirus hv	Hendra Virus	VALUE REQUIRED		
Paramyxovirus mv	Menangle Virus	VALUE REQUIRED		
Paramyxovirus nv	Nipah Virus	VALUE REQUIRED		
Pear Bud Drop Agent	Pear Bud Drop Agent	VALUE REQUIRED		
Pecluvirus ipcv	Indian Peanut Clump Virus	VALUE REQUIRED		
Pecluvirus pcv	Peanut Clump Virus	VALUE REQUIRED		
Pestivirus CSFV strain Brescia	Classical swine fever virus (strain Brescia)	not present		

Phlebovirus rvfv	Rift Valley Fever	VALUE REQUIRED		
Phyllody Agent	Phyllody Agent	VALUE REQUIRED		
Phytoreovirus rdv	Rice Dwarf Virus	VALUE REQUIRED		
Phytoreovirus rgdv	Rice Gall Dwarf Virus	VALUE REQUIRED		
Plum Bark Split Virus	Plum Bark Split Virus	VALUE REQUIRED		
Porcine herpesvirus 1	Swine pseudorabies	not present		
Potexvirus (?) or Potyvirus (?)	Potato veinal necrosis virus (PVYN)	VALUE REQUIRED		
Potexvirus gcsv	Groundnut Chlorotic Spotting Virus	VALUE REQUIRED		
Potyvirus bcmv	Azuki bean mosaic virus	VALUE REQUIRED		
Potyvirus cdv	Datura Colombian Virus	VALUE REQUIRED		
Potyvirus ddmv	Datura Distortion Mosaic Virus	VALUE REQUIRED		
Potyvirus demv	Datura Enation Mosaic Virus	VALUE REQUIRED		
Potyvirus pvv	Potato Virus V	VALUE REQUIRED		
Potyvirus pvy	Potato Virus Y	VALUE REQUIRED		
Prosopis fiebrigii or Closterovirus wylv ?	Wheat Yellow Leaf Virus	VALUE REQUIRED		
Quince Sooty Ringspot Agent	Quince Sooty Ringspot Agent	VALUE REQUIRED		
Quince Yellow Blotch Agent	Quince Yellow Blotch Agent	VALUE REQUIRED		
Reoviridae-related pathogenic virus (REO-III, REO-IV)	Reo-like viruses	VALUE REQUIRED		
Rhabdovirus aev	Alfalfa Enation Virus	VALUE REQUIRED		
Rhadinovirus aihv-1	Alcelaphine herpesvirus 1	VALUE REQUIRED		
Rymovirus bstv	Brome Streak Mosaic Virus	VALUE REQUIRED		

Sampaguita Yellow Ringspot Mosaic Agent	Sampaguita Yellow Ringspot Mosaic Agent	VALUE REQUIRED		
Satsuma dwarf virus, Sadwa virus SDV	Satsuma dwarf virus	not present		
Sobemovirus cmmv	Cocksfoot Mild Mosaic Virus	VALUE REQUIRED		
Sobemovirus cnmov	Cynosurus Mottle Virus	VALUE REQUIRED		
Sobemovirus rymv	Rice Yellow Mottle Virus	VALUE REQUIRED		
Soybean Dwarf Virus	Soybean Dwarf Virus	VALUE REQUIRED		
Sweetpotato chlorotic stunt virus	Sweetpotato chlorotic stunt virus	VALUE REQUIRED		
Tenuivirus ewsmv	European Wheat Striate Mosaic Virus	VALUE REQUIRED		
Tenuivirus mmcsv	Maize Mottle/Chlorotic Stunt Virus	VALUE REQUIRED		
Tenuivirus rwsv	Rice Wilted Stunt Virus	VALUE REQUIRED		
Tomato Yellow Leaf Curl Sardinia Virus, TYLCSV	Tomato Yellow Leaf Curl Sardinia Virus	not present		
Tombusviridae of unknown genus	Chlorotic Ringspot Agent	VALUE REQUIRED		
Tombusvirus galv	Grapevine Algerian Latent Virus	VALUE REQUIRED		
Tospovirus cacv	Capsicum chlorosis virus	not present		
Trichovirus aclsv	Apple Chlorotic Leafspot Virus	VALUE REQUIRED		
Trichovirus crmv	Cherry Rusty Mottle Agent	VALUE REQUIRED		
Trichovirus ginv	Grapevine Berry Inner Necrosis Virus	VALUE REQUIRED		
Trichovirus pvt	Potato Virus T	VALUE REQUIRED		
Trichovirus spp	Quince Stunt Agent	VALUE REQUIRED		
Tymovirus (?)	Citrus sudden death n/a probably Tymovirus	not present		

Tymovirus aplv	Andean Potato Latent Virus	VALUE REQUIRED		
Tymovirus cymv	Cocoa Yellow Mosaic Virus	VALUE REQUIRED		
Tymovirus dmv	Dulcamara Mottle Virus	VALUE REQUIRED		
Tymovirus okmv	Okra Mosaic Virus	VALUE REQUIRED		
Umbravirus grv	Groundnut Rosette Viruses	VALUE REQUIRED		
Unknown pathogeic coronavirus- and arterivirus-like virus	Yellowhead disease of shrimp	VALUE REQUIRED		
Unknown pathogenic virus 1	Australian lymphoidal Parvo-Like Virus of fish	VALUE REQUIRED		
Unknown pathogenic virus 10	Hibiscus Leaf Curl Agent	VALUE REQUIRED		
Unknown pathogenic virus 11	Horsechestnut Variegation Agent	VALUE REQUIRED		
Unknown pathogenic virus 12	Horsechestnut Yellow Mosaic Agent	VALUE REQUIRED		
Unknown pathogenic virus 2	Euonymus Mosaic Agents	VALUE REQUIRED		
Unknown pathogenic virus 3	French Bean Mosaic Virus	VALUE REQUIRED		
Unknown pathogenic virus 4	Grapevine Bratislava Mosaic Agent	VALUE REQUIRED		
Unknown pathogenic virus 5	Grapevine Chasselas Latent Agent	VALUE REQUIRED		
Unknown pathogenic virus 6	Grapevine Little Leaf Agent	VALUE REQUIRED		
Unknown pathogenic virus 7	Grapevine Vein Mosaic Agent	VALUE REQUIRED		
Unknown pathogenic virus 8	Grapevine Vein Necrosis Agent	VALUE REQUIRED		
Unknown pathogenic virus 9	Grapevine vein yellow agent	VALUE REQUIRED		
Unknown pathogenic virus ccdv	Citrus chlorotic dwarf virus ccdv	VALUE REQUIRED		
Veinal necrosis virus (PVYN)	Veinal necrosis virus (PVYN)	VALUE REQUIRED		
Viral Hemorrhagic Septicemia Virus	Viral Hemorrhagic Septicemia (VHS)	VALUE REQUIRED		

Waikavirus rtsv	Rice Tungro Virus	VALUE REQUIRED		

Invertebrates

Table 6. Results of Invertebrate invasive species pathway risk analysis. Species are listed by taxonomic subcategories and ranked by risk of introduction. Species considered to be a threat to biosecurity were not included in the report. Refer to Tables 1-3 for invasive species pathway codes.

Scientific name	*Common Name*	*Extent*	*Primary Pathways*	*Notes for Primary Pathways*
Freshwater Mollusks				
Low Risk				
Limnoperna fortunei	Golden mussel	not present	T1.2.1, T1.2.2, T2, T5, T5.2, L1.3, L1.3.4, L2, L3, L3.1, L3.2, L3.3, M3	ship ballast water and other vessels that hold water; hull/surface fouling, recreational boats and ski-dus; military travel-ships; travel and tourism; cruise ships, personal boats, fishing gear; aquatics recreation gear; aquatic/pond plants; aquatic propagules; live seafood/estuary food; non-food; bait; pet aquaria-tropical fish (water and live products); koi fish and aquatic plants; aquaculture-fish and shellfish seed; migrating water fowl
Marine Mollusks				
Risk Unknown				
Lydorus pedicellatus	Blacktip shipworm	unknown	T1.2.2	bores into ship hulls
Potamocorbula amurensis	Amur River Corbula Clam	VALUE REQUIRED		
Teredo barstschi	Shipworm	VALUE REQUIRED		
Crustaceans				
Risk Unknown				
Sphaeroma quoyanum	Isopod	VALUE REQUIRED		
Nematodes				
Moderate Risk				
Globodera pallida	Pale cyst nematode	not present		
Radopholus similis	Burrowing Nematode	not present	L1.3.1.7	movement of infected plants (banana, citrus)

Rotylenchulus reniformis	Reniform Nematode	not present	L1.3.1.7	movement of infected plants (Phoenix roeselenii and Cycas sp.)
Low Risk				
Globodera rostochiensis	Golden Nematode	not present		
Risk Unknown				
Gyrodactylus elegans	Parasitic flatworm of fish	unknown	L3.3, M3.3	salmonid hatcheries and migration
Ichthyophithirius multifilis	Parsitic protozoan of fish	unknown	L2.1, L3.2	infects tropical fish, goldfish, and food fish
Oodinium pilularis	Velvet disease	unknown	L3.2	aquarium fish parasite
Cryptocotyle lingua	Black Spot parasite of fish	VALUE REQUIRED		
Mitraspora cyprini Fujita	Parasitic protozoan of fish	VALUE REQUIRED		
Mitraspora cyprini Fujita	Parasitic protozoan of fish	VALUE REQUIRED		
Pleistophora hyphessobryconis	Neon-tetra disease of fish	VALUE REQUIRED		
Protopalina symphysodonis	Protopalina symphysodonis infection of fish	VALUE REQUIRED		
Trichodinella epizootica	Protozoic parasite of fish	VALUE REQUIRED		

Plants

Table 7. Results of Plant invasive species pathway risk analysis. Species are listed by taxonomic subcategories and ranked by risk of introduction. Species considered to be a threat to biosecurity were not included in the report. Refer to Tables 1-3 for invasive species pathway codes.

Scientific name	***Common Name***	***Extent***	***Primary Pathways***	***Notes for Primary Pathways***
Algae				
High Risk				
Caulacanthus ustulatus	red algae	unknown	T 1.2.1, L 3.2	
Caulerpa brachypus	Caulerpa brachypus	unknown	T 1.2.1, L 3.2	

Caulerpa racemosa	Caulerpa racemosa	unknown	T 1.2.1, L 3.2	
Lyngbya spp.	Lyngbya spp.	unknown		
Moderate Risk				
Sargassum horneri	Asian seaweed	limited	-	
Low Risk				
Sargassum muticum	Sargassum muticum	unknown	-	
Grasses				
High Risk				
Urochloa panicoides	liverseed grass	not present	L1.3.1.7	cereal seed contaminant
Moderate Risk				
Digitaria abyssinica	Digitaria abyssinica	not present	MISSING CODE	
Digitaria velutina	velvet fingergrass	not present	MISSING CODE	
Imperata cylindrica	cogongrass	not present	T3.2, L1.3.1.5	packing material, forage, soil stabilization
Leptochloa chinensis	Asian sprangletop	not present	L1.3.1.5, L1.3.1.7	forage, rice contaminant
Nardus stricta	matgrass	not present	L1.3.4, M3.3	seed transported on mud clinging to hooves of grazing animals
Oryza longistaminata	red rice	not present	L1.1, L1.3.1.6	rice breeding research, rice seed contaminant
Oryza punctata	red rice	not present	L1.1, L1.3.1.6	rice breeding research, rice seed contaminant
Rottboellia cochinchinensis	itchgrass	not present	M3.3, M3.2, M3.4, T1.3.3	Seed spread by birds, flood water, rodents, farm machinery
Setaria pumila ssp. pallidefusca	cattail grass	not present	-	
Sorghum almum	Columbus grass	not present	L3.1, L1.3.1.3	livestock forage
Low Risk				
Chrysopogon aciculatus	pilipiliula	not present	MISSING CODE	ag weed of tea, rubber, tobacco farms
Imperata brasiliensis	Brazilian satintail	not present	L 1.3.1.7, L 3.2	
Ischaemum rugosum	murainograss	not present	MISSING CODE	

Milium vernale	milium	not present	L1.3.1.5	
Nassella trichotoma	serrated tussock	not present	L3.4, M3.3, T1.3.3, T1.3.1, L1.3.1.4,, L1.2	seed transported on mud clinging to hooves of grazing animals, sheep fleece, cultivation equipment, vehicle tires, firewood, moving soil
Paspalum scrobiculatum	Kodo-millet	not present	L2.3, L3.6	medicinal, food (alternative grain)
Pennisetum macrourum	African feathergrass	not present	-	
Pennisetum macrourum	African feathergrass	not present	-	
Pennisetum polystachion	missiongrass	not present	L1.3.1.6, M3.3	hay and grain contaminant, clinging to animals
Saccharum spontaneum	wild sugarcane	not present	L2.3, L3.1, L1.1	medicinal, religious uses, material for sugarcane breeding
Sorghum propinquum	sorghum	not present	L3.1, L1.3.1.3	livestock forage
Herbaceous Plants				
High Risk				
Allaria petiolata	garlic mustard	not present	L1.3.2, L2.3	
Ambrosia tomentosa	skeletonleaf bursage	not present	L 1.3.2	double-check!
Anthriscus sylvestris	wild chervil	not present	L 1.3.2	wildflower mixes
Butomus umbellatus	flowering rush	not present	L 1.3.2	
Carum carvi	wild caraway	not present	L 2.3, L 1.3.2	culinary herb
Clematis orientalis	Chinese clematis	not present	L 1.3.2	
Dipsacus laciniatus	cutleaf teasel	not present	M 4.1	mowing along highways
Echium vulgare	common viper's bugloss	not present	M 3.2	
Epilobium hirsutum	hairy willow herb	not present	T 1.2.1 , L 1.3.2	
Heracleum mantegazzianum	giant hogweed	not present	L 1.3.1.1	dried flower arrangements
Hieracium aurantiacum	orange hawkweed	not present	L 1.3.1.3, L 1.3.2	
Hieracium caespitosum	yellow hawkweed	not present	L 1.3.1.3, L 1.3.2	

Hygrophila polysperma	Miramar weed	not present	L 1.3.1.4, L 1.3.2	
Lysimachia vulgaris	garden loosestrife	not present	L3.1.1	intentional release (details unknown)
Orobanche minor	small broomrape	not present	L1.3.1.3	seed mixes
Ottelia alismoides	ducklettuce	not present	-	
Peganum harmala	harmel	not present	-	
Peganum harmala	harmel	not present	-	
Sagittaria graminea	grass-leaved arrowhead	not present	L1.3.1.4, L3.2	aquatic gardens, aquarium trade
Salsola collina	spineless Russian thistle	not present	L1.3.1.6	birdseed contaminant
Striga spp.	witchweed	not present	M8	Unknown pathway
Vallisneria spp.	eelgrass	not present		
Moderate Risk				
Aeginetia spp.	aeginetia	not present	L 1.3.1.7	parasite of sugar cane
Alectra spp.	alectra	not present	L 1.3.1.7	parasite of legumes
Alternanthera sessilis	sessile joyweed	not present	L 1.3.2	
Alyssum corsicum	yellowtuft	not present	M 4.2.1	phytomining
Alyssum murale	yellowtuft	not present	M 4.2.1	phytomining
Azolla pinnata	mosquito fern	not present	L 3.2, L 3.3	
Bryonia alba	white bryony	not present	L 3.6	homeopathy
Carthamus leucocaulos	whitestem distaff thistle	not present	MISSING CODE	
Centaurea macrocephala	bighead knapweed	not present	L 1.3.1.3, L 1.3.2	
Chaenorhinum minus	dwarf snapdragon	not present	L1.3, 1.3.1.3	ornamental
Drymaria arenarioides	lightening weed	not present	MISSING CODE	

Euphorbia serrata	serrate spurge	not present	MISSING CODE	
Galega officinalis	goatsrue	not present	L 1.3.1.5, L 1.3.2	forage crop
Hieracium pilosella	mouseear hawkweed	not present	L 1.3.1.3, L 1.3.2	
Hieracium piloselloides	king devil hawkweed	not present	L 1.3.1.3, L 1.3.2	
Hieracium x floribundum	yellow devil hawkweed	not present	L 1.3.1.3, L 1.3.2	
Hydrocharis morsus-ranae	European frog-bit	not present	L 1.3.1.4, L 1.3.2	
Impatiens glandulifera	policeman's helmet	not present	L 1.3.2	
Lagarosiphon major	oxygenweed	not present	L1.3.1.4	aquatic gardens
Lespedeza cuneata	sericea lespedeza	not present	L1.3.1.5, L3.6, L1.1	crop research
Limnophila indica	ambulia	not present	L3.2, M3.2	
Limnophila sessiliflora	blume (ambulia)	not present	L3.2, M3.2	
Ludwigia peruviana	water primrose	not present	L1.3, L3.2	
Murdannia keisak	marsh dew flower	not present	L1.3.1.6	Rice seed contaminant
Myosoton aquaticum	giant chickweed	not present	M8, L1.3	
Najas minor	slender-leaved naiad	not present	L3.11, L3.2, T1.2.1	
Physalis longifolia	long-leaf groundcherry	not present	-	
Picris hieracioides	hawkweed oxtongue	not present	L1.3	nursery
Polygonum x bohemicum	Bohemian knotweed	not present	L1.3	nursery
Pontederia cordata	pickerelweed	not present	-	
Pueraria montana var. lobata	kudzu	not present	L1.3, L1.3.1.5, M4.2, L3.6	Livestock fodder, erosion control, folk art, medicinal
Salvia pratensis	meadow clary	not present	-	
Salvia sclarea	clary sage	not present	L2.3	essential oil

Salvia virgata	southern meadow sage	not present	-	
Senecio madagascariensis	Madagascar ragwort	not present	L1.3.1.6	contaminated hydromulch seed
Striga asiatica	witchweed	not present	M8	Unknown pathway
Tagetes minuta	wild marigold	not present		
Thymelaea passerina	spurge flax	not present	L1.3.1.6	Grain contaminant
Trapa natans	water-chestnut	not present	L3.2, M3.2	Farm dams, fish ponds, water features, ponded or slow moving water bodies near towns
Tussilago farfara	coltsfoot	not present	M4.2.1, L2.3	Gravel contaminant, medicinal
Utricularia inflata	swollen bladderwort	not present	L1.3.1.4, L3.2	aquatic gardens, aquarium trade
Low Risk				
Cirsium japonicum	Japanese thistle	not present	L 3.6	
Crassula helmsii	Australian swamp stonecrop	not present	L 1.3.2, L 3.2	
Cuscuta australis	Australian dodder	not present	MISSING CODE	
Cuscuta monogyna	Eastern Dodder	not present	MISSING CODE	
Cuscuta reflexa	giant dodder	not present	MISSING CODE	
Eichhornia azurea	anchored water hyacinth	not present	L 3.3	
Glossostigma diandrum	mud mat	not present	L 3.2, M 3.4	migrating geese, waterfowl
Hieracium atratum	polar hawkweed	not present	L 1.3.1.3, L 1.3.2	
Hieracium glomeratum	queen devil hawkweed	not present	L 1.3.1.3, L 1.3.2	
Hieracium laevigatum	smooth hawkweed	not present	L 1.3.1.3, L 1.3.2	
Homeria spp.	cape tulip	not present	L 1.3.1.2, L 1.3.2	
Lepyrodiclis holosteoides	false jagged-chickweed	not present	MISSING CODE	
Lythrum virgatum	purple loosestrife	not present	L1.3	

Mikania cordata	mile-a-minute	not present	MISSING CODE	
Mikania micrantha	bittervine	not present	MISSING CODE	
Monochoria hastata	arrowleaf falsepickerelweed	not present	-	
Opuntia aurantiaca	jointed prickly pear	not present	L1.3	Grown for cochineal insect that creates scarlet dye
Sagittaria sagittifolia	arrowhead	not present	L1.3.1.4, L3.2	aquatic gardens, aquarium trade
Salsola vermiculata	wormleaf salsola	not present	-	
Salvinia auriculata	giant salvinia	not present	L1.3.1.4, T1.2.2	aquatic gardens, boat propellers, docking lines, boating equipment, fishing gear
Senecio linearifolius	narrowleaf ragwort	not present	-	
Senecio squalidus	Oxford ragwort	not present	-	
Solanum cardiophyllum	heartleaf nightshade	not present		
Solanum viarum	tropical soda apple	not present	M8	Unknown pathway
Spermacoce alata	winged false buttonweed	not present	MISSING CODE	
Trapa bicornis	water caltrap	not present	L3.2, M3.2	Farm dams, fish ponds, water features, ponded or slow moving water bodies near towns
Tridax procumbens	coat buttons	not present	M1.3.2, L1.3.1.6	found by railroad spur in TX, contaminant in coffee imported from Mexico
Tripleurospermum perforatum	scentless false mayweed	not present	L1.3.1.5, L1.3.1.6	Contaminated forage, grain and grass seed
Woody Plants				
High Risk				
Euryops multifidus	hawk's eye	not present	L 1.3.1.3, L 1.3.2	
Hedera hibernica	English ivy	not present	L 1.3.2	
Moderate Risk				
Halimodendron halodendron	Russian salttree	not present	M 4.2.2	

Prosopis strombulifera	creeping mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Low Risk				
Melastoma malabathricum	Malabar melastome	not present	L1.3.1.1	dried flower arrangements
Mimosa diplotricha	giant sensitive plant	not present	L1.3, L1.3.1.5	cover crop, animal forage
Mimosa invisa	giant sensitive plant	not present	L1.3, L1.3.1.5	cover crop, animal forage
Mimosa pellita	lollipop mimosa	not present	M3.2, L1.3	water, horticultural
Mimosa pigra	catclaw mimosa	not present	M3.2, L1.3	water, horticultural
Prosopis alpataco	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis argentina	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis articulata	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis burkartii	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis caldenia	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis calingastana	cusqui	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis campestris	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis castellanosii	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock

Prosopis denudans	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis elata	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis farcta	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis ferox	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis fiebrigii	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis hassleri	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis humilis	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis kuntzei	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis pallida	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis palmeria	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis reptans	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis rojasiana	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock

Prosopis ruizlealii	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis ruscifolia	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis sericantha	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Prosopis torquata	mesquite	not present	L1.3, L1.3.1.5, L1.3.1.4, M4.2	Fodder, fuelwood, shade, soil stabilization, soil improvement and hedgerows to contain livestock
Rubus moluccanus	wild raspberry	not present	L1.3, L2.3	Nursery, culinary, medicinal
Senecio inaequidens	South African ragwort	not present	L4.3	wool contaminant
Solanum tampicense	wetland nightshade	not present	M8, M3.3	Unknown pathway, possibly accidental release or bird dispersal
Solanum torvum	turkeyberry	not present	L2.3	cultivated for fruit

Vertebrates

Table 8. Results of Vertebrate invasive species pathway risk analysis. Species are listed by taxonomic subcategories and ranked by risk of introduction. Species considered to be a threat to biosecurity were not included in the report. Refer to Tables 1-3 for invasive species pathway codes.

Scientific name	***Common Name***	***Extent***	***Primary Pathways***	***Notes for Primary Pathways***
Amphibians				
High Risk				
Bufo marinus	Giant toad	notpresent	L3.7, L3.4	
Eleutherodactylus coqui	Coqui frog	notpresent	L1.3.1.7, L3.2, L3.4	
Moderate Risk				
Eleutherodactylus planirostris	Greenhouse frog	notpresent	L1.3.1.7	stowaway on tropical plants and landscaping materials (esp. from FL & HI)
Low Risk				

Dendrobates auratus	Green-and-black poison dartfrog	notpresent	M1	biocontrol of mosquitos
Glandirana rugosa	Japanese wrinkled frog	notpresent	M1	insect control
Osteopilus septentrionalis	Cuban treefrog	notpresent	T1.2.3, T3.1 , L1.2, L1.3.1.7	
Rana clamitans	Green frog	notpresent	L2.2, L3.3	frogs legs for culinary uses
Birds				
High Risk				
Porphyrio porphyrio	Purple Swamphen	notpresent	L3.4, L3.10	
Streptopelia decaocto	Eurasian collared dove	notpresent	L3.2, L3.8	pet escapes, intro for hunting
Threskiornis aetheopicus	Sacred Ibis	notpresent	L3.10	zoo escape (allowed to fly away)
Zosterops japonica	Japanese White-eye	notpresent	L3.10	zoo escape (eradicated in San Diego in 1980's)
Low Risk				
Acridotheres cristatellus	Crested mynah	notpresent	L3.4, L3.11	
Aerodramus bartschi	Mariana swiftlet	notpresent	L3.4, L3.11	Small population introduced to Oahu but now threatened
Aerodramus fuciphagus	Edible-nest swiftlet	notpresent	L3.4	Swiftlet farming for "edible nest" products, an Asian delicacy
Alectoris barbara	Barbary partridge	notpresent	L3.4	aviculture
Padda oryzivora	Java sparrow	notpresent	L3.2, L3.5	
Quelea quelea	Red-billed quelea	notpresent	L3.2	
Risk Unknown				
Acridotheres tristis	Common mynah	notpresent	L3.4, L3.11	
Fishes				
High Risk				
Amia calva	Bowfin	notpresent		
Cichlasoma spilurum	Blue-eyed cichlid	notpresent	L3.2	
Esox lucius	Northern Pike	notpresent	L3.8	Illegal stocking
Hypophthalmichthys nobilis	Bighead Carp	notpresent	L3.3, L3.4	

Lepstosteus lucius	Longnose Gar	notpresent	MISSING CODE	
Mylopharyngodon piceus	Black Carp	notpresent	L3.2, L3.4	
Scardinius erythropthalmus	Rudd	notpresent	L3.1, L3.3	bait, aquaculture
Serrasalminae	Piranha	notpresent	L3.2, L3.8, L3.10, L3.11	aquarium releases, intentional stocking
Moderate Risk				
Channa argus	Northern Snakehead	notpresent	L2.1	
Clarias batrachus	Walking catfish	notpresent	L3.2, L3.3	
Gymnocephalus cernuus	Ruffe	notpresent	T1.2.1	
Hypophthalmichthys harmandi	Largescale Carp	notpresent	L3.3, L3.4	
Hypophthalmichthys molitrix	Silver Carp	notpresent	L3.3, L3.4	
Lepisosteus osseus	Longnose Gar	notpresent	MISSING CODE	
Neogobius melanostomus	Round goby	notpresent	T1.2.1	
Low Risk				
Cichlasoma salvini	Yellowbelly cichlid	notpresent	L3.2	
Dorosoma cepedianum	Gizzard shad	notpresent	L3.8	
Monopterus albus	Asian swamp eel	notpresent	L3.2, L3.4	
Mammals				
High Risk				
Dasypus novemcinctus	Nine-banded armadillo	notpresent	L3.2, L3.4	zoos
Moderate Risk				
Meriones unguiculatus	Mongolian gerbil	notpresent	L3.2, L3.9	
Low Risk				
Cricetomys gambianus	Gambian giantpouched rat	notpresent	L3.2	
Cynomys ludovicianus	Prairie dog	notpresent		

Erinaceus europaeus	European hedgehog	notpresent	L3.4	fur farms
Mastomys spp.	Multimammate rator mouse	notpresent	T1.2.3, L3.9	
Myocastor coypus	Nutria	notpresent	L3.4	fur farms
Pteropus spp.	Flying fox	notpresent	MISSING CODE	
Trichosurus vulpecula	Brush-tailed possum	notpresent	L3.4	fur farms
Reptiles				
High Risk				
Anolis equestris	Knight anole	notpresent	L3.2	
Anolis sagrei	Brown anole	notpresent	T1.3.1, T1.2.3, L1.3.1.7, L3.2	
Boiga irregularis	Brown treesnake	notpresent	T1.1, T1.2.3, T3.1	
Caiman crocodilus	Spectacled caiman	notpresent	L3.2	
Ctenosaura similis	Black spinytail iguana	notpresent	L3.2, L3.4	zoos
Gekko gecko	Tokay gecko	notpresent	L3.2	
Nerodia rhombifer	Diamondback water snake	notpresent	L3.2	
Tupinambis merianae	Argentina giant tegu	notpresent	L3.2	
Moderate Risk				
Ctenosaura pectinata	Mexican spinytail iguana	notpresent	L3.2, L3.4	zoos
Python molurus	Burmese python	notpresent	L3.2	
Varanus niloticus	Nile monitor	notpresent	L3.2, L3.11	
Low Risk				
Agkistrodon spp.	Copperhead snake	notpresent	L3.2, L3.7	

Invasive Species Pathway Risk Analysis Results by Pathway Code

Results by Main Pathway Types

Figure 2. Number of species in each main pathway type

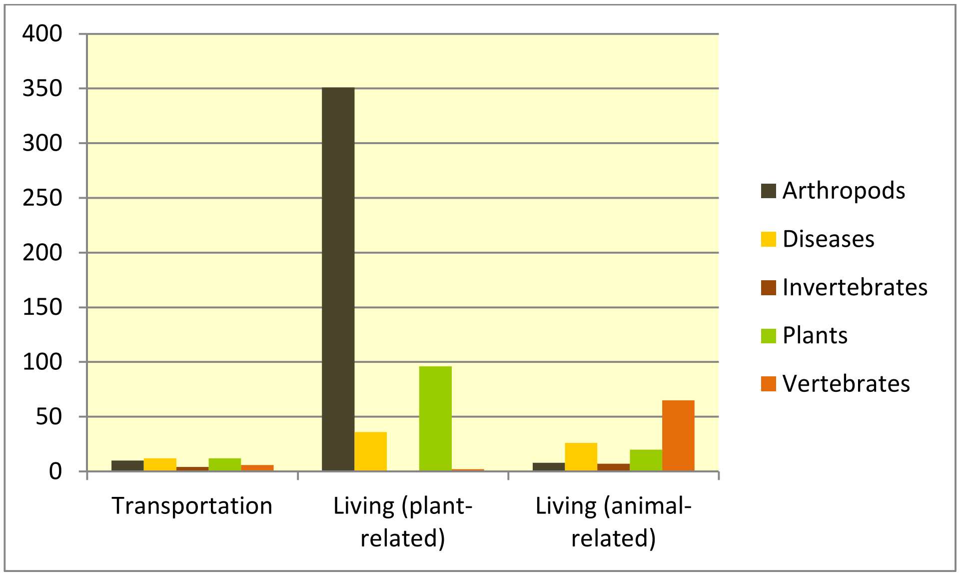
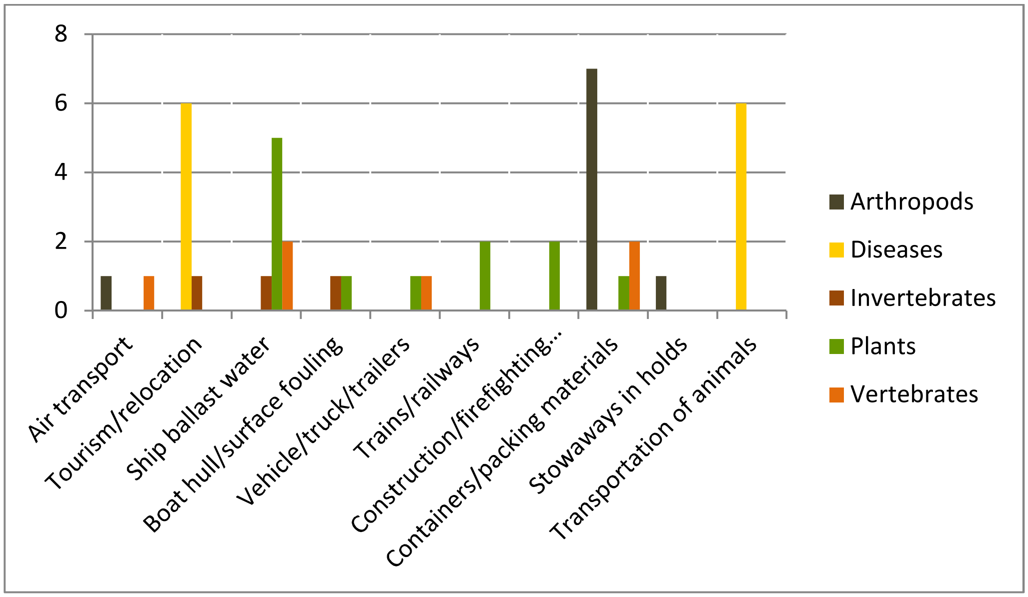


Table 9. Number of species in each main pathway type

Main Pathway	Arthropods	Diseases	Invertebrates	Plants	Vertebrates
Transportation	10	12	4	12	6
Living (plant-related)	351	36	0	96	2
Living (animal-related)	8	26	7	20	65

Results of Transportation Pathways Invasive Species Risk Analysis

Figure 3. Number of species in each transportation pathway



Air Travel

Table 10. Species that could enter California through air travel

Type	Subtype	Scientific name	Common Name
Arthropod	Beetle	*Popillia lewisi*	Scarab beetle
Vertebrate	Reptile	*Boiga irregularis*	Brown treesnake

Tourism & Relocation

Table 11. Species that could enter California through tourism and human relocation

Type	Subtype	Scientific name	Common Name
Disease	Bacterium	*Xanthomonas anoxopodis pv. citri*	Citrus Canker
	Fungus	*Tilletia tritici (caries)*	Wheat smut
	Virus	*Aphtae epizooticae*	Hoof and mouth disease
		Avian Influenza A (H5N1)	Avian influenza
		Badnavirus cymvr	Citrus yellow mosaic virus
Invertebrate	Aquatic mollusk, freshwater	*Limnoperna fortunei*	Golden mussel

Ship Ballast Water

Table 12. Species that could enter California through ship ballast water

Type	Subtype	Scientific name	Common Name
Invertebrate	Aquatic mollusk, freshwater	*Limnoperna fortunei*	Golden mussel
Plant	Algae	*Caulacanthus ustulatus*	Red algae
		Caulerpa brachypus	Caulerpa brachypus
		Caulerpa racemosa	Caulerpa racemosa
	Herbaceous	*Epilobium hirsutum*	Hairy willow herb
		Najas minor	Slender-leaved naiad
Vertebrate	Fish	*Gymnocephalus cernuus*	Ruffe
		Neogobius melanostomus	Round goby

Boat Hull or Surface Fouling

Table 13. Species that could enter California through boat hull or surface fouling

Type	Subtype	Scientific name	Common Name
Invertebrate	Aquatic mollusk, freshwater	*Limnoperna fortunei*	Golden mussel
Plant	Herbaceous	*Salvinia auriculata*	Giant salvinia

Cars, Buses, Trucks, ATVs, Boat Trailers

Table 14. Species that could enter California through terrestrial vehicles

Type	Subtype	Scientific name	Common Name
Plant	Grass	*Nassella trichotoma*	Serrated tussock
Vertebrate	Reptile	*Anolis sagrei*	Brown anole

Trains & other Railways

Table 15.Species that could enter California through trains and other railways

Type	Subtype	Scientific name	Common Name
Plant	Herbaceous	*Epilobium hirsutum*	Hairy willow herb
		Tridax procumbens	Coat buttons

Construction & Firefighting Vehicles

Table 16. Species that could enter California through construction and firefighting vehicles

Type	Subtype	Scientific name	Common Name
Plant	Grass	*Nassella trichotoma*	Serrated tussock
		Rottboellia cochinchinensis	Itchgrass

Shipping & Packing Materials

Table 17. Species that could enter California through shipping and packing materials

Type	Subtype	Scientific name	Common Name
Arthropod	Bee, wasp	*Diprion similis*	Introduced pine sawfly
		Sirex noctilio	Sirex woodwasp
	Beetle	*Agrilus biguttatus*	Oak splendour beetle
		Anoplophora glabripennis	Asian longhorned beetle
		Agrilus planipennis	Emerald ashborer
		Sinoxylon anale	Dunnage beetle
	Butterfly, moth	*Lymantria dispar*	Gypsy moth
Plant	Grass	*Imperata cylindrica*	Cogongrass
Vertebrate	Amphibian	*Osteopilus septentrionalis*	Cuban treefrog
	Reptile	*Boiga irregularis*	Brown treesnake

Stowaways in Holds

Table 18. Species that could enter California as stowaways in holds

Type	Subtype	Scientific name	Common Name
Arthropod	Butterfly, moth	*Lymantria dispar*	Gypsy moth

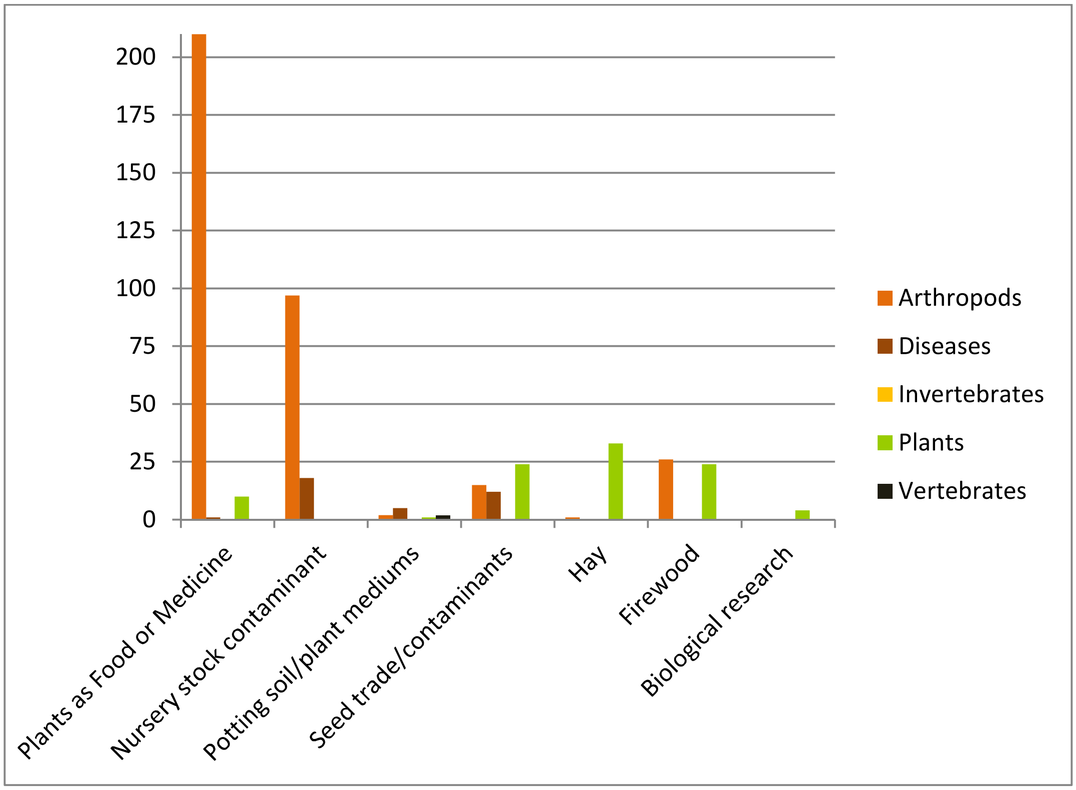
Transportation of Animals

Table 19. Species that could enter California through the transportation of animals

Type	Subtype	Scientific name	Common Name
Disease	Bacterium	*Bacillus anthracis*	Anthrax
		Ehrlichia ruminantium	Heartwater; cowdriosis
	Virus	*Alphavirus eeev*	Eastern Equine Encephalitis Virus
		Aphtae epizooticae	Hoof and mouth disease
		Avian Influenza A (H5N1)	Avian influenza
		Badnavirus cymvr	Citrus yellow mosaic virus

Results of Plant-Related Living Industry Pathways Invasive Species Risk Analysis

Figure 4. Number of species in each plant-related living industry pathway



Plants as Food or Medicine

Table 20. Species that could enter California through plants imported as food or medicine

Type	Subtype	Scientific name	Common Name
Arthropod	Bee, wasp	*Dryocosmus kuriphilus*	Chestnut gall wasp
		Leptocybe invasa	Blue gum chalcid
	Beetle	*Acalymma vittatum*	Striped cucumber beetle
		Anomala foraminosa	Scarab beetle
		Anomala insitiva	Scarab beetle
		Anomala orientalis	Oriental beetle
		Brachycerus spp.	Garlic beetles
		Cathartus quadricollis	Squarenecked grain beetle
		Cerotoma trifurcata	Bean leaf beetle
		Chalcodermus aeneus	Cowpea curculio
		Coccotorus scutellaris	Plum gouger
		Conotrachelus aguacatae	Small avocado seed weevil
		Conotrachelus juglandis	Butternut curculio
		Conotrachelus nenuphar	Plum curculio
		Conotrachelus perseae	Small seed weevil
		Conotrachelus retentus	Black walnut curculio

	Copturus aguacatae	Avocado stem weevil
	Cryptorhynchus mangiferae	Mango seed weevil
	Curculio caryae	Pecan weevil
	Curculio elephas	Chestnut weevil
	Curculio nucum	Hazelnut weevil
	Cylas formicarius elegantulus	Sweetpotato weevil
	Cylas spp.	Exotic weevil
	Diabrotica barberi	Northern corn rootworm
	Diabrotica undecimpunctata howardi	Spotted cucumber beetle
	Diabrotica virgifera virgifera	Western corn rootworm
	Diabrotica virgifera zea	Mexican corn rootworm
	Diaprepes sp.	Exotic weevil
	Diocalandra spp.	Coconut weevils
	Diocalandra taitensis	Tahitian coconut weevil
	Elytroteinus subtruncatus	Fijian ginger weevil
	Epilachna borealis	Squash beetle
	Epilachna tridecimnotata	Ladybird beetle
	Epilachna varivestis	Mexican bean beetle
	Euscepes postfasciatus	Indian sweetpotato weevil
	Heilipus lauri	Avocado seed weevil
	Hesperophanes campestris	Chinese longhorned beetle
	Hypothenemus hampei	Coffee berry borer
	Leptinotarsa decemlineata	Colorado potato beetle
	Listroderes subcinctus	Chilean vegetable weevil
	Lophocateres pusillus	Siamese grain borer
	Naupactus xanthographus	South American fruit tree weevil
	Omphisa anastomosalis	Sweetpotato vine borer
	Oulema melanopus	Cereal leaf beetle
	Phloeotribus liminarius	Peach bark beetle
	Phyllophaga congrua	May beetle
	Prostephanus truncatus	Larger grain borer
	Protaetia fusca	Mango flower beetle
	Protaetia orientalis	Oriental flower beetle
	Rhabdoscelus obscurus	New Guinea sugarcane weevil
	Sphenophorus maidis	Maize billbug
	Sternochetus mangiferae	Mango seed weevil
	Typophorus nigritus viridicyaneus	Sweetpotato leaf beetle
	Zygogramma exclamationis	Sunflower beetle
Butterfly, moth	*Acrobasis juglandis*	Pecan leaf casebearer

Acrobasis nuxvorella	Pecan nut casebearer
Acrolepia assectella	Leek moth
Acrolepiopsis assectella	Leek moth
Adoxophyes orana	Summer fruit tortrix moth
Antaeotricha leucillana	Stenomine oecophorid
Apamea apamiformis	Riceworm
Argyrotaenia pulchellana	Grey red-barred twist
Argyrotaenia velutinana	Redbanded leafroller
Carposina niponensis	Peach fruit moth
Celama sorghiella	Sorghum webworm
Chilo plejadellus	Rice stalk borer
Chilo suppressalis	Asiatic rice borer
Chrysodeixis chalcites	Golden twin spot moth
Chrysodeixis eriosoma	Green garden looper
Conogethes punctiferalis	Yellow peach moth
Conopomorpha cramerella	Cocoa pod borer
Conopomorpha litchiella	Lychee leaf miner
Corcyra cephalonica	Rice moth
Cryptophlebia leucotreta	False codling moth
Cydia caryana	Hickory shuckworm
Cydia funebrana	Red plum maggot
Cydia splendana	Chestnut moth
Darna pallivitta	Limacodid moth
Diaphania hyalinata	Melonworm
Diatraea crambidoides	Southern corn stalk borer
Diatraea grandiosella	Southwestern corn borer
Diatraea saccharalis	Sugarcane borer
Dyspessa ulula	Onion carpenter worm
Earias fabia	Spotted bollworm
Endopiza viteana	Grape berry moth
Euproctis chrysorrhoea	Browntail moth
Gonodonta pyrgo	Citrus fruitpiercing moth
Harrisina americana	Grapeleaf skeletonizer
Heliocoverpa armigera	Cotton bollworm
Hemimene juliana	Nut fruit tortrix
Leucinodes orbonalis	Eggplant fruit borer
Leucoptera malifoliella	Pear leaf blister moth
Lymire edwardsii	Edwards' wasp moth
Malacosoma americanum	Eastern tent caterpillar
Maruca testulalis	Bean pod borer
Melittia calabaza	Southwestern squash vine borer
Melittia cucurbitae	Squash vine borer
Opogona sacchari	Banana moth

	Ostrinia nubilalis	European corn borer
	Pammene fasciana	Chestnut leaf roller
	Papaipema nebris	Stalk borer
	Papilio demoleus	Lime swallowtail
	Pectinophora scutigera	Pink-spotted bollworm
	Phyllocnistis citrella	Citrus leafminer
	Plathypena scabra	Green cloverworm
	Prays endocarpa	Citrus pock caterpillar
	Proeulia spp.	Proeulia spp.
	Sannina uroceriformis	Persimmon borer
	Scrobipalpa ocellatella	Sugarbeet crown borer
	Sesamia cretica	Durra stalk borer
	Spodoptera eridania	Southern armyworm
	Stenoma catenifer	Avocado seed moth
	Thaumatotibia leucotreta	False codling moth
	Zeuzera pyrina	Leopard moth
	Zophodia convolutella	Gooseberry fruitworm
Fly	*Anastrepha fraterculus*	South American fruit fly
	Anastrepha grandis	South American cucurbit fruit fly
	Anastrepha ludens complex	Mexican fruit fly complex
	Anastrepha obliqua	West Indian fruit fly
	Anastrepha sp.	Exotic fruit fly
	Anastrepha striata	Guava fruit fly
	Anastrepha suspensa	Caribbean fruit fly
	Bactrocera albistrigata	White Striped Fruit Fly
	Bactrocera correcta	Guava fruit fly
	Bactrocera cucurbitae	Melon fly
	Bactrocera irvingiae	Irvinge fruit fly
	Bactrocera latifrons	Solanaceous fruit fly
	Bactrocera scutellata	Striped fruit fly
	Bactrocera tryoni	Queensland fruit fly
	Bactrocera zonata	Peach fruit fly
	Ceratitis capitata	Mediterranean fruit fly
	Ceratitis rosa	Natal fruit fly
	Contarinia johnsoni	Grape blossum midge
	Dacus bivittatus	African pumpkin fly
	Dacus cucurbitae	Melon fruit fly
	Dacus sp.	Exotic fruit fly
	Horidiplosis ficifolii	Ornamental fig pest
	Ophiomyia phaseoli	Bean fly
	Rhagoletis boycei	Walnut husk fly
	Rhagoletis cerasi	European cherry fruit fly
	Rhagoletis cingulata	Cherry fruit fly

	Rhagoletis fausta	Black cherry fruit fly
	Rhagoletis juglandis	Walnut husk fly
	Rhagoletis mendax	Blueberry maggot
	Rhagoletis spp.	Exotic fruit fly
	Rhagoletis suavis	Walnut husk fly
	Tipula oleracea	Common crane fly
	Toxotrypana curvicauda	Papaya fruit fly
	Zonosemata electa	Pepper maggot
Mite	*Amphitetranychus viennensis*	Fruit tree spider mite
	Brevipalpus chilensis	False grape mite
	Eriophyes litchii	Lychee erinose mite
	Euvarroa sinhai	Euvarroa sinhai
	Raoiella indica	Red palm mite
	Steneotarsonemus spinki	Panicle rice mite
	Tropilaelaps clareae	Honeybee mite
Scale, aphid	*Abgrallaspis aguacatae*	Armored scale
	Abgrallaspis palmae	Tropical palm scale
	Acutaspis albopicta	Albopicta scale
	Acutaspis tingi	Ting scale
	Aleurocanthus spiniferus	Orange spiny whitefly
	Aleurocanthus woglumi	Citrus blackfly
	Aonidiella orientalis	Oriental scale
	Aphis glycines	Soybean aphid
	Aspidiotus destructor	Coconut scale
	Ceroplastes ceriferus	Indian wax scale
	Ceroplastes floridensis	Florida wax scale
	Ceroplastes rubens	Red wax scale
	Ceroplastes rusci	Fig wax scale
	Coccus viridis	Green scale
	Dysmicoccus alazon	Alazon mealybug
	Fiorinia theae	Tea scale
	Furcaspis oceanica	Coconut red scale
	Howardia biclavis	Mining scale
	Ischnaspis longirostris	Black thread scale
	Kilifia acuminata	Acuminate scale
	Leptocorisa acuta	Rice seed bug
	Mesolecanium nigrofasciatum	Terrapin scale
	Morganella longispina	Plumose scale
	Myndus crudus	American palm cixiid
	Oebalus pugnax	Rice stink bug
	Parlatoria blanchardi	Parlatoria date scale
	Parlatoria ziziphi	Black citrus scale
	Phenococcus aceris	Apple mealybug

		Phenococcus manihoti	Cassava mealybug
		Phylloxera devastatrix	Pecan phylloxera
		Pinnaspis buxi	Boxwood scale
		Pinnaspis strachani	Lesser snow scale
		Planococcus lilacinus	Coffee mealybug
		Planococcus minor (Maskell)	Passionvine mealybug
		Pseudaulacaspis pentagona	White peach scale
		Pseudococcus cryptus	Citriculus mealybug
		Pseudococcus elisae	Banana mealybug
		Quadraspidiotus ostreaeformis	European fruit scale
		Saccharicoccus sacchari	Pink sugarcane mealybug
		Scotinophara lurida	Rice stinkbug
		Singhiella simplex	Fig whitefly
		Sogatodes orizicola	Rice delphacid
		Toxoptera citricida	Brown citrus aphid
		Trialeurodes floridensis	Avocado whitefly
		Trioza tripunctata	Blackberry psyllid
		Unaspis citri	Citrus snow scale
	Springtail	*Sminthurus viridus*	Lucerne flea
	Thrips	*Danothrips trifasciatus*	Thrips
		Liothrips oleae	Olive thrips
		Scirtothrips dorsalis (Hood)	Chilli thrips
		Selenothrips rubrocinctus	Redbanded thrips
		Thrips angusticeps	Cabbage thrips
		Thrips florum	Banana flower thrips
		Thrips palmi	Melon thrips
Disease	Bacterium	*Xanthomonas anoxopodis pv. citri*	Citrus Canker
Plant	Grass	*Oryza longistaminata*	Red rice
		Oryza punctata	Red rice
		Paspalum scrobiculatum	Kodo-millet
		Saccharum spontaneum	Wild sugarcane
	Herbaceous	*Allaria petiolata*	Garlic mustard
		Carum carvi	Wild caraway
		Salvia sclarea	Clary sage
		Solanum torvum	Turkeyberry
		Tussilago farfara	Coltsfoot
	Woody	*Rubus moluccanus*	Wild raspberry

Nursery Stock Contaminant

Table 21. Species that could enter California as nursery stock contaminants

Type	Subtype	Scientific name	Common Name

Arthropod	Bee, wasp	*Diastrophus radicum*	Raspberry root gall wasp
		Diprion similis	Introduced pine sawfly
		Leptocybe invasa	Blue gum chalcid
	Beetle	*Adoretus sinicus*	Chinese rose beetle
		Adoretus spp.	Adoretus spp.
		Agrilus ruficollis	Rednecked cane borer
		Anomala foraminosa	Scarab beetle
		Anomala insitiva	Scarab beetle
		Anomala orientalis	Oriental beetle
		Anomala sulcatula	Anomala sulcatula
		Anoplophora chinensis	Citrus longhorned beetle
		Cathartus quadricollis	Squarenecked grain beetle
		Cerotoma trifurcata	Bean leaf beetle
		Chalcodermus aeneus	Cowpea curculio
		Chlorophorous annularis	Bamboo longhorned beetle
		Coccotorus scutellaris	Plum gouger
		Conotrachelus aguacatae	Small avocado seed weevil
		Conotrachelus juglandis	Butternut curculio
		Conotrachelus nenuphar	Plum curculio
		Conotrachelus perseae	Small seed weevil
		Conotrachelus retentus	Black walnut curculio
		Copturus aguacatae	Avocado stem weevil
		Cylas formicarius elegantulus	Sweetpotato weevil
		Cylas spp.	Exotic weevil
		Diabrotica barberi	Northern corn rootworm
		Diabrotica undecimpunctata howardi	Spotted cucumber beetle
		Diabrotica virgifera virgifera	Western corn rootworm
		Diabrotica virgifera zea	Mexican corn rootworm
		Diabrotica barberi	Northern corn rootworm
		Diabrotica undecimpunctata howardi	Spotted cucumber beetle
		Diabrotica virgifera virgifera	Western corn rootworm
		Diabrotica virgifera zea	Mexican corn rootworm
		Diaprepes sp.	Exotic weevil
		Maladera castanea	Asiatic garden beetle
		Phloeotribus liminarius	Peach bark beetle
		Phyllophaga congrua	May beetle
	Butterfly, moth	*Adoxophyes orana*	Summer fruit tortrix moth
		Apamea apamiformis	Riceworm
		Argyrotaenia pulchellana	Grey red-barred twist
		Argyrotaenia velutinana	Redbanded leafroller

	Carposina niponensis	Peach fruit moth
	Celama sorghiella	Sorghum webworm
	Chilo plejadellus	Rice stalk borer
	Chilo suppressalis	Asiatic rice borer
	Choristoneura fumiferana	Spruce budworm
	Chrysodeixis chalcites	Golden twin spot moth
	Chrysodeixis eriosoma	Green garden looper
	Conogethes punctiferalis	Yellow peach moth
	Conopomorpha cramerella	Cocoa pod borer
	Conopomorpha litchiella	Lychee leaf miner
	Corcyra cephalonica	Rice moth
	Cryptophlebia leucotreta	False codling moth
	Cydia caryana	Hickory shuckworm
	Cydia funebrana	Red plum maggot
	Darna pallivitta	Limacodid moth
	Dendrolimus superans sibiricus	Siberian silk moth
	Diaphania hyalinata	Melonworm
	Hemimene juliana	Nut fruit tortrix
Fly	*Anastrepha fraterculus*	South American fruit fly
	Anastrepha grandis	South American cucurbit fruit fly
	Anastrepha ludens complex	Mexican fruit fly complex
	Anastrepha obliqua	West Indian fruit fly
	Anastrepha sp.	Exotic fruit fly
	Anastrepha striata	Guava fruit fly
	Anastrepha suspensa	Caribbean fruit fly
	Bactrocera albistrigata	White striped fruit fly
	Bactrocera correcta	Guava fruit fly
	Bactrocera cucurbitae	Melon fly
	Bactrocera dorsalis	Oriental fruit fly
	Bactrocera latifrons	Solanaceous fruit fly
	Bactrocera scutellata	Striped fruit fly
	Bactrocera tryoni	Queensland fruit fly
	Bactrocera zonata	Peach fruit fly
	Ceratitis capitata	Mediterranean fruit fly
	Ceratitis rosa	Natal fruit fly
	Contarinia johnsoni	Grape blossum midge
Mite	*Amphitetranychus viennensis*	Fruit tree spider mite
	Brevipalpus chilensis	False grape mite
Scale, aphid	*Acutaspis tingi*	Ting scale
	Aleurocanthus spiniferus	Orange spiny whitefly
	Aleurocanthus woglumi	Citrus blackfly
	Aonidiella orientalis	Oriental scale

		Aphis glycines	Soybean aphid
		Aspidiotus destructor	Coconut scale
		Asterolecanium epidendri	Orchard scale
		Aulacaspis yasumatsui	Cycad aulacaspis scale
		Ceroplastes ceriferus	Indian wax scale
		Ceroplastes floridensis	Florida wax scale
		Ceroplastes rubens	Red wax scale
		Ceroplastes rusci	Fig wax scale
		Chionaspis furfura	Scurfy scale
		Coccus viridis	Green scale
		Crisicoccus azaleae	Azalea mealybug
		Dysmicoccus alazon	Alazon mealybug
		Fiorinia theae	Tea scale
		Icerya aegyptiaca	Egyptian fluted scale
	Thrips	*Danothrips trifasciatus*	Thrips
Disease	Bacterium	*Candidatus Liberibacter africanus*	Huanglongbing disease of citrus-African strain
		Candidatus Liberibacter americanus	Huanglongbing disease of Citrus-Americas strain
		Candidatus Liberibacter asiaticus	Huanglongbing disease of Citrus-Asian strain
		Candidatus Liberibacter sp.	Huanglongbing Disease of Citrus
		Xanthomonas anoxopodis pv. citri	Citrus canker
		Xylella fastidiosa CVC	Citrus/Select agent (citrus variegated chlorosis strain)
		Xylophilus ampelinus (Xanthomonas ampelina)	Grapevine bacterial blight
	Fungus	*Acremonium (Cephalosporium) diospyri*	Persimmon wilt
		Cronartium flaccidum	Scotch pine blister rust
		Cryphonectria parasitica	Chestnut blight
		Discula destructiva	Dogwood Anthracnose
		Phomopsis vaccinii	Phomopsis soft rot
		Phytophthora alni	Alder Phytophthora
		Puccinia graminis f. sp. tritici	Wheat stem rust (Uganda 99 strain)/Black rust
	Virus	*Cilivirus cilv-c*	Citrus leprosis virus C
		Nepovirus gtrsv	Grapevine Tunisian ringspot virus
		Potyvirus ppv	Plum pox virus
		Potyviruses: Potyviridae	Plum pox

Invertebrate	Nematode	*Radopholus similis*	Burrowing nematode
		Rotylenchulus reniformis	Reniform nematode
Plant	Herbaceous	*Aeginetia spp.*	Aeginetia
		Alectra spp.	Alectra
	Grass	*Imperata brasiliensis*	Brazilian satintail
		Leptochloa chinensis	Asian sprangletop
		Urochloa panicoides	Liverseed grass
Vertebrate	Amphibian		
		Anolis sagrei	Brown anole
		Eleutherodactylus coqui	Coqui frog
		Osteopilus septentrionalis	Cuban treefrog
		Eleutherodactylus planirostris	Greenhouse frog

Potting Soils & Planting Mediums

Table 22. Species that could enter California through potting soils and planting mediums

Type	Subtype	Scientific name	Common Name
Arthropod	Beetle	*Adoretus spp.*	Adoretus spp.
		Adoretus sinicus	Chinese rose beetle
Disease	Fungus	*Acremonium (Cephalosporium) diospyri*	Persimmon wilt
		Sclerophthora rayssiae var. zeae	Brown stripe downy mildew of maize
		Synchytrium endobioticum	Potato wart/Select agent
		Thecaphora (Angiosorus) solani	Potato smut
		Tilletia tritici (caries)	Wheat smut
Plant	Grass	*Nassella trichotoma*	Serrated tussock
Vertebrate	Amphibian	*Eleutherodactylus coqui*	Coqui frog
		Osteopilus septentrionalis	Cuban treefrog

Seed Trade and Seed Contamination

Table 23. Species that could enter California through the seed trade and seed contamination

Type	Subtype	Scientific name	Common Name
Arthropod	Bee, wasp	*Solenopsis geminata*	Tropical fire ant
	Beetle	*Atrichonotus taeniatulus*	Small lucerne weevil
		Conotrachelus aguacatae	Small avocado seed weevil
		Curculio caryae	Pecan weevil
		Curculio elephas	Chestnut weevil

		Lophocateres pusillus	Siamese grain borer
		Oulema melanopus	Cerealleaf beetle
	Butterfly, moth	*Celama sorghiella*	Sorghum webworm
		Chilo plejadellus	Rice stalk borer
		Chilo suppressalis	Asiatic rice borer
		Choristoneura fumiferana	Spruce budworm
		Corcyra cephalonica	Rice moth
		Cydia caryana	Hickory shuckworm
		Hemimene juliana	Nut fruit tortrix
	Scale, aphid	*Icerya aegyptiaca*	Egyptian fluted scale
Disease	Bacterium	*Dickeya solani*	Black leg disease of potato
	Fungus	*Colletotrichum coffeanum*	Brown blight
		Entyloma oryzae	Leaf smut of rice
		Microcyclus ulei	South American leaf blight
		Peronosclerospora sacchari (philippinensis)	Sugarcane downy mildew
		Phakopsora meibomiae	Soybean rust
		Phakopsora pachyrhizi	Asian soybean rust
		Puccinia graminis f. sp. tritici	Wheat stem rust (Uganda 99 strain)/Black rust
		Sclerophthora rayssiae var. zeae	Brown stripe downy mildew of maize
		Sirococcus clavigignenti-juglandacearum	Butternut canker
		Thecaphora (Angiosorus) solani	Potato smut
		Tilletia tritici (caries)	Wheat smut
Plant	Grass	*Oryza longistaminata*	Red rice
		Oryza punctata	Red rice
		Pennisetum polystachion	Missiongrass
		Sorghum almum	Columbus grass
		Sorghum propinquum	Sorghum
	Herbaceous	*Centaurea macrocephala*	Bighead knapweed
		Chaenorhinum minus	Dwarf snapdragon
		Heracleum mantegazzianum	Giant hogweed
		Hieracium atratum	Polar hawkweed
		Hieracium aurantiacum	Orange hawkweed
		Hieracium caespitosum	Yellow hawkweed
		Hieracium glomeratum	Queen devil hawkweed
		Hieracium laevigatum	Smooth hawkweed
		Hieracium pilosella	Mouseear hawkweed
		Hieracium piloselloides	King devil hawkweed

		Hieracium x floribundum	Yellow devil hawkweed
		Murdannia keisak	Marsh dew flower
		Senecio madagascariensis	Madagascar ragwort
	Woody	*Euryops multifidus*	Hawk's eye
		Salsola collina	Spineless Russian thistle
		Senecio madagascariensis	Madagascar ragwort
		Thymelaea passerina	Spurge flax
		Tridax procumbens	Coat buttons
		Tripleurospermum perforatum	Scentless false mayweed

Hay

Table 24. Species that could enter California through hay

Type	Subtype	Scientific name	Common Name
Arthropod	Beetle	*Atrichonotus taeniatulus*	Small lucerne weevil
Plant	Grass	*Imperata cylindrica*	Cogongrass
		Leptochloa chinensis	Asian sprangletop
		Milium vernale	Milium
	Herbaceous	*Galega officinalis*	Goatsrue
		Lespedeza cuneata	Sericea lespedeza
		Pueraria montana var. lobata	Kudzu
		Tripleurospermum perforatum	Scentless false mayweed
	Woody	*Mimosa diplotricha*	Giant sensitive plant
		Mimosa invisa	Giant sensitive plant
		Prosopis alpataco	Mesquite
		Prosopis argentina	Mesquite
		Prosopis articulata	Mesquite
		Prosopis burkartii	Mesquite
		Prosopis caldenia	Mesquite
		Prosopis calingastana	Cusqui
		Prosopis campestris	Mesquite
		Prosopis castellanosii	Mesquite
		Prosopis denudans	Mesquite
		Prosopis elata	Mesquite
		Prosopis farcta	Mesquite
		Prosopis ferox	Mesquite
		Prosopis fiebrigii	Mesquite
		Prosopis hassleri	Mesquite
		Prosopis humilis	Mesquite
		Prosopis kuntzei	Mesquite
		Prosopis pallida	Mesquite

		Prosopis palmeria	Mesquite
		Prosopis reptans	Mesquite
		Prosopis rojasiana	Mesquite
		Prosopis ruizlealii	Mesquite
		Prosopis ruscifolia	Mesquite
		Prosopis sericantha	Mesquite
		Prosopis torquata	Mesquite

Firewood

Table 25. Species that could enter California through firewood

Type	Subtype	Scientific name	Common Name
Arthropod	Beetle	*Agrilus biguttatus*	Oak splendour beetle
		Agrilus planipennis	Emerald ashborer
		Anoplophora chinensis	Citrus longhorned beetle
		Anoplophora glabripennis	Asian longhorned beetle
		Callidiellum rufipenne	Lesser Japanese cedar longhorned beetle
		Hylobius pales	Pales weevil
		Hylotrupes bajulus	Old house borer
		Hylurgus ligniperda	Redhaired pine bark beetle
		Hylurgus palliatus	A bark beetle
		Mononychellus alternatus	Japanese pine sawyer
		Orthotomicus erosus	Mediterranean pine engraver
		Pissodes nemorensis	Eastern pine weevil
		Pityogenes chalcographus	Spruce engraver
		Platypus quercivorus	Oak ambrosia beetle
		Tetropium castaneum	A longhorned beetle
		Tomicus destruens	Pine shoot beetle
		Tomicus minor	Lesser pine shoot beetle
		Tomicus piniperda	Pine shoot beetle
		Urocerus gigas	A horntail
	Butterfly, moth	*Antaeotricha leucillana*	Stenomine oecophorid
		Choristoneura fumiferana	Spruce budworm
		Dendrolimus superans sibiricus	Siberian silk moth
		Lymantria dispar	Gypsy moth
		Lymantria mathura	Pink gypsy moth
		Lymantria monacha	Nun moth
		Rhyacionia buoliana	European pine shoot moth
Plant	Woody	*Prosopis alpataco*	Mesquite
		Prosopis argentina	Mesquite
		Prosopis articulata	Mesquite

		Prosopis burkartii	Mesquite
		Prosopis caldenia	Mesquite
		Prosopis calingastana	Cusqui
		Prosopis campestris	Mesquite
		Prosopis castellanosii	Mesquite
		Prosopis denudans	Mesquite
		Prosopis elata	Mesquite
		Prosopis farcta	Mesquite
		Prosopis ferox	Mesquite
		Prosopis fiebrigii	Mesquite
		Prosopis hassleri	Mesquite
		Prosopis humilis	Mesquite
		Prosopis kuntzei	Mesquite
		Prosopis pallida	Mesquite
		Prosopis palmeria	Mesquite
		Prosopis reptans	Mesquite
		Prosopis rojasiana	Mesquite
		Prosopis ruizlealii	Mesquite
		Prosopis ruscifolia	Mesquite
		Prosopis sericantha	Mesquite
		Prosopis torquata	Mesquite

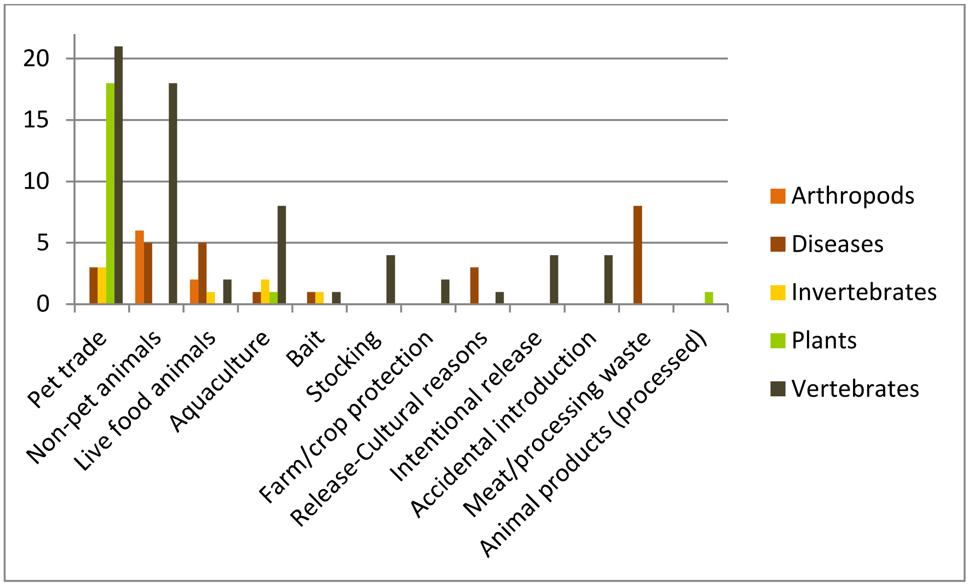
Biological Research

Table 26. Species that could enter California through biological research

Type	Subtype	Scientific name	Common Name
Plant	Grass	*Oryza longistaminata*	Red rice
		Oryza punctata	Red rice
		Saccharum spontaneum	Wild sugarcane
	Herbaceous	*Lespedeza cuneata*	Sericea lespedeza

Results of Animal-Related Living Industry Pathways Invasive Species Risk Analysis

Figure 5. Number of species in each animal-related living industry pathway



Pet & Aquarium Trade

Table 27. Species that could enter California through the pet and aquarium trade

Type	Subtype	Scientific name	Common Name
Disease	Bacterium	*Ehrlichia ruminantium*	Heartwater; cowdriosis
	Virus	*Avulavirus ndv*	Exotic Newcastle disease
		Paramyxovirus-1 (PMV-1)	Exotic newcastle disease (END)
Invertebrate	Aquatic mollusk, freshwater	*Limnoperna fortunei*	Golden mussel
	Nematode	*Ichthyophithirius multifilis*	Parsitic protozoan of fish
		Oodinium pilularis	Velvet disease
Plant	Algae	*Caulacanthus ustulatus*	Red algae
		Caulerpa brachypus	Caulerpa brachypus
		Caulerpa racemosa	Caulerpa racemosa
	Herbaceous	*Azolla pinnata*	Mosquito fern
		Crassula helmsii	Australian swamp stonecrop
		Glossostigma diandrum	Mud mat
		Hygrophila polysperma	Miramar weed
		Impatiens glandulifera	Policeman's helmet
		Imperata brasiliensis	Brazilian satintail
		Limnophila indica	Ambulia

		Limnophila sessiliflora	Blume (ambulia)
		Ludwigia peruviana	Water primrose
		Najas minor	Slender-leaved naiad
		Sagittaria graminea	Grass-leaved arrowhead
		Sagittaria sagittifolia	Arrowhead
		Trapa bicornis	Water caltrap
		Trapa natans	Water-chestnut
		Utricularia inflata	Swollen bladderwort
Vertebrate	Amphibian	*Eleutherodactylus coqui*	Coqui frog
	Bird	*Padda oryzivora*	Java sparrow
		Quelea quelea	Red-billed quelea
		Streptopelia decaocto	Eurasian collared dove
	Fish	*Cichlasoma salvini*	Yellowbelly cichlid
		Cichlasoma spilurum	Blue-eyed cichlid
		Clarias batrachus	Walking catfish
		Monopterus albus	Asian swamp eel
		Mylopharyngodon piceus	Black Carp
		Serrasalminae	Piranha
	Mammal	*Cricetomys gambianus*	Gambian giant pouched rat
		Dasypus novemcinctus	Nine-banded armadillo
		Meriones unguiculatus	Mongolian gerbil
	Reptile	*Anolis equestris*	Knight anole
		Anolis sagrei	Brown anole
		Caiman crocodilus	Spectacled caiman
		Chelydra serpentina	Snapping turtle
		Ctenosaura pectinata	Mexican spinytail iguana
		Ctenosaura similis	Black spinytail iguana
		Nerodia rhombifer	Diamondback water snake
		Python molurus	Burmese python

Non-Pet Animals

Table 28. Species that could enter California through non-pet animals

Type	Subtype	Scientific name	Common Name
Arthropod	Bee, wasp	*Apis mellifera capensis*	Cape honeybee
	Butterfly, moth	*Attacus atlas*	Atlas silk moth
		Laspeyresia spp.	Laspeyresia spp.
	Fly	*Cochliomyia hominivorax*	Screwworm
	Mite	*Euvarroa sinhai*	Euvarroa sinhai
		Tropilaelaps clareae	Honeybee mite
Vertebrate	Amphibian	*Bufo marinus*	Giant toad

	Bird	*Acridotheres cristatellus*	Crested mynah
		Acridotheres tristis	Common mynah
		Aerodramus bartschi	Mariana swiftlet
		Aerodramus fuciphagus	Edible-nest swiftlet
		Alectoris barbara	Barbary partridge
		Porphyrio porphyrio	Purple Swamphen
	Fish	*Hypophthalmichthys harmandi*	Largescale carp
		Hypophthalmichthys molitrix	Silver carp
		Hypophthalmichthys nobilis	Bighead carp
		Monopterus albus	Asian swamp eel
		Mylopharyngodon piceus	Black carp
	Mammal	*Dasypus novemcinctus*	Nine-banded armadillo
		Erinaceus europaeus	European hedgehog
		Myocastor coypus	Nutria
		Trichosurus vulpecula	Brush-tailed possum
	Reptile	*Ctenosaura pectinata*	Mexican spinytail iguana
		Ctenosaura similis	Black spinytail iguana

Live Food Animals

Table 29. Species that could enter California through live food animals

Type	Subtype	Scientific name	Common Name
Arthropod	Bee, wasp	*Apis mellifera capensis*	Cape honeybee
	Butterfly, moth	*Choristoneura fumiferana*	Spruce budworm
Disease	Bacterium	*Ehrlichia ruminantium*	Heartwater; cowdriosis
		Mycoplasma capricolum capripneumoniae	Contagious Bovine Caprine Pleuropneumonia
		Mycoplasma mycoides mycoides	Bovine pleuropneumonia
	Unknown	*Unknown pathogenic virus or prion 1*	Bovine spongiform encephalopathy (BSE)
		Unknown pathogenic virus or prion 2	Chronic wasting disease (Cervids)
Invertebrate	Nematode	*Ichthyophithirius multifilis*	Parsitic protozoan of fish
Vertebrate	Fish	*Channa argus*	Northern snakehead
	Amphibian	*Rana clamitans*	Green frog

Aquaculture

Table 30. Species that could enter California through aquaculture

Type	Subtype	Scientific name	Common Name
Disease	Virus	*Novirhadovirus Viral Hemorrhagic Septicemia Virus (VHSV)*	Viral Hemorragic septicemia
Invertebrate	Aquatic mollusk, freshwater	*Limnoperna fortunei*	Golden mussel
	Nematode	*Gyrodactylus elegans*	Parasitic flatworm of fish
Plant	Herbaceous	*Azolla pinnata*	mosquito fern
Vertebrate	Amphibian	*Rana clamitans*	Green frog
	Fish	*Clarias batrachus*	Walking catfish
		Hypophthalmichthys harmandi	Largescale carp
		Hypophthalmichthys molitrix	Silver carp
		Hypophthalmichthys nobilis	Bighead carp
		Scardinius erythropthalmus	Rudd
	Reptile	*Tupinambis merianae*	Argentina giant tegu
		Varanus niloticus	Nile monitor

Bait

Table 31. Species that could enter California through fishing baits

Type	Subtype	Scientific name	Common Name
Disease	Virus	*Novirhadovirus Viral Hemorrhagic Septicemia Virus (VHSV)*	Viral hemorragic septicemia
Invertebrate	Aquatic mollusk, freshwater	*Limnoperna fortunei*	Golden mussel
Vertebrate	Fish	*Scardinius erythropthalmus*	Rudd

Stocking for Fishing & Hunting

Table 32. Species that could enter California through stocking for fishing and hunting

Type	Subtype	Scientific name	Common Name
Vertebrate	Bird	*Streptopelia decaocto*	Eurasian collared dove
	Fish	*Dorosoma cepedianum*	Gizzard shad
		Esox lucius	Northern pike
		Serrasalminae	Piranha

Farm & Crop Protection

Table 33. Species that could enter California through animals for farm and crop protection

Type	Subtype	Scientific name	Common Name
Vertebrate	Amphibian	*Bufo marinus*	Giant toad
	Reptile	*Agkistrodon spp.*	Copperhead snake

Release of Organisms for Cultural Reasons

Table 34. Species that could enter California through the release of animals for cultural reasons

Type	Subtype	Scientific name	Common Name
Vertebrate	Bird	*Padda oryzivora*	Java sparrow

Intentional Release

Table 35. Species that could enter California through intentional release

Type	Subtype	Scientific name	Common Name
Vertebrate	Bird	*Threskiornis aetheopicus*	Sacred Ibis
		Zosterops japonica	Japanese white-eye
	Fish	*Serrasalminae*	Piranha
	Reptile	*Varanus niloticus*	Nile monitor

Accidental Introduction or Escape from Captivity

Table 36. Species that could enter California through accidental introduction or escape from captivity

Type	Subtype	Scientific name	Common Name
Vertebrate	Bird	*Acridotheres cristatellus*	Crested mynah
		Acridotheres tristis	Common mynah
		Aerodramus bartschi	Mariana swiftlet
		Porphyrio porphyrio	Purple Swamphen

Minimally Processed Animal Products

Table 37. Species that could enter California through minimally processed animal products

Type	Subtype	Scientific name	Common Name
Plant	Herbaceous	*Senecio inaequidens*	South African ragwort

RECOMMENDATIONS – NEXT STEPS

- Expert review of pathway analysis
- Address information gaps
- Assign threat levels (human, economic, and ecosystem health)

- Identify risk host organisms and countries of origin for each species
- Identify ISCC agencies responsible for each pathway
- Invasive Species of Highest Concern for California
- High Risk Pathways of Introduction
- Current Program Capacity to Address Each High Risk Pathway

LITERATURE CITED

Links for the references used for the research for the Invasive Species Pathway Risk Analysis will be linked to each species on the CISAC Invasive Species List and Scorecards for California (http://ice.ucdavis.edu/invasives/)

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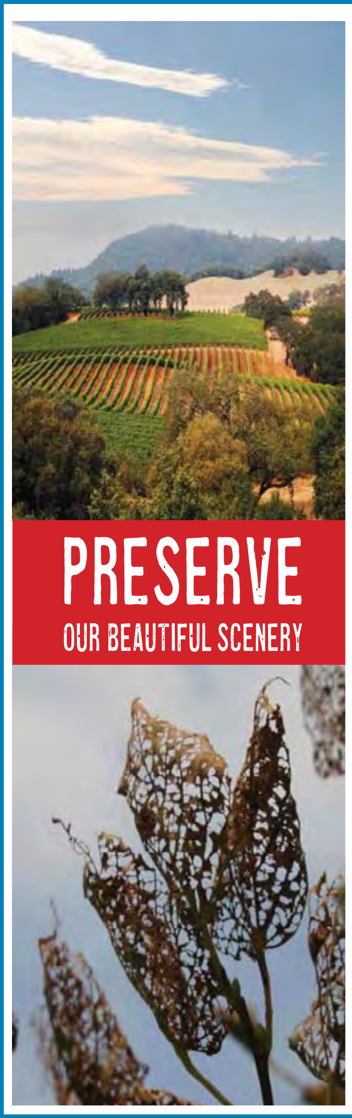
California Invasive Species Advisory Committee

Survey Report
June 2013



Prepared by Jen Dalton, Kitchen Table Consulting
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California Invasive Species Advisory Committee Survey Report

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Purpose

The goal of this brochure and survey project is to help inform public education efforts regarding invasive species and specialty crops and test the effectiveness of outreach and education efforts.

Method

The California Invasive Species Advisory Committee created 20, 818 brochures and distributed them to 26 Agricultural Commissioner offices in California. The Agricultural Commissioners were asked to display them at their farmers' markets and at other venues.

The brochures were created to appeal to the farmers' market shopper and addressed key issues relating to invasive species in California and ways in which invasive species affect specialty crops, while providing suggestions for action. Five county Agricultural Commissioners from throughout the state were chosen to conduct in-person surveys at their chosen farmers' markets. They represented each area of the state, suburban/urban and rural, small as well as large markets. The five counties were: Los Angeles, Mendocino, San Mateo, Solano and Tulare.

A script was created to help initiate conversation, the respondent was then shown the brochure and asked four questions before and after viewing it.

Sample Size

Surveys were targeted to farmers' market shoppers and were conducted by individuals on behalf of the Agricultural Commissioners in those counties, or by the Agricultural Commissioners themselves. Surveyors either walked around the market with brochures and surveys or created information booths with brochures and surveys. All surveys were conducted in person. Surveys were administered during May of 2013 at the start of the farmers' market season.

A total of 109 surveys were conducted. See below for a breakdown of location and quantity per location.

Los Angeles County: 28 completed surveys taken at the following markets: Downey (14), Hollywood (10) and South Pasadena (4).

Mendocino County: 50 completed surveys from the following markets: Fort Bragg (12), Mendocino (14) Ukiah (11), Willits (13).

San Mateo County: 9 surveys completed. Coastside Farmers' Market (5), Kaiser South San Francisco (4).

Solano County: 17 surveys conducted, all at the Vallejo Farmers' Market.

Tulare County: 5 surveys conducted. Visalia (1), Tulare Outlet (4).

According to data sourced from the 2012 United States Census, total population of Los Angeles (9,962,789), Mendocino (87,428), San Mateo (739,311), Solano (420,757) and Tulare counties (451,977) is 11,662,262. According to a Research Advisors sample size table, the number of respondents needed for a 95% confidence level for a population of 10 million plus, at a 5% margin of error, is 384.

This survey, however, was not distributed to the broad population, nor was it intended to be, rather it reached a self-selecting subset of the population that shops at farmers' markets, the low hanging fruit, so to speak, for our consumer target. Data for the percentage of the population that shops at farmers' markets is not available. Therefore, we cannot determine an absolute confidence level of these survey responses. According to the Los Angeles county surveyor, 30-40% of the people approached were willing to take the survey.

Questions

The four questions asked were developed jointly by the California Invasive Species Advisory Committee, Kitchen Table Consulting, and members of the California Agricultural Commissioners and Sealers Association (CACASA). They are as follows:

1. Do you feel like you know a lot/a little/or nothing about invasive species?
2. Are you aware that invasive species affect California's food supply and the natural environment?
3. Do you know how invasive species can affect fruit and vegetables found in the farmers market?
4. Did looking at the brochure teach you anything new about the ways invasive species can affect agriculture? If yes, what did you learn?

Results per County

Los Angeles County Survey for California Invasive Species Advisory Committee, 2013

Data are self-assessed, N=28.	**A Lot (%)**	**A Little (%)**	**Nothing (%)**	**Yes (%)**	**No (%)**
Knowledge about invasive species in general	7	82	11		
Aware that invasive species affect California's food and environment				96	4
Know that invasive species can affect food at farmers' market				57	43
Looking at the brochure taught me something new about invasive species' effect on agriculture				93	7

If yes, what did you learn?
New bugs, don't like pesticides
Very anti-pesticide
New pests move with people/things
Water pests move on boats
New bugs/pests, no natural enemies here
Weeds are invasive pests, no natural enemies here
Farmers have to fight new bugs without any natural predators
New pests hard to fight for farmers
Mussels and weeds are invasive pests
Quagga mussels and stink bugs new
New bugs hard to stop here
Costs farmers to stop them from moving
Star thistle is invasive and not native to California, new bugs
Interesting which bugs we are concerned about here

Los Angeles County farmers' market shoppers, who live in a relatively urban environment, know "a little" (82.14%) about invasive species in general. A large majority, 96.43%, are aware that they affect California's food supply and the natural environment but they are almost equally divided in awareness that the affects reach the fruits and vegetables available at the farmers' market. Since over 92% said they learned something new we can speculate that the brochure and survey conversation led to a positive outcome. Much of the "what did you learn" responses varied on the theme of "new bugs" and "new pests" with some responding with specifics like "quagga mussels and stink bugs." Still others responded that they now understand the cost to farmers, that pests spread via people and "things," that there are no natural predators and that pesticides must be used. The mention of pesticides and natural predators is interesting to note because the brochure does not mention these words. We can assume this information was relayed by the survey taker. One respondent said, "very anti-pesticide;" this sentiment is also not mentioned or alluded to in the brochure.

Mendocino County Survey for California Invasive Species Advisory Committee, 2013

Data are self-assessed, N=50.	A Lot (%)	A Little (%)	Nothing (%)	Yes (%)	No (%)	Other (%)
Knowledge about invasive species in general	20	68	12			
Aware that invasive species affect California's food and environment				80	14	6
Know that invasive species can affect food at farmers' market				66	22	12
Looking at the brochure taught me something new about invasive species' effect on agriculture				68	12	20

If yes, what did you learn?
General information about Invasive Species: 18%
New species: 38%
IS also includes animals and insects: 4%
How to identify Invasive species: 2%
Will read it later: 6%

The majority (68%) of Mendocino County respondent's know "a little" about invasive species. As Mendocino County is primarily a rural, agricultural-based county it's little surprise that 80% said they are aware that invasive species impact the food supply and natural environment while 66% knew that specialty crops at the farmers' markets are impacted. With such an educated sample size, it's logical that only 68% learned something new from the brochure. What they learned however is a positive net result.

San Mateo County Survey for California Invasive Species Advisory Committee, 2013

Data are self-assessed, N=9.	A Lot (%)	A Little (%)	Nothing (%)	Yes (%)	No (%)
Knowledge about invasive species in general	11	33	56		
Aware that invasive species affect California's food and environment				56	44
Know that invasive species can affect food at farmers' market				33	67
Looking at the brochure taught me something new about invasive species' effect on agriculture				89	11

If yes, what did you learn?
"I learned about the Asian Citrus Psyllid, and I'll keep any eye out for it in my garden!"
"I learned about how fruit flies can come into California inside fruit, and about the Asian Citrus Psyllid."
"I learned about Quagga Muscles and not to release aquatic plants into the environment."
"Gypsy moth introduction pathways, increased forest fire risks posed by invasive species."
"Report a pest smart phone app and about county office duty biologists."
"How it affects U.S. food supply."
"How farmers are affected."

In San Mateo County, the majority (56%) of respondents know "nothing" about invasive species yet the majority (56%) are also aware that they impact food and the natural environment. Most respondents (67%) did not know that produce at the farmers' market is impacted and 89% learned something from the brochure and encounter with the surveyor. Some of the things learned included: keeping an eye out for the Asian Citrus Psyllid and Quaggua muscles, how farmers and the food supply are affected, to report a pest via the phone app or by calling the local Agricultural Commissioner, and to not release aquatic plants into the environment. Effective educational outreach.

Solano County Survey for California Invasive Species Advisory Committee, 2013

Data are self-assessed, N=17.	**A Lot (%)**	**A Little (%)**	**Nothing (%)**	**Yes (%)**	**No (%)**
Knowledge about invasive species in general	12	23	65		
Aware that invasive species affect California's food and environment				29	71
Know that invasive species can affect food at farmers' market				29	71
Looking at the brochure taught me something new about invasive species' effect on agriculture				100	0

If yes, what did you learn?
"Awareness"
"Pictures are important"
"To call the ag commission"
"To call the 1-800 number"

In Solano County 65%, the majority of respondents, know "nothing" about invasives with 100% learning something new from the brochure. Over 70% did not know they impacted the food supply or the natural environment or specialty crops. Though only 17 surveys were conducted, awareness was raised and respondents commented on the effectiveness of the photographs.

Tulare County Survey for California Invasive Species Advisory Committee, 2013

Data are self-assessed, N=5.	**A Lot (%)**	**A Little (%)**	**Nothing (%)**	**Yes (%)**	**No (%)**
Knowledge about invasive species in general	20	80	0		
Aware that invasive species affect California's food and environment				100	0
Know that invasive species can affect food at farmers' market				100	0
Looking at the brochure taught me something new about invasive species' effect on agriculture				80	20

If yes, what did you learn?
"Awareness"
"To get a vacuum"

Respondents in Tulare County are somewhat educated with 80% knowing "a little" about invasive species. All respondents knew they affect the environment and food supply as well as the fruits and vegetables at the farmers markets. And 80% learned something new from reading the brochure. Awareness was a big response as well as the need for a vacuum cleaner, presumably to use on the Brown Marmorated Stinkbug (an effective eradication technique).

Summary of Five County Surveys for California Invasive Species Advisory Committee, 2013

Data are self-assessed, N=109.	**A Lot (%)**	**A Little (%)**	**Nothing (%)**	**Yes (%)**	**No (%)**	**Other (%)**
Knowledge about invasive species in general	15	62	23			
Aware that invasive species affect California's food and environment				75	22	3
Know that invasive species can affect food at farmers' market				57	38	5
Looking at the brochure taught me something new about invasive species' effect on agriculture				83	8	9

Summary Results

Among the five counties surveyed, 62.38% know "A little" about invasive species, 75.22% are aware that invasives affect California's food supply and the natural environment and 56.88 percent know they can affect produce at the farmers' market. A full 82.56% reported they learned something new about the way invasive species impact agriculture in California. Looking at these numbers, we can postulate that a majority in these counties are somewhat aware of invasive species. It's interesting to note that part of that awareness includes such a healthy percentage of knowledge about their impact on the food supply, natural environment and fruits and vegetables available at farmers' markets. Whether that knowledge existed before reading the brochure and participating in the survey can't really be known; however, the project can be deemed successful because such a large percentage agreed that new knowledge was gained.

Reponses to What Was Learned Question

Many reported on the benefit of photos to help identify species and others noted the importance of reporting pests when they see them. Other responses included:

General information and awareness about invasive species
Identification of new species
Information about how to identify Invasive species
To get a vacuum
Call the Ag Commissioner
Call the 1-800 number
Keep an eye out for Asian Citrus Psyllid in my garden
How fruit flies can come into California inside fruit, and about the Asian Citrus Psyllid
Don't release aquatic plants into the environment
Gypsy moth introduction pathways
Increased forest fire risks posed by invasive species
Report a pest smart phone app
County office duty biologists
The affect on U.S. food supply
How farmers are affected
New bugs, don't like pesticides
Very anti-pesticide
New pests, water pests
New pests move with people/things
Water pests move on boats
Weeds are invasive pests, no natural enemies here
Farmers have to fight new bugs without any natural predators
New pests hard to fight for farmers
Mussels and weeds are invasive pests
Star thistle is invasive and not native to California, new bugs

What We Learned

What specific conclusions can be drawn from the very last question asked, "What did you learn?" In both urban/suburban and rural counties key takeaways ranged from the general ("awareness") to the specific ("I learned about the Asian Citrus Psyllid, and I'll keep any eye out for it in my garden!"). The main result of this campaign was increased awareness. By merely participating in the survey, respondents increased their understanding and the survey effort can be seen as successful in the dissemination of information and as an active education initiative.

This brochure was created for a "general" readership, assuming no prior knowledge. If we use knowing "nothing" prior to this campaign as a bar, further education and outreach efforts could be directed to those areas with the least understanding yet highest need. The two counties with the least understanding are San Mateo (56%) and Solano (65%). Both of these counties are located near major urban areas (San Francisco Bay Area and Sacramento respectively) with Solano in the middle of an agriculture production area. Perhaps further efforts can be focused here.

Some small comparisons can be drawn between urban/suburban results to those from rural counties surveyed. Three counties surveyed include an urban/suburban population (L.A., San Mateo, Solano), two are considered rural (Mendocino, Tulare). L.A., Solano and San Mateo combined had 54 responses with Mendocino and Tulare combined at 55. While L.A. boasted 82% knowing "a little" about invasive species, the majority in San Mateo and Solano know "nothing". In Mendocino and Tulare counties, the majority of those surveyed knew "a little" about invasive species before reading the brochures. With 28 surveyed in L.A. and 50 surveyed in Mendocino County, do those in the more urban Los Angeles area know more than those in Mendocino County ("a little", 68%)? Note that when we compare Mendocino and L.A. counties, only 7% in L.A. knew "a lot" whereas 20% in Mendocino reported they know "a lot." What does this say about the need for further education? No majority knew "a lot" which suggests a general need for more education and outreach to both rural and urban/suburban populations.

Mendocino County boasted the most survey responses. As a large rural area surrounded by agriculture industry one might be surprised that comparatively so few farmers' market shoppers knew "a lot" about invasive species (20%). Perhaps more rural education is needed, especially for those closest to agricultural areas where specialty crops are most impacted. If we look at the answers to the first three questions, Tulare County, while only five complete surveys, seems the most educated and Solano and San Mateo counties seem the most in need; while Mendocino and Los Angeles counties appear to have greater knowledge.

We could say that in general more knowledge is more power. The more people know, the more they are able to participate in helping to protect the environment and the food supply.

Presentation and Messaging

It is hard to speculate if gaps exist in the presentation or messaging component of the project because we have no data reflecting this and were not present while the surveys were conducted. What we can see from the data is that information was understood and that people learned something new. We can also see, based on the "What did you learn?" answers from L.A. county that information that was not included in the brochure or poster (pesticide use and natural predators) was provided, in addition to the information in the materials. Perhaps the surveyor in L.A. county used the conversations as an opportunity for providing additional education to the respondents.

In Solano County we heard that pictures are important; respondents appreciated the photos in the brochure to help tell the story and provide education. In the creation of this brochure and poster project, Kitchen Table Consulting found some difficulty in locating images appropriate for print. One recommendation would be to locate and capture images that help lay people and especially those with less familiarity with the natural environment, identify invasive species from many angles and situations. An assumption based on observation tells us that people are more likely to learn when they can see different species in a familiar context. For example, if an insect is likely found on the leaf of an orange tree or on the orange itself, the photo should reflect this relationship.

Additional food for thought, consider conducting more general audience outreach to increase the number of people in the know. Continue to conduct this outreach to grocery stores, nurseries, outdoor markets, and other areas that attract people who want to be engaged in their food system and environment.

Moving Forward

Now that the California Invasive Species Advisory Committee has a colorful, educational brochure with ample photographs and up-to-date information it would benefit education and outreach efforts to print more and re-supply the Agricultural Commissioners with a directive to continue to disseminate them to farmers' markets, garden clubs, nurseries, and other venues. Consistent messaging over time will be the key to reaching this consumer target.

Appendix I: Brochure

HELLO INVASIVE SPECIES, GOODBYE CALIFORNIA

Some invasive species destroy crops, damage natural water systems and limit our fresh fruit and vegetable choices. Others can ruin recreation areas, scenic waterways and forests. Have you seen any of the particularly harmful pests shown below?

Yellow Starthistle

This spiny, noxious weed grows abundantly and is a pest in pastures, croplands and natural areas. It crowds out native plants and is toxic to horses. If you hike through them, don't spread the seeds with you—dust off to prevent hitchhikers on your clothes or boots.

photo: CDFA

Asian Citrus Psyllid

Oranges, lemons, grapefruit—this aphid-sized insect carries the huanglongbing disease that threatens all of California's backyard and commercial citrus crops. Check your citrus trees often, and if you think you may have seen a psyllid, report it immediately to the pest hotline, 800-491-1899.

photo: David Hall

Brown Marmorated Stinkbug

This trouble-maker feeds on fruit trees and some crops. Very difficult to control, they can be a serious problem for backyard gardeners and organic growers. If you see them near your house, vacuum them up and freeze the bag to exterminate.

photo: Gary Bernon

Water Hyacinth

A popular addition to water gardens, this aquatic nuisance damages lakes, streams, irrigation and aqueducts and costs millions to control in the Sacramento-San Joaquin River Delta. Please don't plant it or release it to the wild.

photo: Willey Durden

European Grapevine Moth

This pest may have entered California on illegally imported produce or nursery stock and threatens our world famous wine industry. The ongoing eradication project is now a successful model for collaboration and effectiveness.

Gold-Spotted Oak Borer

Responsible for destroying massive numbers of oak trees in San Diego County, these beetles are headed north. They lurk under bark, so please don't move firewood: Buy It Where You Burn It.

photo: Mike Lewis

Quagga Mussels

They reproduce often and in the billions, completely clogging water supply channels and damaging recreational boating areas. They spread by hitchhiking on boats, so always clean, drain and dry your vessel.

Asian Long-Horned Beetle

A black and white beetle with a big impact—they decimate entire forests and may damage orchards. Currently found in New England and the Midwest, California's hardwoods are now vulnerable. Be mindful, they hitchhike on wooden packing materials and firewood.

photo: Karen Snover-Clift

Brown Tree Snake

Death to birds! Because birds do so much to control crop pests, this snake harms agriculture as well as the environment. Thanks to vigilance by U. S. Customs and Border Protection, it's not in California – yet.

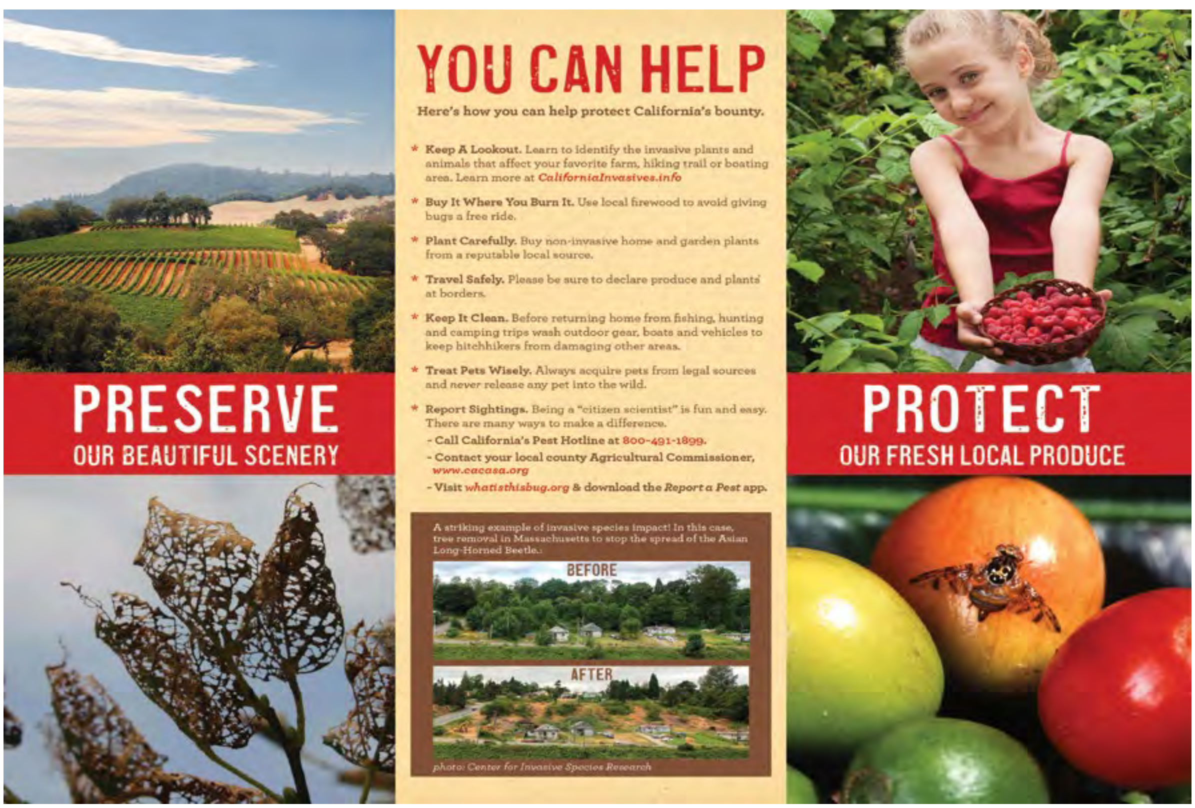
photo: Gordon Rodda, Bugwood.org

Endangered:

FRUIT – VEGETABLES – ECONOMY – FIELDS – FORESTS – LAKES

INVASIVE SPECIES COUNCIL OF CALIFORNIA

Funded by a grant from the Department of Food and Agriculture's Specialty Crop Block grant program



PRESERVE
OUR BEAUTIFUL SCENERY

YOU CAN HELP

Here's how you can help protect California's bounty.

* **Keep A Lookout.** Learn to identify the invasive plants and animals that affect your favorite farm, hiking trail or boating area. Learn more at *CaliforniaInvasives.info*
* **Buy It Where You Burn It.** Use local firewood to avoid giving bugs a free ride.
* **Plant Carefully.** Buy non-invasive home and garden plants from a reputable local source.
* **Travel Safely.** Please be sure to declare produce and plants at borders.
* **Keep It Clean.** Before returning home from fishing, hunting and camping trips wash outdoor gear, boats and vehicles to keep hitchhikers from damaging other areas.
* **Treat Pets Wisely.** Always acquire pets from legal sources and *never* release any pet into the wild.
* **Report Sightings.** Being a "citizen scientist" is fun and easy. There are many ways to make a difference.
  - Call California's Pest Hotline at 800-491-1899.
  - Contact your local county Agricultural Commissioner, *www.cacasa.org*
  - Visit *whatisthisbug.org* & download the *Report a Pest* app.

A striking example of invasive species impact! In this case, tree removal in Massachusetts to stop the spread of the Asian Long-Horned Beetle.

BEFORE

AFTER

photo: Center for Invasive Species Research

PROTECT
OUR FRESH LOCAL PRODUCE

Appendix II: Poster

Appendix III: Survey Script

In-Person Survey

Script:

[Hand them the brochure if they do not already have it]

Hi. Thanks for taking our brochure. Please take 30 seconds to look at it. Would you mind answering a few questions? It will take less than three minutes of your time.

1. Do you feel like you know a lot/a little/or nothing about invasive species?

2. Are you aware that invasive species affect California's food supply and the natural environment?

3. Do you know how invasive species can affect fruit and vegetables found in the farmers market?

4. Did looking at the brochure teach you anything new about the ways invasive species can affect agriculture?
if yes: what did you learn?

Thanks so much for talking to me.

Fig. 1. Host location and acceptance of *B. oleae* by *P. cosyrae*

Host age (days)	n	Dissection		Rearing	
		Flies /fruit	Wasps/ fruit	Flies /fruit	Wasps/ fruit
4	14	1.47 ± 0.21a	0 a	1.80 ± 0.19 a	0 a
6	12	2.45 ± 0.25 ab	0 a	2.45 ± 0.31 a	0 a
8	12	2.70 ± 0.37a	0.25 ± 0.25 ab	2.25 ± 0.35 a	0 a
10	12	1.71 ± 0.28 ab	0.67 ± 0.22 b	1.37 ± 0.38 a	1.08 ± 0.31 b
Statistics		$F_{3,46} = 4.7$, $P =$ 0.01	$F_{3,46} = 3.8$, $P = 0.02$	$F_{3,46} = 2.3$, $P = 0.10$	$F_{3,46} = 12.8$, $P < 0.001$

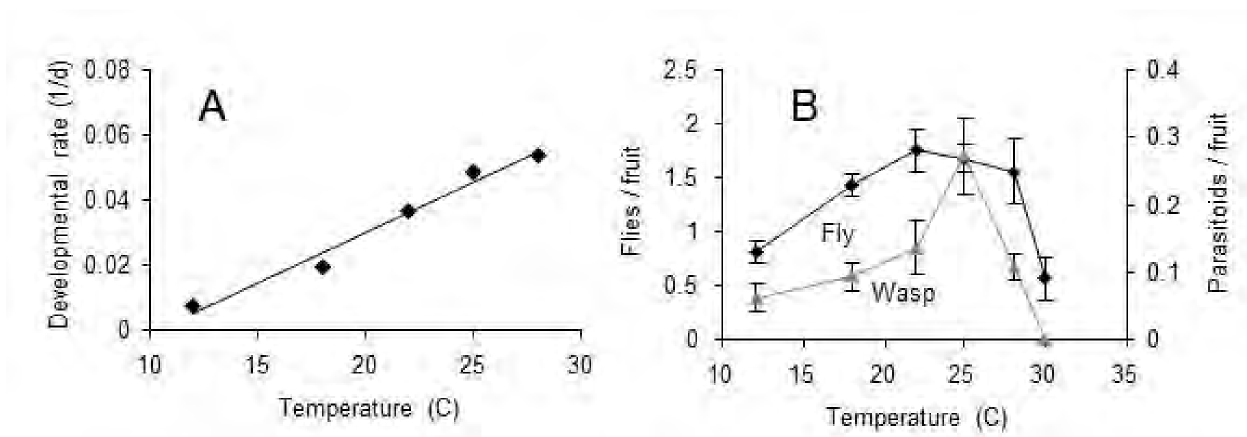


Fig. 2. (A) Relationship between temperature (*X* ºC) and developmental rate (*Y*, 1/day) of *P. ponerophaga*, and **(B)** effects of temperature on the survival of *B. oleae* and *P. ponerophaga*.

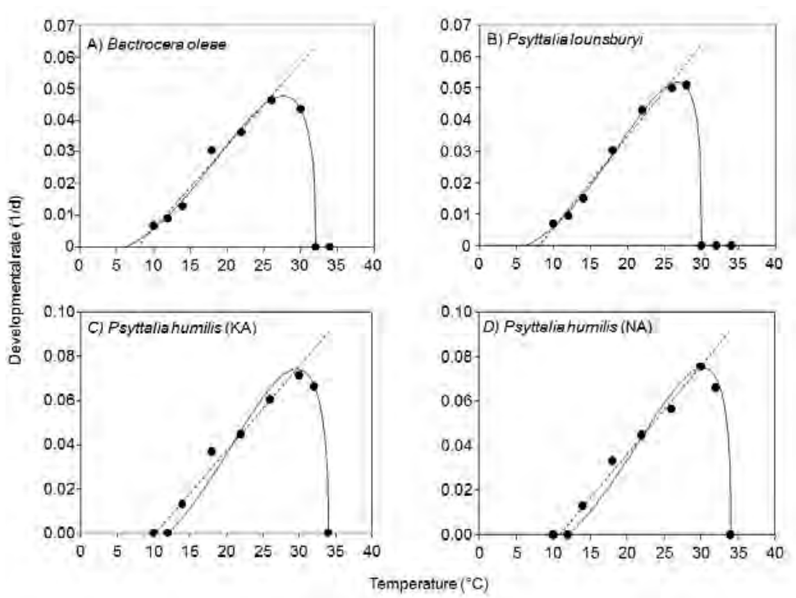


Fig. 3. Relationship between temperature and developmental rate (1/day) for (A) olive fruit fly, (B) *Psyttalia lounsburyi* (C) *Psyttalia humilis* Kenya (KA), and (D) *P. humilis* Namibia (NA). All data are fitted to a nonlinear model (solid line, Equation 1).

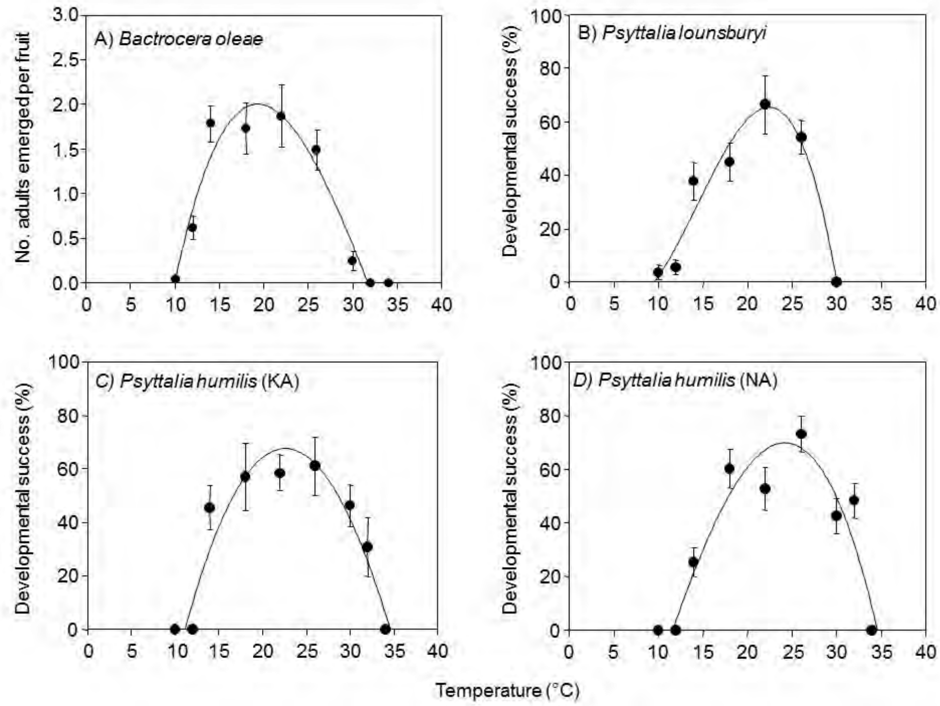


Fig. 4. Relationship between temperature and survival rate (number of adults flies emerged or percentage developmental success of parasitoids).

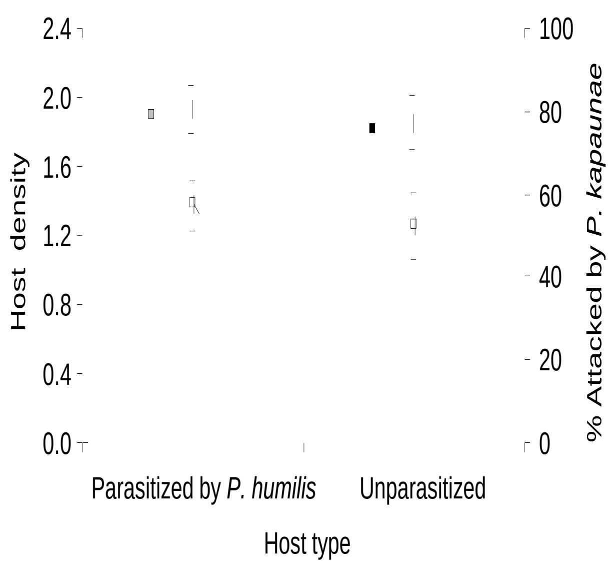


Fig. 5. Potential intra-guild predation by *P. kapaunae* on *P. humilis*. Values are mean ± SE host density in the two fruit containing unparasitized or previously parasitized OLF larvae by *P. humilis* and percentage of the different types of hosts attacked by *P. kapaunae*.

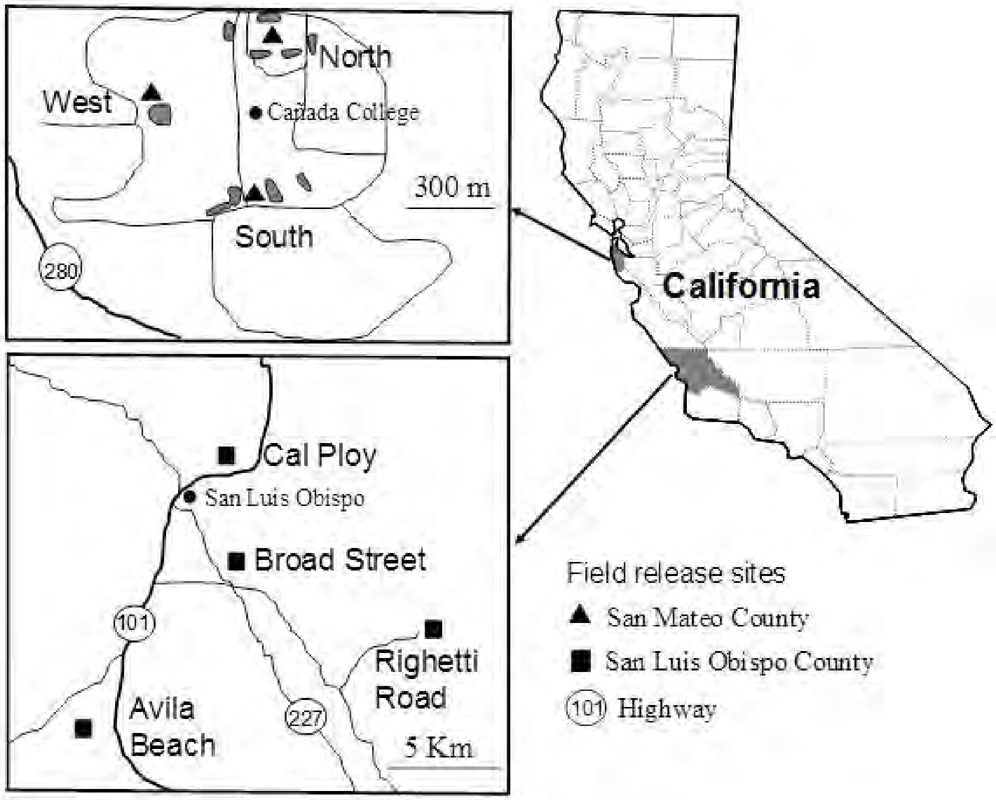


Fig. 6. Release sites in San Luis Obispo and San Mateo Counties.

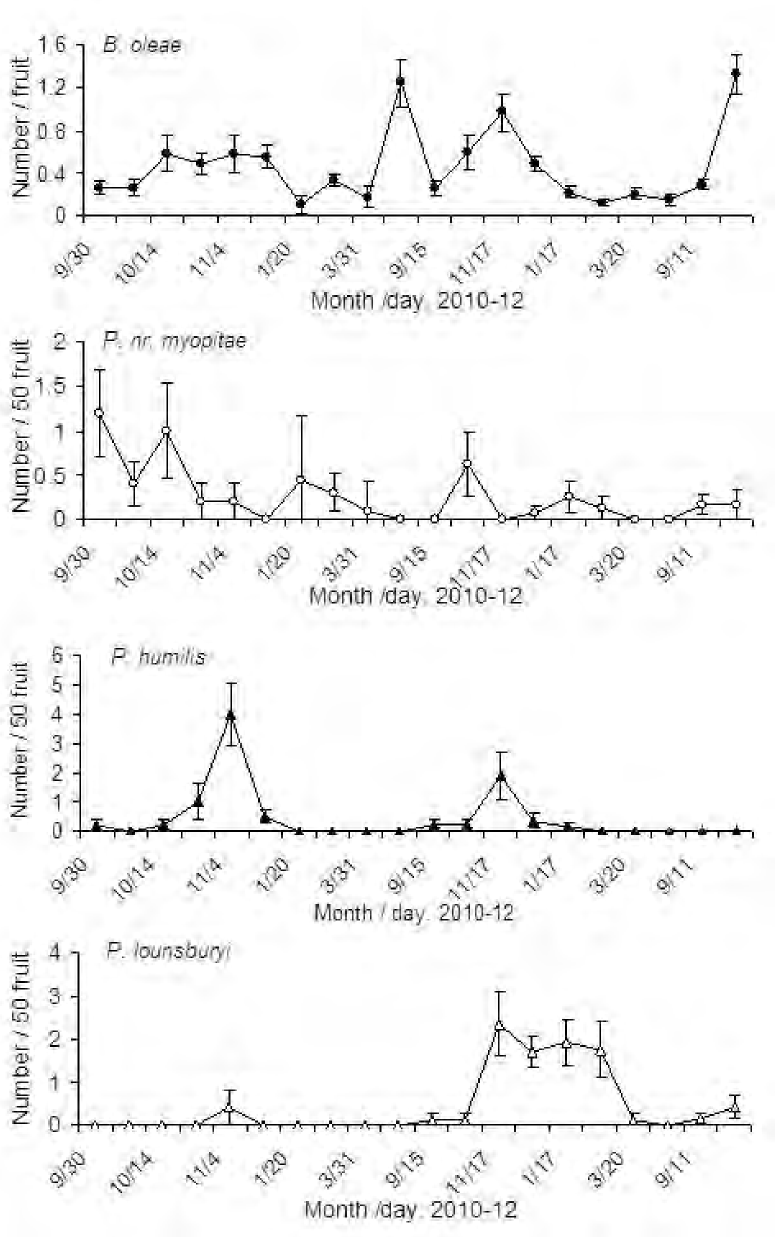


Fig. 7. Number (mean ± SE) of emerged adult *B. oleae* per fruit or adult *P. humilis*, *P. lounsburyi* or *P.* nr. *myopitae* per 50 fruit from September 2010 to October 2012 (olives were not available for sampling during the summer months) at the Cañada College campus, Redwood City, San Mateo, CA.

Project 3: Areawide mating disruption for vine mealybug in grapes
ATTACHMENTS

Photo 1: Napa (areawide)

Photo 1: Napa Grapevine Leafroll-Associated Viruses

Photo 3: Lodi-Woodbridge (meso dispensers)

Photo 3: Puffer delivery system

Figure 1: Adult male mealybug flight captures in pheromone-baited traps for September to October, 2011 and 2012, in an areawide mating disruption trial in one of three north coast sites. Each site is approximately 150 acres in size and composed of multiple vineyard blocks.

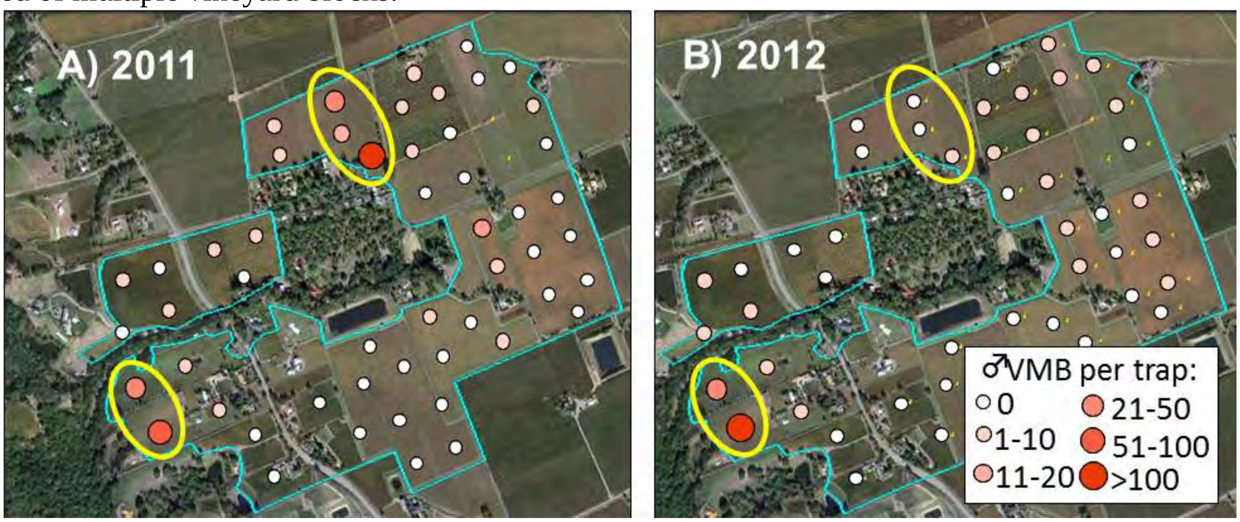


Figure 2: Location of positive GLRaV vines in a 2008 planted vineyard with (thick red lines) and without (dotted black lines) insecticide treatments, showing the location of infection and the year the vines were found, based on symptoms (Yr1 = 2009, Yr2 = 2010, Yr3 = 2011, Yr3 = 2012).

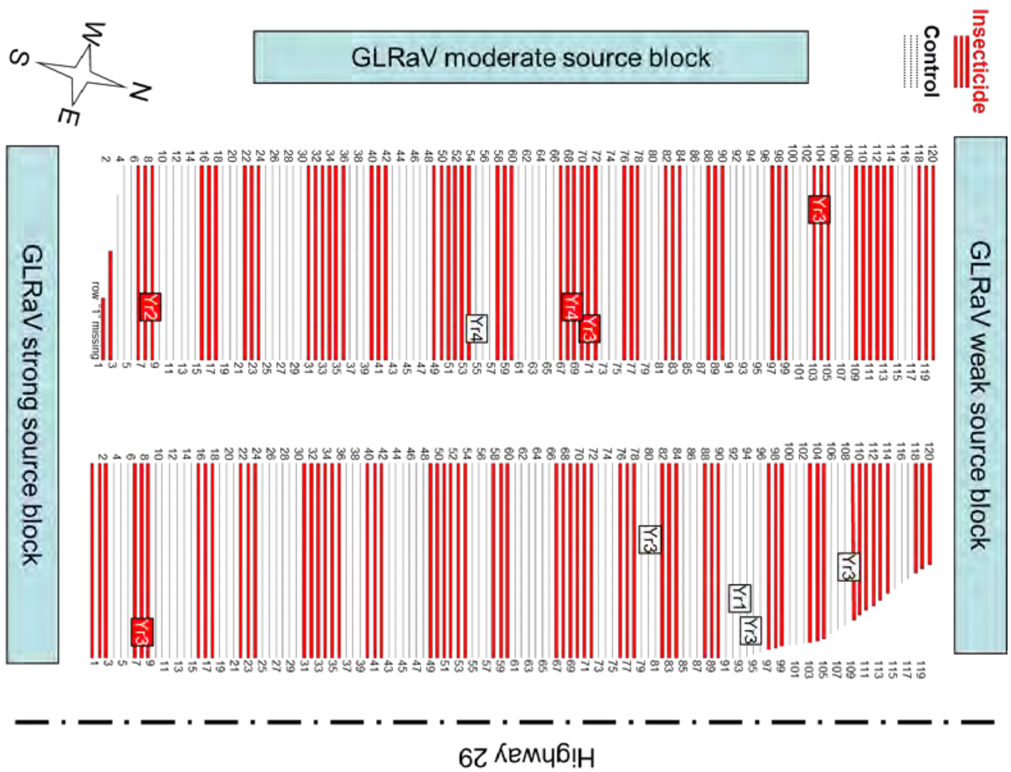


Figure 3: Cluster damage ratings in treatments with insecticides only, plastic mating disruption dispensers, or meso-mating disruption dispensers in (A) 2011 and (B) 2012.

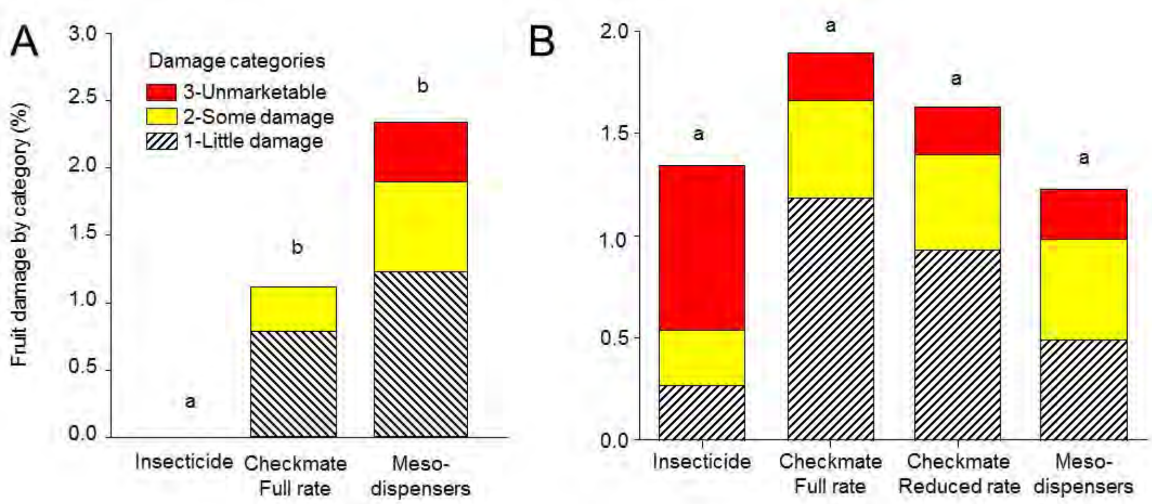


Figure 4: A) Seasonal vine mealybug flight pattern as affected by mating disruption and no mating disruption. B) Effect of mating disruption on percentage of clusters damaged, where 'red" is total damage (unmarketable), yellow is moderate damage, striped bar is light damage and gray is no damage. Denair, CA, 2011.

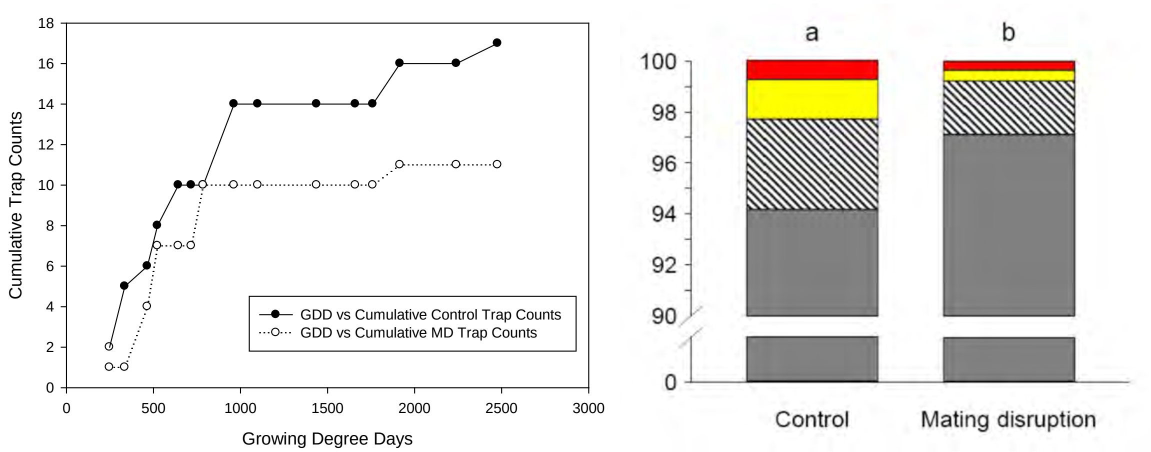


Figure 5: Vine mealybug trap suppression patterns of a single high rate puffer (5.123 mg ai/puff, 42 gm ai canister) (B and C) compared to no pheromone treatment(A and D), Fowler, CA. Patterns are derived by geostatistical interpolation of VMB capture in a 64-trap grid of pheromone baited traps. High capture rates are indicated by reds, low numbers by pale yellows. Puffer application was alternated weekly between west (A and B) and east (C and D) plots with the puffer placed in center of the treatment plot.

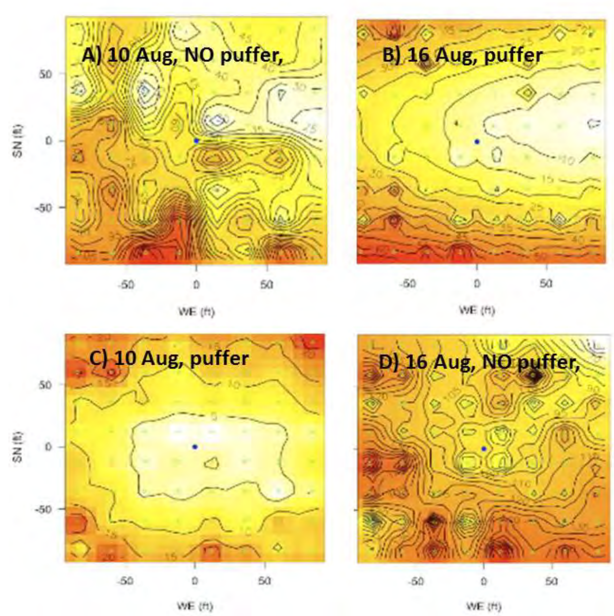


Figure 6: Vine mealybug trap suppression patterns of a single puffer (1.56 mg ai/puff, 12 gm ai canister) (B and C) compared to no pheromone treatment(A and D),Fowler, CA. Two of the four replicates (weeks) are shown. Patterns are derived by geostatistical interpolation of VMB capture in a 64-trap grid of pheromone baited traps. High capture rates are indicated by reds, low numbers by pale yellows. Puffer application was alternated weekly between west (A and B) and east (C and D) plots with the puffer placed in center of the treatment plot.

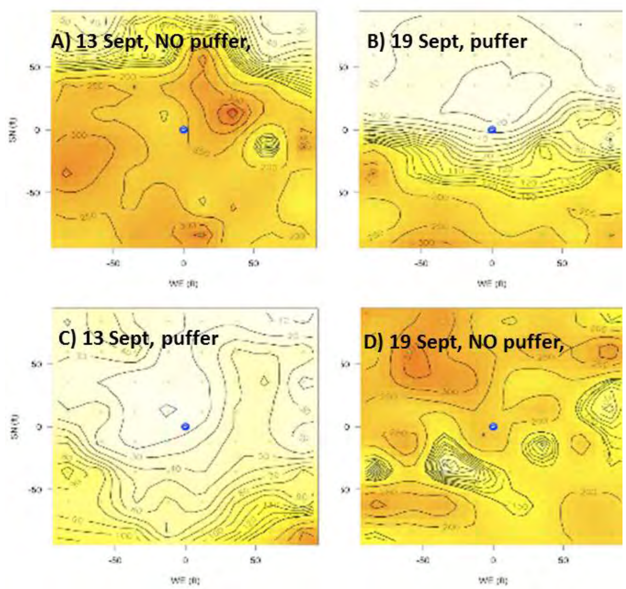


Figure 7: Vine mealybug trap suppression patterns in plots using different rates of Checkmate dispensers shows a similar level of reduction using 188 and 250 dispensers, but a breakdown in control at and below 125 dispensers per acre. San Luis Obispo, CA.

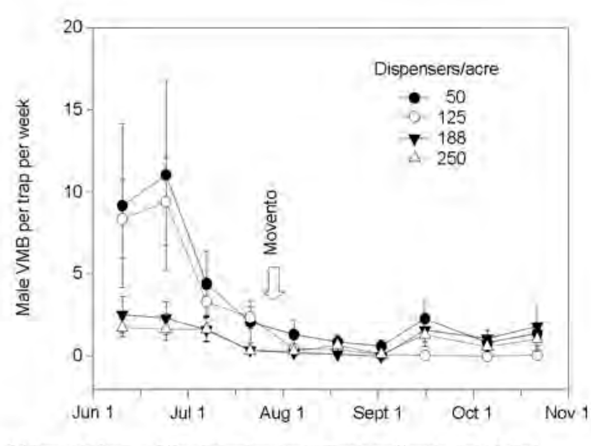


Figure 8: Over the three trials (A – July 25-August 5 2012, B – October 12-22 2012), flights of male mealybug were substantial and despite warm morning temperatures and low wind velocities the insects did not orient to upwind pheromone point sources. Adult males were consistently caught in the vicinity of mealybug source and rarely upwind from that source on any observation day. With only one exception, the traps closest to the mealybug source had the highest numbers of captured males. These results suggest that the males are not strong flyers, and while there may have been pressure to remain near the live female source (e.g., the colony placed into the field) the study showed the impact of dispensers placed in a field where there were few heavily infested vines.

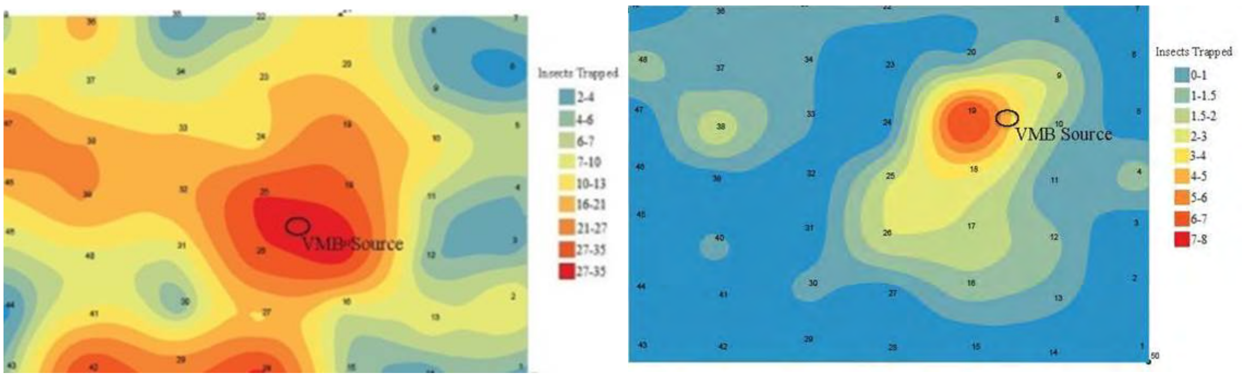


Figure 9: The results showed no parasitism before the release, suggesting that there was little (or no) parasitoid activity in the orchard prior to parasitoid release. For a simple analysis, data from the three post-treatment sample dates are combined. Comparison of the average number of parasitized mealybugs showed no difference between the control, one cyclolavandulyl butyrate, or one VMB septa; there were significantly more *A. pseudococci* found on branches baited with three VMB lures. The results suggest that the vine mealybug pheromone is used by *A. pseudococci* to locate the mealybug.

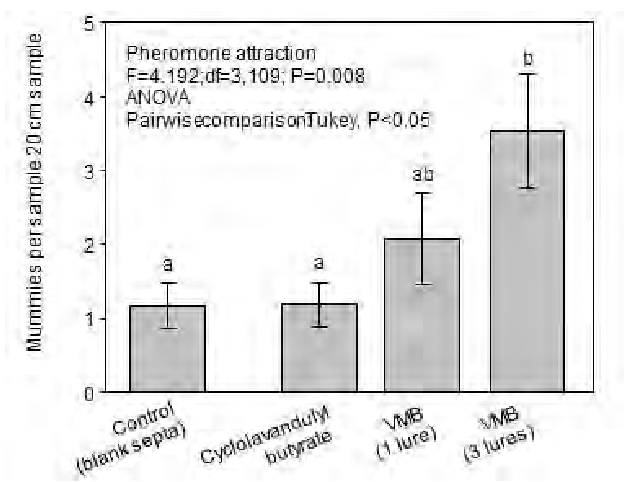


Table 1:

Rate [1]	Load [2]	Dose [3]	No Damage (0)	Little damage (1)	Damaged (2)	Unmarketable (3)
0	0		71.67	21.67	6.67	0.00
125	200 mg		90.00	5.56	3.33	1.11
125	300 mg	3	87.22	10.56	1.11	1.11
175	143 mg		99.44	0.56	0.00	0.00
175	214 mg	3	98.33	1.11	0.56	0.00
250	100 mg		92.78	5.00	1.67	0.00
250	150 mg	3	90.56	7.22	2.22	0.00

[1] Rate is the number of dispenser per acre
[2] Load is the amount of ai per dispenser (in mg per dispenser)
[3] Dose is the total amount of ai delivered per acre (Rate x Load)

Financial Management

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Contributing Reviewers

Introduction – Sustainability and Financial Management

The Almond Board of California defines sustainability in relation to almond growing as “Sustainable almond farming utilizes production practices that are economically viable and are based upon scientific research, common sense and a respect for the environment, neighbors and employees.” This definition is consistent with the concept that sustainability is a balance among three principles or E’s – **E**cologically Sound, Socially **E**quitable and **E**conomically Viable. But, clearly, the economic **E** of sustainable agriculture is literally where the buck stops. If a farm or processing facility is not profitable (i.e., economically viable), it is not sustainable.

Financial management is one of the keys to an economically viable and sustainable agricultural operation. In the case of farming, it is a delicate balance between good business sense and good farming sense.

One way to assess the economic viability of practices used to produce or process almonds would be to conduct a cost/benefit analysis for each practice. Based on each individual cost/benefit analysis, a decision then could be made to continue or discontinue the practice. However, while it may be straightforward to determine the cost of a practice; it can be challenging to quantify the value of the benefits, particularly if related to ecological improvements.

Nevertheless, there are basic, practical financial management methods that when implemented can help maintain, and hopefully enhance, the economic viability of the agricultural business. Using the recommended practices in this module to assess your farm or processing operation can identify strengths as well as insights for improvement in financial management.

The appropriate person(s) from your farm or processing operation who is responsible for financial decisions should complete the assessment for this module. If your operation has a management team, it may be useful to complete the assessment together.

	For this orchard or facility, the following practices related to production and profitability were used:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	PRODUCTION AND PROFITABILITY					
1	An annual net profit analysis of the operation (i.e., total revenue minus total expenses) was done to help ensure profitability.	❑	❑	❑	❑	❑
2	The cost and payback for orchard or facility renovation, expansion and/or renewal has been periodically assessed to ensure implementation is timed to optimize economic benefits.	❑	❑	❑	❑	❑
3	Options, in addition to almond farming or processing, for increasing the overall profitability of the farm or facility have been considered.	❑	❑	❑	❑	❑
4	Other:				❑	

Economics of Almond Growing

The Almond Board website is a rich source of information for general production economics, for assessing and tracking costs and returns, and for improving the profitability of almond growing.

Almonds are one of California's most valuable commodities. Ensure that you are smartly managing production costs and returns by using the resources available at the Board's webpage listed in References.

About Profitability

It is likely that most farm and facility managers think of and plan *production* – crops, meat, timber, and, in this case, almonds and almond products. Next, they calculate the anticipated income for the year, then expenses, and eventually juggle figures until achieving a positive balance. This order of approach tends to make profitability the ultimate test, for which all other considerations are compromised.

Importantly, profit *itself* is a form of production that ranks alongside other elements that likely constitute your definition of a good quality of life, which probably includes prosperity or at least economic security and viability.

So, consider developing a plan that focuses on profit upfront by first qualifying profit as 'profit from crops' or 'profit from hunting.' Then, envision a future resource base and landscape that ensures profit can be produced for years to come. Next, test all actions that will be taken to achieve that profit to ensure that the actions are socially, environmentally and economically sound – simultaneously – both short and long term. The tests should include a 'gross profit analysis,' which is designed to highlight how much each enterprise contributes to covering fixed costs, or overhead. This reordered approach ensures that the plan will indeed produce profit.

When planning production and then testing profitability, there is the tendency to overlook or skimp on details that cost the operation profit, and, in the end, may produce undesirable social or environmental consequences.

On the other hand, when a plan is implemented for profit, the farm is more likely to earn higher profits and improve social and environmental benefits for the entire community.

My 'Secret Sauce'…

It is human nature to want to do better than the competition. It also is human nature to think we have better ways of doing things than the competition and our ways must be kept secret to maintain our competitive edge. The end result for many agricultural sectors is that practitioners minimally share information with peers, especially "competitive edge" information such as production costs.

However, knowing what peers are doing to resolve financial challenges can be benefit the entire industry. There may be creative ways for the California Almond Community to share production costs so useful benchmarks can be set and improvements made.

	For this orchard or facility, the following practices related to accounting and financial analyses were used:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	ACCOUNTING AND FINANCIAL ANALYSES					
5	A financial accounting system and budgeting approach to track and report finances for the entire farm or facility was used to inform operational decisions.	❑	❑	❑	❑	❑
6	A financial accounting system and budgeting approach to track and report finances separately for each management unit (field/block or facility segment) was used to inform operational decisions.	❑	❑	❑	❑	❑
7	It was understood how to interpret both cash and accrual financial statements including a balance sheet, income statement, cash flow and financial ratios.	❑	❑	❑	❑	❑
8	An independent financial advisor has been met with on an annual basis.	❑	❑	❑	❑	❑
9	A financial profitability analysis for a potential investment(s) was done before the investment(s) was made.	❑	❑	❑	❑	❑
10	Financial management reports (profit and loss statements) were generated to track financial performance for each management unit (field/block or facility segment).	❑	❑	❑	❑	❑
11	Costs and returns were tracked for all important farming or facility practices.	❑	❑	❑	❑	❑
12	Costs and returns were tracked for new farming or facility practices and compared to costs and returns for practices they replaced.	❑	❑	❑	❑	❑
13	Sensitivity analysis, e.g., change in almond prices and/or yield over time, was used to analyze financial risk over time.	❑	❑	❑	❑	❑
14	University cost studies were used as benchmarks for the sensitivity analyses.	❑	❑	❑	❑	❑
15	Other:				❑	

	For this orchard or facility, the following practices related to financial planning and risk management were used:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	PLANNING AND RISK MANAGEMENT					
16	Marketing and production plans have been developed for the farm or facility and seasonal outcomes were compared to these plans.	❑	❑	❑	❑	❑
17	A succession plan has been established for the farm or facility.	❑	❑	❑	❑	❑
18	A written will and estate plan has been prepared for the farm or facility, and has been reviewed at appropriate intervals.	❑	❑	❑	❑	❑
19	A business continuation plan (disaster management plan) for the farm or facility has been developed.	❑	❑	❑	❑	❑
20	A risk management plan has been developed for the farm or facility and includes identifying issues that may affect future profitability such as urban sprawl, water quality, labor or climate change.	❑	❑	❑	❑	❑
21	Key personnel for the farm or facility had health insurance.	❑	❑	❑	❑	❑
22	Key personnel for the farm or facility had disability insurance.	❑	❑	❑	❑	❑
23	Key personnel for the farm or facility had life or accidental death insurance.	❑	❑	❑	❑	❑
24	Other:				❑	

Succession Planning

Succession planning is the process to identify and develop internal people who can fill key business leadership positions in the company. Changes may be expected (e.g., via voluntary step down/retirement) or unexpected (e.g., via debilitating illness or accident).

Regardless, it is smart business sense to plan for succession to ensure an effective transition and maintain company productivity.

Estate Planning

Estate planning is a process to effectively transfer financial assets from one generation to the next. Because it can be complicated and costly, estate planning should be done carefully and in advance.

Disaster Planning

Unexpected things happen. A key staff person dies suddenly, extreme weather occurs, etc. Planning ahead for potential catastrophic events helps ensure business and financial stability if a disaster occurs.

Agriculture and Relationships

A typical occurrence in agriculture is the development of friendly, dependable relationships with others in the industry. However, relationships should not preclude smart business decisions. Just because agricultural products have been purchased from the same local company for years, for example, does not mean that other companies and better deals should not be considered.

	For this orchard or facility, the following practices related to purchasing and borrowing were used:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	PURCHASING AND BORROWING					
25	More than one quote was obtained for major input purchases such as pesticides and fertilizers.	❑	❑	❑	❑	❑
26	More than one quote was obtained for major equipment purchases such as tractors, flails, sprayers and harvesters.	❑	❑	❑	❑	❑
27	Interest rates and services from more than one lending institution were compared before borrowing a significant amount of money.	❑	❑	❑	❑	❑
28	Before purchasing or borrowing to invest in another farm or facility, key financial ratios of the targeted operation were considered.	❑	❑	❑	❑	❑
29	Other:				❑	

Key Financial Ratios to Consider before Investing in New Farms or Facilities

Current Ratio for the Targeted Operation = Current Assets ÷ Current Liabilities

Net Working Capital for the Targeted Operation = Current Assets – Current Liabilities

Net Profit Margin for the Targeted Operation = Net Profit After Taxes ÷ Total Revenue

References and more information

Almond Board of California Orchard Economics web page. http://www.almondboard.com/AboutTheAlmondBoard/Pages/OrchardEconomics.aspx.

Almond Board of California. 2011. The Escalating Cost of Producing Almonds. *California Almonds Outlook March 2011*. Almond Board of California, Modesto, CA.

Savory, Allan, Jody Butterfield and Sam Bingham. 2006. *Holistic Management Handbook: Healthy Land, Healthy Profits.* Island Press, Washington, DC.

University of California, Davis Agricultural & Resource Economics Cost Studies: http://coststudies.ucdavis.edu/.

Self-Assessment for Carrot Production

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Funded by a California Department of Food and Agriculture
Specialty Crop Block Grant to SureHarvest

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Project History

Over the last 10 years the field of sustainable agriculture has become more and more important in the eyes of food retailers, buyers and consumers. As is often the case when new concerns arise in relation to food and food production, the spot light shines on the grower. Sustainable agriculture is challenging to define, and once defined it can be challenging for a grower to figure out how to implement it on the farm in an economically viable way. To meet these challenges a group of specialty crop trade associations, NGO's, and other specialty crop stakeholders met to discuss the topic of sustainable agriculture. One outcome of these discussions was an application to the California Department of Food and Agriculture Specialty Crop Block grant program for funds to hire sustainable agriculture professionals to help develop a plan to meet the challenges presented by sustainable agriculture. The Great Valley Center coordinated the grant application and engaged SureHarvest to provide the technical expertise. SureHarvest is a company with extensive experience in sustainable agriculture strategic planning, program design, and program implementation. The grant application was successful and began in September of 2009. The Great Valley Center directed the project and contracted with SureHarvest for project design, facilitation and implementation.

The grant had two primary goals. The first was to develop, through a stakeholder process, a sustainable agriculture strategic plan that each of the participating groups could use internally to help lay the foundation for their own sustainable agriculture program specific to their specialty crop. The second was to develop a tool, or tools, that could be used by their member growers to put the strategic plan into action on the farm.

The following paragraphs contain the sustainable agriculture strategic plan developed by the project leadership team, the members of which are listed in Table 1.

Sustainability Strategic Plan for the Multi-Commodity Project

The sustainability strategic plan for the Multi-Commodity Project is based on SureHarvest's 5 P's of sustainability framework. The 5 P's are: Principles, Processes, Practices, Performance Metrics, and Progress. They are defined as follows:

1. Principles – This is the sustainable vision for the project. It consists of the goals that the participants want to achieve from the design and implementation of the project.
2. Processes – These are the resource areas on the farm that need to be addressed in order to meet the principles or goals of the project. For example, this could be water, energy, and human resources management.
3. Practices – These are the practices that are implemented on the farm that impact the processes or resource areas. They are the on-the-ground actions that are carried out to assure that the principles or goals of the sustainable program are met.
4. Performance Metrics – These are the metrics used to measure the outcomes resulting from the practices implemented on the farm. There are many - examples include crop quality, water use, energy use, and worker satisfaction. Performance Metrics are used to measure the level of success in meeting the principles or goals of the project.

5. Progress – The process used to improve performance over time and communicate the results internally and externally. In other words, tracking the degree of progress one is making towards achieving the goals of the project. Measuring progress will require some kind of system for assessing the farm's performance over time, creating action plans to improve particular areas of performance, and reassessment over time to track progress.

Table 1. Multi-Commodity Project Leadership Team

Organization	Representative
Almond Board of California	Gabriele Ludwig*, Robert Curtis*
Bolthouse Farms	Troy Elliott*, Justin Groves*
California Grape & Tree Fruit League	Chris Valadez*, Barry Bedwell
California Specialty Crop Council	Lori Berger*
California Garlic & Onion Research Advisory Board	Robert Ehn
California Olive Council	Patty Darragh
California Pear Advisory Board	Bob McClain
California Pepper Commission	Glen Fischer*
California Pistachio Board	Robert Klein*
California Raisin Marketing Board	Gary Schultz
California Tomato Farmers	Ed Beckman*
California Tree Fruit Agreement	Gary VanSickle*, Lauren Friedman
California Walnut Board	David Ramos
Del Monte Foods	Pat McCaa
Sun-Maid Growers	Rick Stark*

*Leadership Team Member

Multi-Commodity Project Principles (1st P):

The principles for the Multi-Commodity Project were established by the Project Leadership Team. They are:

1. Create a resource area/practice template that:
    a. Will focus on increasing the economic performance for the participant.
    b. Is scalable and can be used by participating groups to accomplish the goals of their own sustainability programs.
    c. Provides the participant the ability to gauge the state of sustainability of the industry and their farm.
    d. Encourages continual improvement on the farm.
    e. As a whole encourages ecological harmony.
    f. Better defines the 3 E's of sustainability (economic viability, environmental soundness and social equity/responsibility) in a way we can all agree upon.
    g. Is open to and usable by any individual or group in the future that was not involved in the original effort.
    h. Benefit the participants and not result in unintended negative consequences.

2. The program should provide the information/data needed for groups to tell their sustainability story better to all their audiences, e.g. buyers, regulators, consumers, NGO's.
3. The outcomes from the project cause no harm to producers.

The Leadership Team of the Multi-Commodity Project decided the best tool for implementing their sustainability strategic plan was a self-assessment of practices template that stakeholders from specific specialty crops could then fine tune for their own use. The team chose to use the model developed by the California Sustainable Almond Program (CASP), which is a California Almond Board program developed in partnership with SureHarvest. The Leadership Team formed a stakeholder committee to draft the self-assessment template that covered the practice areas listed in the Multi-Commodity Project Strategic Plan. The Stakeholder Committee members are listed in Table 2.

Individual Contact	Title	Expertise
Billy Heller	Grower, Pacific Triple E Farms	Crop management
Bob Giampaoli	Grower, Live Oak Farms	Crop management
Cliff Sadoian	Grower	Crop management
Pat McCaa	Manager, Pest Management, Del Monte Foods	Crop management
Mechel S. Paggi (Mickey)	Director, Center for Agricultural Business, California State University, Fresno	Ag Business & economics
Glen Fischer	Ag Representative, Saticoy Foods Inc.	Crop management
John Trumble	Professor of Entomology, University of California Riverside	Pest management
Jeff Mitchell	Extension Specialist, University of California, Davis	Soils & plant nutrition
Pete Goodell	UC IPM Area Advisor, University of California, Davis	Pest management
Terry Prichard	Extension Specialist, University of California, Davis	Irrigation & crop water relations
Bill Peacock	Representing raisin growers via the Raisin Marketing Board and Tree Fruit Growers	Crop management
Troy Elliott	Director of Agronomy, Bolthouse Farms	Crop management

Table 2. Multi-Commodity Project Stakeholder Committee

The second phase of the Multi-Commodity Project began with SureHarvest obtaining a CDFA Specialty Crop Block Grant to finish the self-assessment template with the Multi-Commodity Leadership Team and Stakeholder Committees and then fine-tune the template into workbooks for individual specialty crops working with willing growers and stakeholders from each specialty crop community. The self-assessment workbook for carrots which is presented on the following pages was developed using the Multi-Commodity self-assessment template through a series of reviews and edits by growers, other stakeholders and SureHarvest staff. Troy Elliott and Phillip Northover of Bolthouse Farms were particularly helpful during the review process. The final version was produced by SureHarvest and submitted to CDFA along with their final report in June of 2013.

Air Quality Management

Pressure is being brought to bear on urban and rural industries, including agriculture, to reduce air pollutants in the Great Central Valley of California. This section of the self-assessment will help the grower identify practices that influence air quality, highlight where the grower is doing well, and determine areas that need improvement.

Air Quality Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In Field and Adjacent Land					
1.1 To minimize airborne dust and PM10[5] particles a reduced tillage program is in place					
1.2 To minimize airborne dust and PM10 particles a no-till program is in place					
1.3 If tillage is done, moisture content of the soil is taken into consideration to minimize dust					
1.4 An every row permanent cover crop is maintained in perennial crops					
1.5 Vegetation is maintained on non-cropped areas such as headlands, roadsides, and field edges to reduce wind erosion causing airborne dust					
1.6 Crop residues are either chipped and/or incorporated into the soil or composted rather than burned					
Roads					
2.1 Vehicle speed is restricted on dirt roads around fields to minimize airborne dust					
2.2 Dirt roads are treated with an anti-dust agent that meet the 50% PM10 control for a Fugitive PM10 Management Plan[6] 9 (note: committee recommended put the list in this document, it will be added to the fine-tuned workbooks. The list is about 2 pages long, see the website below for copy)					
2.3 Dirt roads are graveled, watered, chipped, mulched (crop residues), sanded or seeded					
2.4 Heavily used roads are paved (e.g. main thoroughfares on farm)					
Engines and Fuel Consumption					

[5] PM 10 are particles 10 microns in diameter or smaller and pose a health risk because they pass through the throat and nose and penetrate the lungs.
[6] For details see http://www.airquality.nrcs.usda.gov/Documents/files/Dust_Control_Products.htm

3.1 Engines are maintained on a regular schedule to ensure they are running at optimum performance and efficiency and emissions are minimized					
3.2 At least some vehicles are equipped with engines able to use alternative fuels with lower emissions (e.g., compressed natural gas, flex fuel, biodiesel, propane)					
3.3 Some off-road farm vehicles are battery powered (e.g. golf carts)					
3.4 Vehicle miles are tracked on an annual basis					
3.5 Stationary diesel engines have been replaced (or retrofitted) to Tier 3 or better					
3.6 Stationary diesel engines have been replaced (or retrofitted) with technology relying on cleaner burning fuel (e.g. propane, natural gas, biodiesel) or replaced with electric pumps					
3.7 Selection of vehicle power plants and stationary engines is in part determined by lower emissions ratings					
3.8 Some of the farm's energy requirements are obtained through renewable sources such as wind, solar, bio-methane, and/or biofuels					
Pesticide Management and Air Quality					
4.1 Soil fumigants are used only when necessary and applied appropriately (e.g. pre-planting where soil sampling has identified a significant pest problem, proper soil moisture conditions exist and that all regulations have been met)					
4.2 When choosing a pesticide to apply its VOC 'footprint' is considered[7]					
4.3 Practices are implemented that reduce pesticide drift such as use of air induction nozzles, turning sprayers off at turn-arounds, not spraying when a temperature inversion exists in the field, and when wind exceeds 10 mph or the velocity specified on the label.					
Greenhouse Gas Emissions					
5.1 I am aware of the role of CO_2, nitrous oxide (N_2O), and methane (CH_4) as greenhouse gases and where they are produced in my farming operations					
5.2 CO_2 and N_2O production are calculated and tracked					

What are VOC's?

VOC stands for volatile organic compound. These are carbon based compounds contained in products used on the farm, such certain pesticides, that volatilize (evaporate) when exposed to the air. Ground-based ozone is produced by chemical reactions involving VOC's, nitrogen oxides (NOx) and sunlight. While not direct air pollutants themselves, VOC's are important ozone precursors and considered key targets for reduction in the Central Valley of California in

[7] A VOC calculator is found at: http://apps.cdpr.ca.gov/voc-calculator/

regions where air quality is an issues. The California Department of Pesticide regulation does not know the reactivity of every VOC and ideally reactivity should be used to precisely determine VOC emissions. That said, appropriate data and analytical methods do exist at this time to make accurate estimates. The Department does hope to use reactivity at some point in the future. It calculates VOC emissions based on the best available science (Dr Matt Fossen, pers. comm., Environmental Scientist, Calif. Dept. Pesticide Regulation). Air Quality and greenhouse gas emissions are such important topics in the Central Valley of California it is important to consider the various sources of potential air quality problems.

Energy Management

Energy is essential for crop production and it comes in several forms; as sunlight to power photosynthesis, as fuel to power our internal combustion motorized vehicles and pumps, and as electricity to power our shop and office lights and electronic equipment. Tracking energy is very important because it is getting more and more expensive all the time, increasing our cost of production. Burning of fuel produces greenhouse gases (GHGs) affecting air quality and contributing to climate change. So minimizing energy consumption saves money and reduces GHG production. Completing this section should help improve your understanding of energy use in your operation and encourage you to consider some forms of energy conservation.

Energy Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 The total amount (gallons) of fuel used annually on the farm in all operations is recorded and year to year comparisons are made. Each fuel type is recorded.					
1.2 The total amount of fuel used annually per acre and per unit of crop production is determined and year-to-year comparisons are made[8]					
1.3 The total amount of fuel used annually is calculated for each field and year-to-year comparisons are made. Each fuel type is recorded.					
1.4 Annual fuel consumption and/or electrical use for irrigation pumps is recorded and comparisons made from year-to-year.					
1.5 Electrical use for office(s), shop(s), and outdoor security lighting is tracked using energy bills and year-to-year comparisons are made					
1.6 Fuel and electricity used are converted to a common metric such as British thermal units (Btu) so they can be combined to calculate the total amount of energy used annually for crop production and year to year comparisons are made[9]					
1.7 The amount of energy used annually per acre and per unit of crop production is calculated and year to year comparisons are made					
1.8 The amount of energy used annually in each field is calculated and year-to-year comparisons are made					

[8] This can be a simple calculation of dividing the total gallons of fuel used for the year divided by the total amount of crops produced for the year

[9] Energy conversion calculators for kilowatt hours to BTU's and gas or diesel to BTU's are readily and freely available on the Internet. For example using Google type 'convert gas to BTU's and you will be directed to a website where a calculator is available to make your conversion. Simply type in the number of gallons of gas and the calculator will produce the number of BTU's it represents.

1.9 An energy management plan is being implemented on the farm that includes yearly goals for overall energy use as well as energy used per unit of crop production.[10]					
1.10 A process is in place to ensure that the most appropriate piece of equipment is used for a given job (e.g. the most appropriate horse power engine for the job)					
1.11 One or more solar energy systems are installed on the property to generate electricity					
1.12 One or more wind generators are installed on the property to generate electricity					
1.13 Residue from crop production is used in a cogeneration plant					
1.14 Engines (stationary and mobile) and motors are maintained on a regular schedule to ensure they are running at an optimum fuel efficiency or optimum efficiency.					
1.12 Pumping plant efficiency (energy per acre foot pumped) is checked every 1 to 3 years (based on use) and adjustments made if necessary (FSU website recommends every 1-3 years based on use)					
1.13 At least some light switches are fitted with motion detectors or photo cells to reduce time of use					
1.14 At least some office and shop lights have been fitted with low energy consumption compact florescent or LED lights.					

Indirect Energy Use/Consumption:

Energy is directly expended when driving a vehicle, operating a pump, photocopying, or turning on and using a light bulb. Energy is also expended to manufacture inputs that are used on the farm, such as fertilizers, compost and pesticides. This type of energy consumption is called imbedded energy. If you want to figure out the total amount of energy consumed to produce a crop then calculations should also be made to determine the amount of embedded energy that was consumed to produce the fertilizers, compost, and pesticides that were used to produce the crop.

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[10] Ideally one would convert all energy consumption to BTU's (British Thermal Units) but initial energy management plans could start with using gallons of gasoline and diesel and kilowatt hours for electricity.

Financial Management

The economic E of sustainable farming is literally where the buck stops. If a farm is not profitable, it is not sustainable. People farm not because they want to be accountants. They farm because they want to grow things. However, while financial management may be a challenging part of farming, doing it well is one of the keys to a successful and sustainable farm. This chapter will help the grower recognize strengths in financial management as well as point out areas where improvements are needed.

Financial Management **(The most appropriate person to fill out this section/chapter is the CEO/owner of the farm)**	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Planning and Risk Management					
1.1 A marketing and production plan has been developed for my farm and seasonal outcomes are compared to these plans					
1.2 A succession[11] plan is in place for the farm					
1.3 I have a written will and estate plan for the farm[12]					
1.4 A business continuation plan (disaster[13] management plan) has been developed for the farm					
1.5 A risk management plan has been developed for the farm					
1.6 Key personnel in the company have health insurance					
1.7 Key personnel in the company have disability insurance					
1.8 Key personnel have life or accidental death insurance					
Accounting and Financial Analyses					
2.1 I use a financial accounting system to track and report farm finances and use it to make decisions about my farming operation					
2.2 I understand how to interpret both cash and accrual financial statements including a balance sheet, income statement, cash flow, and financial ratios					
2.3 I meet with a financial advisor on an annual basis					
2.4 Financial profitability analyses for investments are done if investments are made					

[11] A succession plan is one where the change in leadership in the company has been determined, whether it is expected such as the CEO voluntarily stepping down/retiring, or unexpected such as due to illness or accident.
[12] An estate plan is a plan for the financial assets to pass from one generation to the next. It does not deal with the human and intellectual capital and passing that transition to the next generation. That is succession planning.
[13] Disaster in this case is not just weather but also unexpected death of one or more key company personnel.

2.5 The revenue and returns are tracked for each field/management unit in my financial management reports					
2.6 Costs and returns are tracked for all important farming practices					
2.7 Costs and returns are tracked for implementing new sustainability practices and compared to costs and returns of practices they replaced					
2.8 Sensitivity analysis, i.e. change in crop prices over time, is used to analyze financial risk over time					
Purchasing and Borrowing					
3.1 More than one quote is obtained for major input purchases such as pesticides and fertilizers					
3.2 Interest rates and services from more than one lending institution are compared before borrowing a significant amount of money					

Food Safety Management

What is safe food? This is a question that is being debated by everyone all along the supply chain. New food safety compliance is costing some growers a lot of money. When you think about it, proving a food to be safe is a very difficult thing to do because in reality one has to prove that it is not safe.

Food Safety Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Food Safety Management Planning					
1.1 A written food safety policy is in place for the farm that includes a commitment to food safety, how it is implemented, and how it is communicated to the employees.					
1.2 A written food safety plan is in place that identifies all locations of the farm and products covered by the plan. The plan addresses potential physical, chemical, and biological hazards and hazard control procedures, including monitoring, verification and record keeping, for the following areas: water, soil amendments, field sanitation, production environment and worker practices					
1.3 The food safety plan is reviewed at least annually					
1.4 Record keeping is kept to demonstrate the food safety plan is being followed					
1.5 A person has been designated as being responsible for food safety functions on the farm					
1.6 All employees are trained in food safety procedures and practices on the farm					
Food Safety Risk Assessment of Field					
2.1 An assessment has been made of the production field focusing on the likelihood of intrusions by animals that pose significant food safety risks (e.g. deer, pigs, livestock) and, if necessary, actions are taken to reduce the likelihood of intrusion					
2.2 An evaluation has been made on land and waterways adjacent to the field for possible sources of human pathogens of concern (e.g. manure storage, CAFOs, grazing/open range areas, surface water, sanitary facilities and composting operations)					
2.3 An assessment of historical land use has been made to determine any potential issues from these uses that might impact food safety (e.g. hazardous waste sites, landfills, etc.)					
2.4 My company participates in a third party food safety certification					

program (e.g. Agriculture Marketing Service GAP Certified, Scientific Certification Systems, Primus. Global GAP)					
Water					
3.1 The water system description for the field/ranch has been created that indicates, either with drawings or maps, the location of permanent fixtures, such as pumps, wells, underground lines, gates & valves reservoirs, and returns					
3.2 Irrigation water and water used in harvest operations is tested for microbial quality, and if microbial levels are above specific action levels, corrective actions are taken					
3.4 Records of all water tests are retained, along with Certificates of Analysis, for at least 2 years					
3.5 Irrigation pipe and drip tape are stored in a manner that reduces or eliminates the potential for pest infestation					
3.6 Water applied to edible portions of the crop, either as overhead irrigation or pesticide applications, is tested for microbial quality					
Organic Soil Amendments					
4.1 Raw manure or a soil amendment that contains un-composted or incompletely composted or non-thermally treated animal manure is not applied to field					
4.2 If compost is applied, it is sourced from a supplier that provided their written Standard Operating Procedures that prevents cross-contamination of finished compost with raw materials through equipment, runoff or wind.					
4.3 If organic soil amendments are used microbial testing is performed by the supplier prior to application					
Sanitation					
5.1 Toilet facilities are readily available to all field employees and are located according to Cal OSHA regulations					
5.2 Toilet facilities are clean and maintained on a regular basis					
5.3 Field employees are trained on the importance of sanitation in the field					
5.4 Field sanitation units are accessible to all employees					
5.5 A response plan is in place in the event of a spill from toilet or sanitation facilities and employees are trained to implement it					
5.6 Workers are educated on sanitation issues such as not working on the job while sick or injured (e.g. infected cuts)					
Harvesting and Transportation					
6.1 A traceability system is in place and appropriate for my crop					
6.2 A mock recall has been done to check the effectiveness of the traceability system (mock recalls would usually be done in conjunction with a packer/shipper or processor)					

6.3 All harvesting containers and bulk hauling vehicles that come into direct contact with the harvest crop are cleaned and/or sanitized on a scheduled basis using a written record system					
6.4 Packaging materials used in field operations are properly stored and protected from contamination					
6.5 Harvesting equipment that comes into contact with the crop is kept in good repair					

Soil Management

Soil is the most complex ecosystem on earth. Gaining a greater understanding of the soil resource in your fields is critical for making informed soil management decisions. Knowing your soil resource gives you greater control over yield and crop quality and is especially important in determining the long-term sustainability of your farm.

Soil provides the crop with three vital things: water, nutrients and air. These three things are best provided by a soil with good depth and structure i.e. a soil in which the particles are bound together into small clumps (aggregates) of varying size. Soil aggregation is a measure of soil structure. Soil organic matter is important in maintaining soil structure by gluing soil minerals together into aggregates. Spaces between large aggregates (measured as millimeters) permit rapid drainage and easy root growth, and spaces between small aggregates (measured as less 1 millimeter down to 0.001 millimeter) trap water for use between irrigation and rain events. One of the more important aspects controlling aggregate stability is the amount of microbial activity and soil organic matter. Stable aggregates occur in varying sizes and are created by the cementing action of microbes and their byproduct and soil organic matter. The assemblage of soil aggregates creates habitat to promote faunal and microbial diversity, an important index of soil quality. Due to the warm to hot California climate soil organic matter is low in many soils due to rapid breakdown of soil organic matter.
The following self-assessment template will help document the practices producers are using to managing their soil sustainably as well as suggest areas where improvements might be possible.

Soil Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Knowledge of soil properties					
1.1 The soil types in the field has/have been identified using NRCS soils maps					
1.2 The soil types in the field has/have been identified using soil samples taken pre-planting					
1.3 Soil properties for each soil type in the field is recorded, including soil moisture holding capacity, texture, and rooting depth					
1.4 A soil sample has been taken in the field more than 6 years ago and analyzed for macro and micro nutrients					
1.5 A soil sample has been taken in the field within the last 6 years and analyzed for macro and micro nutrients as well as soil chemistry (e.g. pH, CEC, salts)					
1.6 A soil sample has been taken in the field within the last 4 years and analyzed for macro and micro nutrients as well as soil chemistry (e.g. pH, CEC, salts)					

1.7 A soil sample has been taken in the field within the last 2 years and analyzed for macro and micro nutrients as well as soil chemistry (e.g. pH, CEC, salts)					
1.8 If soil pH is less than 5.5 it is amended with lime and if it is above 8.0 it is amended with an acidifying agent					
Soil properties management					
2.1 If water infiltration is poor (water puddles and runs off when soil is dry underneath) the soil is amended either chemically (e.g. with gypsum or organic matter such as compost or manure) or physically (e.g. chiseling or shallow ripping)					
2.2 Cover crops are planted to add organic matter and nutrients to the soil and to improve water infiltration					
2.3 If soil organic matter is low for the soil series in my field I have an ongoing program to build soil organic matter either through additions of compost, manure and growing cover crops or a combination of them					
2.4 Equipment is chosen or is modified to minimize soil compaction (e.g. lightest equipment possible, track-layers, wider or bigger diameter tires, tire pressures as low as possible)					
2.5 Conservation tillage is practiced					
2.6 Tillage passes are fewer than most neighboring farms producing the same commodity					
2.7 Tillage passes are about the same as most neighboring farms producing the same commodity.					
2.8 Surface tillage is practiced on a regular basis					
2.9 Deep tillage is practiced on a regular basis					
Crop nutrition management					
3.1 I have a written crop nutrient management plan that uses a 'budgeting approach'[14] in determining the nutrient needs of the crop and takes into consideration factors like crop tissue analyses, soil type, time of year, soil moisture, crop load, etc. (insert an educational box discussing the 4 R's of nutrient management; see http://www.ipni.net/4r)					
3.2 The crop's nutrient management plan is based solely on the recommendations as given by my field consultant and/or from the soil testing lab					
3.3 With the help of my field consultant I am able to interpret the lab results from the field soil samples and we use them in the crop nutrient management plan					
3.4 I am able to interpret the lab results from the soil samples and I use					

[14] A budgeting approach means that the amount of nutrients leaving the field in the crop is estimated and the amount of nutrients added back to the field is based on this estimate. A one -to-one replacement is not implied or required since factors such as soil type affect nutrient availability to the crop and these factors must also be taken into account.

them in my crop nutrient management plan					
3.5 Plant tissue are taken and analyzed at least once a season and used to help assess crop nutrient needs					
3.6 I record from year-to-year the amount of nitrogen applied per acre and calculate the amount of N applied per unit crop production					
3.7 I record from year-to-year the amount of phosphorus applied per acre and calculate the amount of P applied per unit crop production					
3.8 I record from year-to-year the amount of potassium applied per acre and calculate the amount of K applied per unit crop production					
3.9 Fertilizers are applied using fertigation through drip tape					
3.10 The total amount of nitrogen needed for the season is applied in one application					
3.11 The total amount of nitrogen needed for the season is applied in a split application(s)					
3.12 Fertilizers are applied using a 'spoon feeding' approach where only the amount of nutrients required by the crop at the time are applied and multiple applications are made throughout the growing season based on crop growth stage and nutrient demand					
3.13 Micro nutrients are applied on a regular basis without reference to crop needs or crop history					
3.14 Micro nutrients are applied based on past crop history					
3.15 Micro nutrients are applied based on soil sample test results					
3.16 Micro nutrients are applied based on crop tissue sample test results					
Soil erosion					
4.1 Vegetation is maintained along farm roads, on field edges, and along irrigation canals not controlled by the irrigation district					
4.2 I know the infiltration/run-off rates of the field's soil and the rate of irrigation water is applied and is adjusted according					
4.3 No tillage is done on field borders or along irrigation canals					
4.4 Ditches have been grassed or hardened to prevent downcutting					
4.5 Culverts are properly sized to accommodate high flows, and inlets and outlets have been hardened to prevent scour or energy dissipaters have been installed					

Ecosystem Management

An ecosystem is the complex community of living organisms and their physical environment functioning as an ecological unit. Components of an ecosystem are inseparable and interrelated. An ecosystem management approach to growing specialty crops acknowledges that people are a part of and have a significant impact on ecosystem structures and processes, and that people depend on and must assume responsibility for the ecological, economic, and social systems where they live. Ecosystem management is currently being encouraged and implemented by communities, government agencies, businesses, academics and various conservation organizations throughout the world[15].

Ecosystem Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Habitat maintenance and enhancement					
1.1 Field borders, roadsides, and ditch-banks are kept free of vegetation					
1.2 Hedgerows of trees and/or shrubs are maintained on at least some field edges					
1.3 Vegetation such as grasses, trees or shrubs are maintained along roadsides, ditch-banks and headlands					
1.4 Vernal pools or swales are preserved and managed with setbacks to reduce probability of soil disturbance					
1.5 Trees have been planted to provide habitat for wildlife					
1.6 Trees are maintained to provide habitat for wildlife					
1.7 Nesting boxes for owls have been placed around the farm and they are cleaned annually					
1.8 Perches for raptors have been placed around the farm					
1.9 If water courses exist on my property crops are planted up to the edge of water courses					
1.10 If water courses exist on my property setbacks are in place to minimize disturbance					
1.11 If water courses exist on my property resident vegetation is maintained on the banks					
1.12 If water courses exist on my property banks are vegetated with a mix of grasses, trees and shrubs					
Whole farm issues					
2.1 I am an active member in the local watershed coalition					
2.2 I participate in a watershed stewardship planning group if one exists in my region					
2.3 Invasive pests (e.g. puncture vine, arundo) are monitored for and when found removed from the farm					
2.4 A formal or informal environmental survey of the farm has been done noting the presence of sensitive areas, such as vernal pools, swales, oak trees, habitat for endangered species, and other					

[15] Reeves, K. 2008. Chapter 1. Ecosystem Management *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 15- 63.

environmental features which affect farming and actual farmable acres such as an NRCS conservation survey[16]					
2.5 I manage my property to protect and/or enhance habitat for threatened and endangered species					
2.6 Some or all of the natural areas of my property is protected by a conservation easement (see education box below)					
2.7 Some or all of my property are protected by an agricultural easement program					
2.8 The farm is managed to optimize ecosystem services such as wildlife, pollinators, and/or arthropod natural enemies and increased biodiversity (see box below for definition of an ecosystem service)					
2.9 Indicators of biodiversity on the farm are monitored and recorded, such as animal and plant populations , pollinators, or arthropod natural enemies					
2.10 Unfarmed areas are maintained to increase biodiversity on the farm including wildlife, pollinators and/or arthropod natural enemies					

Education box: What is an ecosystem service?

The biological communities in an agricultural ecosystem provide benefits over and above the commercial crops they produce. These benefits are known as ecosystem services. They include removing carbon dioxide from the atmosphere, reducing greenhouse gases, the recycling of nutrients, regulation of microclimate and local hydrological processes, in some cases they result in the suppression of pest plants and animals through the production of pest natural enemies, and detoxification of noxious chemicals that enter the environment.

Education Box: What are Conservation and Agricultural Easements?

Conservation easements for protection of natural resources are legal agreements that allow landowners to donate or sell some "rights" on portions of their land to a public agency, land trust, or conservation organization. In exchange, the owner agrees to restrict development and farming in natural habitat, and assures the easement land remains protected in perpetuity. A 1996 study conducted by the National Wetlands Conservation Alliance indicated that the leading reasons landowners restored wetlands were to provide habitat for wildlife; to leave something to future generations; and to preserve natural beauty. Only 10% of landowners surveyed in the study restored wetlands solely for financial profit. This would also apply to other habitats besides wetlands. A conservation easement can provide you with financial benefits for the protection, enhancement, and restoration efforts for the natural environments on your property. The belief that natural resources such as wildlife, especially sensitive species, will reduce your land value is not true. Many easement programs include some sort of cash payment for a portion of the costs associated with habitat restoration and enhancement.

[16] NRCS has a lot of resources available for helping with environmental planning on the farm. Contact your local NRCS office and see if they can help you.

Agricultural conservation easements are for the explicit purpose of keeping farmland in production. They are similar to natural resource conservation easements, but, specifically protect farmland and maintain the practice of farming. In 1996, the state established the California Farmland Conservancy Program to protect farmland by buying easements. Based on a study conducted by UC Cooperative Extension and published in 2002, there were 34 local conservation organizations, land trusts, and open space districts that protect farmland through conservation easements (see – *Agricultural Easements: New Tool for Farmland Protection California Agriculture*, January-February 2002, Volume 56:No. 1). Local opportunities may exist for one or both kinds of conservation easements on your property.

Pest Management

Integrated pest management (IPM) is a fundamental part of any sustainable farming program. It is cost-effective, flexible, and resilient. IPM was developed to respond to some significant pest management challenges that developed in the 1950's and 1960's. Events such as the development pesticide resistance by many pests, secondary pest outbreaks, and environmental contamination due to the use of certain problematic pesticides led a forward-looking group of entomologists at the University of California to conclude that agriculture was heading toward a pest management crisis. They realized we had forgotten the fact that pest problems are complex and connected to ecosystem processes. They concluded that the solutions to complex ecological problems must be broad-based and take the farm ecosystem into account. These researchers developed the IPM concept to meet the pest management crisis. Since its inception in 1959, IPM has evolved into the best way to manage pest problems on the farm.

University of California Statewide IPM Program crafted the following as the definition of IPM[17]:
Integrated Pest Management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.

Farming is carried out within the ecosystem and is a long-term endeavor so we want to use management practices that are ecosystem-based and long-term in nature. By using a combination of control techniques to manage a pest problem, we develop a broad-based management strategy that will still be successful even if one particular technique does not work. Also, based on our experience with chemical controls, we know that pest control decisions must take into account not only economic risks, but effects on the environment and people's health, as well[18].

Pest Management **(Could be worthwhile including a list of or pictures of pests of all type to be sure—they are aware of what pests exist)** **My pest management bias**	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pest Management Framework for Farm					
1.1 I have an integrated pest management framework/plan for my farm that takes into account the landscape within which I farm, an					

[17] http://www.ipm.ucdavis.edu/IPMPROJECT/about.html
[18] Ohmart, C. P. and C. P. Storm. 2008. Chapter 6. Pest Management. *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 187- 267.

understanding of the cropping system and how it affects the population levels of key pests, includes monitoring protocols and economic thresholds for key pests, monitoring protocols and important pest natural enemies, and the key biological, cultural and chemical control options available for key pests					
1.2 Each year I review the pest management framework with all those involved in pest management on my farm and make adjustments according to my goals and pest management results from the past year					
Risk Assessment					
2.1 Key pests for my farm have been identified in the following groups: diseases, nematodes, insects, mites, weeds, mammals and birds; and targeted for management					
2.2 Monitoring protocols have been established and are followed for key pests (if available)					
2.3 I and/or my Pest Control Advisor (PCA) have established and use economic thresholds for key pests					
2.4 I and/or my PCA keep written spray records containing the information required by California Department of Pesticide Regulation as well as weather conditions and effectiveness					
2.5 I am aware of the environmentally sensitive areas in and near my field such as distance to ground water, surface water, wetlands, vernal pools, swales, houses, schools, public and private roads					
2.6 I have mapped the environmentally sensitive areas in and near my field such as distance to ground water, surface water, wetlands, vernal pools, swales, houses, schools, public and private roads					
Monitoring					
3.1 I and/or my PCA follow the UC IPM year round program for my crop if available for my crop					
3.2 I and/or my PCA use the UC IPM pest management guidelines if available for my crop					
3.3 I and/or my PCA use the UC IPM pest management manual if available for my crop					
3.4 I monitor pest populations in my fields					
3.5 A licensed Pest Control Advisor monitors pest populations in my fields or personnel working with the PCA monitor pest outbreaks					
3.6 I and/or my PCA monitor for pest natural enemies if they are important in controlling key pests and take their numbers in consideration when making pest management decisions					
3.7 Cultural factors, such as time to harvest, preexisting plant damage, plant moisture stress, plant health, and crop load, are considered in pest management decision-making if they have significant effects on the risk of damage due to key pests					
3.8 I or my PCA keeps qualitative (descriptive) written pest monitoring records and they get shared during the decision making process					

3.9 I and/or my PCA keeps quantitative (numeric) written pest monitoring records and they get shared during the decision making process					
3.10 If I rely on pest management recommendations from a PCA, I and/or my farm manager review with them the pest situation before making a decision to take a management action					
3.11 I encourage my crew supervisors and farm managers to report any pest problem that is out of the ordinary (e.g. pests they have never seen before) and report it to the appropriate person					
3.12 Pictures of important invasive pests are posted in convenient places so employees can monitor for their presence					
Pesticide Management					
4.1 'Smart'[19] sprayers are used when applying pesticides to some or all of my fields					
4.2 Pesticide drift is minimized by using technologies such as air induction nozzles, or some pesticides are applied using chemigation (including drip tape, solid set and pivots)					
4.3 I rotate the use of pesticides according to 'mode of action' to minimize development of resistance					
4.4 I keep a written record of pesticide use by 'mode of action' (FRAC Group Number) as a part of my pesticide resistance strategy					
4.5 A written spray drift management plan has been drawn up for each field that includes a map of the field and location of sensitive areas and sprayer operators follow the plan					
4.6 Calibration and spray coverage tests are done at least once a season on my sprayer and are based on manufacturers' recommendations as well as site characteristics such as crop canopy present					
4.7 Buffer zones have been established for each field based on pesticide label specifications as well as adjacent crops and other sensitive sites					
4.8 Sprays are timed such that there is minimal or no human activity in adjacent areas					
4.9 Dormant season pesticide applications are made when wind speeds exceed 10mph[20]					
4.10 Dormant sprays are not done in dead calm when a temperature inversion exists to avoid long distance pesticide drift					
4.11 Sprayer nozzles are shutoff at row ends near environmentally sensitive areas					
4.12 There is a berm around the wellhead that prevents surface water running from the perimeter to the wellhead					
4.13 Pesticide mixing and loading area is more than 100 feet from the wellhead unless it is protected by a berm or other physical characteristics that prevent surface water running from the perimeter					

[19] A smart sprayer is one equipped with sensors that detect present or absence of target and shuts off when target is not present.
[20] CDPR Rule for Dormant Season Insecticides Fact Sheet

to the wellhead					
4.14 A separate water supply tank is used for pesticide mixing or chemicals are added to the tank at least 100 feet away from the well.					
4.15 Either a double-check valve, reduced pressure principle backflow prevention device or an air gap is in place and maintained between the well pump and sprayer tank[21]					
4.16 Pesticide mixing and loading is done using a closed system or with water soluble pesticide packets when available for the pesticide being applied					
4.17 Spray mixing, loading and calibration is planned so that the tank is empty at the end of the spray job					
4.18 I use the following safe pesticide storage practices: dry pesticides stored above liquids, pesticides are stored more than 300 feet from nearest well, storage area has impermeable floor and sump to contain leaks, an only undamaged containers are stored					
4.19 I have an emergency response plan for pesticide and fertilizer spills and exposure posted in the appropriate places					
4.20 Workers are trained to follow the emergency response plan for pesticide spills or exposure					
4.21 A pesticide risk model such as PRiME[22], WIN PST or UC IPM's Water Tox[23] is used when considering which pesticides to apply					
4.22 The VOC 'footprint' of a pesticide is considered when deciding which pesticides to apply[24]					
Prevention and Cultural Practices					
5.1 I use resistant (if available) or more tolerant varieties/rootstocks to manage some of my key pests					
5.2 I use crop rotation to manage some of my key pests					
5.3Timing of planting of crops to avoid key pests					
Biological control					
6.1 I monitor for pest natural enemies if they are important in controlling my key pests					
6.2 If a pest natural enemy is important for a key pest I implement practices that augment their populations like planting cover crops, nectar sources and avoid using pesticides that may be harmful to natural enemies					
6.3 I release pest natural enemies that have been proven to be effect controls for a key pest					
6.4 Conservation of pest natural enemies is considered when choosing a pesticide to use in the field					

[21] This is a legal requirement
[22] PRiME is the Pesticide Risk Mitigation Engine and can be accessed at http://ipmprime.org/cigipm/
[23] The model output is accessible at http://www.ipm.ucdavis.edu by viewing the webpage for the pest in question and clicking on the link labeled 'Water Quality Compare Treatments)
[24] http://apps.cdpr.ca.gov/voc-calculator/

6.5 Conservation of natural enemies is considered when deciding on spray timing					
6.6 I establish areas adjacent to the field to augment natural enemies by growing plants that provide shelter, nectar, and pollen for them					
Effects of Pest Management on Non-Target Sites & Organisms					
7.1 Effects of a pesticide on pollinators are considered when selecting the material to apply					
7.2 I am a member of the local Irrigated Lands Water Quality Coalition					
7.3 Effects of a pesticide on non-target organisms existing on my farm, such as birds and small mammals, are considered when selecting the material to apply					

Social Responsibility

Human Resources Management	Not Familiar	Familiar, not tried	Have tried it	Currently Use	Not applicable
Staffing and Recruiting Strategy					
1.1 A long term (2-5 years) staffing and recruiting strategy is in place					
1.2 A variety of recruiting methods is used depending on job opening, e.g. word of mouth, newspaper, web recruiting, job fair, temporary or contract services					
1.3 A standard interviewing process is used in recruitment which includes a specific set of review questions					
1.4 A job description exists for each type of job and it is given to the employee and their supervisor					
1.5 Job descriptions are reviewed and updated at least once every two years					
1.6 For non-seasonal employees, an exit interview is conducted to determine why employees left the company					
Employee Orientation, Safety Training, and Career Development					
2.1 An orientation program is provided for new non-seasonal employees					
2.2 Safety training is done according to Cal OSHA regulations, i.e. when employee begins a new job assignment, or any new process, procedure or use of a substance or equipment that creates a new hazard					
2.3 All new employees undergo safety training					
2.4 If labor is contracted, a check is made to ensure contract labor company adheres to all relevant Cal OSHA safety regulations					
2.5 Safety statistics such as time lost due to accidents are tracked and retained for at least 2 years					
2.6 Employees are instructed as necessary to attend training seminars or other educational programs at least once a year that enhance their skills in the workplace					
2.7 Employees are encouraged to attend training seminars or other educational programs at least once a year that enhance their skills in the workplace (e.g. SpraySafe)					
2.8 My company pays for training when required and/or provides tuition reimbursement for work-related college classes					
2.9 A formal career planning process is in place for non-seasonal employees					

2.10 Every non-seasonal employee is provided an employee handbook that includes at a minimum the company's work standards and policies and an overview of benefits					
2.11 The employee handbook is written in an appropriate language(s)					
2.12 An employee meeting is held at least once a year to discuss company goals and to exchange ideas					
2.13 A meeting of top management is held annually to discuss company goals and exchange ideas					
Staying Informed					
3.1Trade journals/appropriate trade literature (including literature on worker issues, safety issues, Farm Bureau, trade association literature, etc.) are made available for the farm management team (FMT) to read					
3.2 The FMT has current membership in local grower association(s)					
3.3 The FMT regularly attend regional and/or statewide industry meetings (e.g. irrigation district, Farm Bureau, Water Coalition, etc), trade shows (e.g. World Ag Expo), and seminars (e.g. UC, CDFA, CSU seminars, research meetings from Commodity Boards)					
3.4 The FMT takes a leadership role in local, regional or state industry associations (e.g. Western Growers, California Grape & Tree Fruit League, Grower-Shipper Association)					
Performance, discipline, grievance process, and employee recognition					
4.1 A job performance process is in place and is linked to pay and promotions					
4.2 A form and process is in place for employees to comment on job satisfaction					
4.3 My company has a grievance process in place and it is documented in the employee handbook					
4.4 Filed grievances are recorded and processed in a timely manner					
4.5 A formal process is in place by which employees are recognized for good job performance and/or years of service					
4.6 A suggestion box is provided in a convenient location so that employees can provide ideas for improvements in company practices, working environment, and other areas.					
Health benefits, paid time off, and other benefits					
5.1 Basic health benefits are provided to non-seasonal employees					
5.2 Non-seasonal employees have paid holidays and vacation time					
5.3 Employees are provided sick leave and/or personal days					
5.4 Non-seasonal employees are provided (or employees are encouraged to) a formal pension plan or a company 401k					

Community Support	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 My company is involved in regional land use planning					
1.2 My company is involved in initiatives, through time commitment and/or donations, that enhance the community such as the Chamber of Commerce, schools/education programs, churches, public health, affordable housing					
1.3 My company is involved in regional water issues such as the regional water quality coalition, irrigation districts, ground water use planning, and/or the irrigated lands waiver program planning					

Waste Management

Sustainable agriculture provides a strategy for managing all aspects of your farming enterprise, including the management of the crop, soil, water, pests and human resources. It also relates to your farms infrastructure as well such as your offices and shop. While the most interesting part of sustainable farming addresses what happens in the field it is important not to forget important issues like waste management. In a lot of situations, waste management is one of the most straightforward processes to address on the farm.

Waste Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In field, shop and office					
1.1 The farm has a written waste management plan that includes waste reduction goals, recycling goals, hazardous material use reduction goals					
1.2 Crop residue or crop byproduct is recycled by either selling to another user (e.g. for cattle feed, co-generator/digester), composted, or returned to the field for incorporation into the soil					
1.3 The farm has an established recycling program for metal, cardboard, plastics, paper and glass					
1.4 The value of recycling is part of the orientation and training of employees					
1.5 The amount of metals, cardboard, plastics, paper and glass recycled annually vs. the amounts thrown away is determined and year to year comparisons are made					
1.6 The number of tires, batteries used per year and the amount of lubricants purchased vs the amount sent back or recycled per year is recorded and year to year comparisons are made					
1.7 All unused or worn out items such as appliances, tractors, ATVs, electrical equipment, are taken to the proper recycling centers for disposal					
1.8 The total amount of hazardous materials, other than pesticides and fertilizers, present on the farm is known and their use is tracked on an annual basis (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.9 Employees are trained on the proper handling and disposal of hazardous materials (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.10 Employees are trained on legal requirements related to cleaning of					

farm equipment with water or steam cleaners and the resulting runoff					
1.11 Hazardous materials no longer used, as well as their containers, are disposed of according to legal requirements					
1.12 The farm participates in the pesticide container recycling program[25]					
1.13 Dumpsters and/or recycling containers are on cement pads to contain spills					
1.14 Dumpsters and/or recycling containers are covered to keep out rain					
1.15 Dumpsters and/or recycling containers are periodically inspected for leaks, spills, and litter. Problems noticed are corrected					
1.16 Bi-lingual signs are posted near the dumpster and/or recycling containers indicating what can or cannot be put in the container					

[25] Use the following link to find out how to participate in an Ag Container recycling program: http://www.acrecycle.org/contact_us.html

Water Management and Water Quality

California is the leading agriculture state in the US by a significant amount. This is due in large part to the high value of the many specialty crops grown in the state. It is also due to the excellent growing conditions such as fertile soils, a Mediterranean climate and the availability of affordable high quality surface and ground water for irrigation. California is also the most populace state in the US and therefore affordable high quality water is needed to support this population. It is clear that because of the demands for high quality, affordable water, this critical resource needs to be used efficiently and effectively by specialty crop producers. The following template will help document practices producers are using to achieve optimum water quality and use efficiency as well as bring to their attention areas where improvements can possibly be made.

Irrigation Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pre-plant Planning					
1.1 Pre-plant analyses of the site was done to identify factors that affect quantity of irrigation water delivery and percolation rate such as existence of soil compaction, a root restricting layer, soil type, soil texture, soil chemistry (pH, salinity, etc.) and soil organic matter					
1.2 Ripping, plowing, chiseling, or other practices were implemented if pre-plant soil tests indicated water percolation and/or drainage problems					
1.3 Soil amendments were applied to correct soil chemical or physical issues if sampling identified factors that would affect water percolation					
1.4 Water source was sampled and evaluated for water quality					
1.5 The irrigation system was designed to deliver the quantity of water required for the crop and accommodate for variation in topography as well as in soil texture that affects water percolation and water holding capacity					
Irrigation Scheduling & Rates					
2.1 I measure and record the total amount of water used in each field every season and calculate water use per unit of crop production.					
2.2 I have a written water management plan for my field(s) that includes goals for the growing season and takes into consideration annual rainfall, crop variety, crop maturity, water-related pest management issues, soil type, soil preparation, slope, water quality, irrigation efficiency, irrigation uniformity, energy efficiency					
2.3 Irrigation is initiated at the start of the season based on visual cues from the crop					

2.4 Irrigation is initiated at the start of the season based on measured soil moisture depletion					
2.5 Irrigation is initiated at the start of the season based on directly measuring plant moisture stress (e.g. with pressure bomb)					
2.6 Irrigation scheduling is influenced by peak energy pricing					
2.7 Water percolation rate and infiltration depth is monitored during the irrigation season					
2.8 Soil moisture depletion is estimated by visual inspection of the crop (e.g. growth or development) that indicates plant water stress (that is clearly not attributed to a pest problem)					
2.9 Soil moisture depletion is tracked through soil coring					
2.10 Soil moisture depletion is tracked using soil-installed moisture monitoring devices					
2.11 Soil moisture depletion is tracked by directly measuring plant moisture stress (e.g. with a pressure bomb)					
2.12 Amount of irrigation and timing are dictated by the amount and timing of water available through my Water District					
2.13 Amount of irrigation and timing are based on visual cues of the crop					
2.14 Amount of irrigation is and timing are based on irrigation history from past growing seasons					
2.15 Amount of irrigation and timing are based on historical crop evapotranspiration (ET)					
2.16 Water demand of the crop is estimated by determining ETo[26] through using data from the nearest CIMIS weather station and used in irrigation rate and scheduling					
2.17 Water demand from the crop is estimated by converting ETo to Etc by using the appropriate crop coefficient factor (Kc) which takes into account crop canopy and used in irritation rate and scheduling					
2.18 When appropriate less than full water demand is applied to the crop (deficit irrigation)					
Irrigation Performance and System Maintenance – Pumps & Filters					
3.1 Pumping plant efficiency has been measured within at least the last 3 years (for areas where water table fluctuates considerably pumping plant efficiency should be checked at least once very 2 years)					
3.2 Pumping plant efficiency has been measured within at least the last 5 years					
3.3 Energy use for irrigation is tracked on an annual basis and related to unit of production					
3.4 Electrical irrigation pumps are on time of use metering					
3.5 If pumping efficiency is significantly reduced I have improved it					

[26] ETo is the reference evapotranspiration and is calculated using measurements of climatic variables including solar radiation, humidity, temperature and wind speed and is expressed in inches or millimeters of water. It is based on water use for a short mowed full coverage grass crop.

3.6 Diesel irrigation pumps are Tier 2 or higher					
3.7 A flow meter is installed on wells and/or pumps and I monitor and record the flows					
3.8 Pressure check points are installed on key lines from pumps					
3.9 Filters status (and flushing system) is manually checked at least twice a season and corrected if necessary					
3.10 Pressure gauges are installed for measuring pressure drops through filters					
Irrigation Performance & System Maintenance – Drip & Micro-sprinklers					
4.1 Distribution uniformity of the irrigation system is tested at least every 2 years					
4.2 The system has pressure compensating emitters to help maintain system distribution uniformity					
4.3 The irrigation system is monitored for leaks, breaks, and clogging every irrigation					
4.4 The irrigation system is monitored for leaks, breaks, and clogging at least once a season					
4.5 Fertigation is used to apply most of the fertilizers for the field					
4.6 An interlock system is installed so injection pump shuts down if irrigation pump shuts down to prevent water source contamination					
4.7 Irrigation lines are flushed at the start of the season and then again at mid season, or more often as needed					
Irrigation Performance & System Maintenance – Sprinklers					
5.1 The irrigation system is monitored for leaks, breaks, and clogging every irrigation					
5.2 The irrigation system is monitored for leaks, breaks, and clogging at least once a season					
5.3 Sprinkler head rotation and nozzle clogging have been checked within the last 12 months and repaired if necessary					
5.4 Sprinkler head rotation and nozzle clogging are checked at least every other irrigation and repaired if necessary					
5.5 Sprinkler heads have been checked for wear in the past 5 years and replaced with the correct nozzle size if necessary to maintain distribution uniformity					
5.6 Fertigation is used to apply most of the fertilizers for the field					
5.7 An interlock system is installed so injection pump shuts down if irrigation pump shuts down to prevent water source contamination					
Irrigation Performance & System Maintenance – Flood & Furrow					
6.1 The field was laser leveled before planting the crop					
6.2 Levee locations in the field are based on observed infiltration rates (i.e. each check is appropriately sized for maximum water application uniformity)					
6.3 Irrigation produces no tail-water					

6.4 Irrigation produces tail-water and a tail-water recovery system is in place					
6.5 Flower meters are installed and flow volumes recorded on lines from pumps or in supply pipelines or ditches (e.g. Weir notch or Parshall flume) or a record of flow volumes is provided by the water district					
Water quality – Source and resource					
7.1 Irrigation water is tested at least every 3 years for quality, including pH, total salt, nitrates, and biological problems. The quality of water in distribution reservoirs is tested if they are present on the farm.					
7.2 If a water quality problem exists it is addressed					
7.3 I have accessed resource maps to determine if my field(s) are in Ground Water Protection Areas (GWPA)[27]					
7.4 If a field is in a GWPA I have accessed and read the legal requirements for handling restricted use pesticides in GWPA areas and they are on file in the office					
7.5 I have identified and mapped areas on the farm that are potential sites for pesticides and fertilizers to enter the ground water					
7.6 The wellhead is situated so no surface water can reach it or a berm has been placed around the wellhead that prevents surface water from reaching it					
7.7 Return water wells, older wells and abandoned wells are sealed to prevent ground water contamination					
7.8 Irrigation practices create no off-site movement of chemical residues and sediments					
7.9 If storm water run-off occurs one or more of the following mitigation practices are implemented: filter fabric fencing; filter strip; straw bale check dam; straw bale water bars; sediment basin; or other containment system					
7.10 Cover crops/vegetation is maintained on drain ditches and non-paved minor roadways to minimize rainfall run-off from field					
7.11 Soil percolation problems in the field have been addressed to minimize off-site movement of irrigation or storm water					

[27] http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpamaps.htm

Self-Assessment for Cherry Production

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Funded by a California Department of Food and Agriculture
Specialty Crop Block Grant to SureHarvest

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Introduction

In the business world, sustainability has come to mean "the concept and practice of balancing *economic prosperity*, *environmental stewardship*, and *social responsibility* so they together lead to an improved quality of life for ourselves and future generations." In other words, being a sustainable business involves:

- being able to stay in business by being profitable
- taking care of the environment
- being a good employer and neighbor.

Project History

Over the last 10 years the field of sustainable agriculture has become more and more important in the eyes of food retailers, buyers and consumers. As is often the case when new concerns arise in relation to food and food production, the spot light shines on the grower. Sustainable agriculture is challenging to define, and once defined it can be challenging for a grower to figure out how to implement it on the farm in an economically viable way. To meet these challenges a group of specialty crop trade associations, NGO's, and other specialty crop stakeholders met to discuss the topic of sustainable agriculture. One outcome of these discussions was an application to the California Department of Food and Agriculture Specialty Crop Block grant program for funds to hire sustainable agriculture professionals to help develop a plan to meet the challenges presented by sustainable agriculture. The Great Valley Center coordinated the grant application and engaged SureHarvest to provide the technical expertise. SureHarvest is a company with extensive experience in sustainable agriculture strategic planning, program design, and program implementation. The grant application was successful and began in September of 2009. The Great Valley Center directed the project and contracted with SureHarvest for project design, facilitation and implementation.

The grant had two primary goals. The first was to develop, through a stakeholder process, a sustainable agriculture strategic plan that each of the participating groups could use internally to help lay the foundation for their own sustainable agriculture program specific to their specialty crop. The second was to develop a tool, or tools, that could be used by their member growers to put the strategic plan into action on the farm.

The following paragraphs contain the sustainable agriculture strategic plan developed by the project leadership team, the members of which are listed in Table 1.

Sustainability Strategic Plan for the Multi-Commodity Project

The sustainability strategic plan for the Multi-Commodity Project is based on SureHarvest's 5 P's of sustainability framework. The 5 P's are: Principles, Processes, Practices, Performance Metrics, and Progress. They are defined as follows:

1. Principles – This is the sustainable vision for the project. It consists of the goals that the participants want to achieve from the design and implementation of the project.

2. Processes – These are the resource areas on the farm that need to be addressed in order to meet the principles or goals of the project. For example, this could be water, energy, and human resources management.
3. Practices – These are the practices that are implemented on the farm that impact the processes or resource areas. They are the on-the-ground actions that are carried out to assure that the principles or goals of the sustainable program are met.
4. Performance Metrics – These are the metrics used to measure the outcomes resulting from the practices implemented on the farm. There are many - examples include crop quality, water use, energy use, and worker satisfaction. Performance Metrics are used to measure the level of success in meeting the principles or goals of the project.
5. Progress – The process used to improve performance over time and communicate the results internally and externally. In other words, tracking the degree of progress one is making towards achieving the goals of the project. Measuring progress will require some kind of system for assessing the farm's performance over time, creating action plans to improve particular areas of performance, and reassessment over time to track progress.

Table 1. Multi-Commodity Project Leadership Team

Organization	**Representative**
Almond Board of California	Gabriele Ludwig*, Robert Curtis*
Bolthouse Farms	Troy Elliott*, Justin Groves*
California Grape & Tree Fruit League	Chris Valadez*, Barry Bedwell
California Specialty Crop Council	Lori Berger*
California Garlic & Onion Research Advisory Board	Robert Ehn
California Olive Council	Patty Darragh
California Pear Advisory Board	Bob McClain
California Pepper Commission	Glen Fischer*
California Pistachio Board	Robert Klein*
California Raisin Marketing Board	Gary Schultz
California Tomato Farmers	Ed Beckman*
California Tree Fruit Agreement	Gary VanSickle*, Lauren Friedman
California Walnut Board	David Ramos
Del Monte Foods	Pat McCaa
Sun-Maid Growers	Rick Stark*

*Leadership Team Member

Multi-Commodity Project Principles (1st P):

The principles for the Multi-Commodity Project were established by the Project Leadership Team. They are:

1. Create a resource area/practice template that:
    a. Will focus on increasing the economic performance for the participant.
    b. Is scalable and can be used by participating groups to accomplish the goals of their own sustainability programs.

   c. Provides the participant the ability to gauge the state of sustainability of the industry and their farm.
   d. Encourages continual improvement on the farm.
   e. As a whole encourages ecological harmony.
   f. Better defines the 3 E's of sustainability (economic viability, environmental soundness and social equity/responsibility) in a way we can all agree upon.
   g. Is open to and usable by any individual or group in the future that was not involved in the original effort.
   h. Benefit the participants and not result in unintended negative consequences.
2. The program should provide the information/data needed for groups to tell their sustainability story better to all their audiences, e.g. buyers, regulators, consumers, NGO's.
3. The outcomes from the project cause no harm to producers.

The Leadership Team of the Multi-Commodity Project decided the best tool for implementing their sustainability strategic plan was a self-assessment of practices template that stakeholders from specific specialty crops could then fine tune for their own use. The team chose to use the model developed by the California Sustainable Almond Program (CASP), which is a California Almond Board program developed in partnership with SureHarvest. The Leadership Team formed a stakeholder committee to draft the self-assessment template that covered the practice areas listed in the Multi-Commodity Project Strategic Plan. The Stakeholder Committee members are listed in Table 2.

Individual Contact	Title	Expertise
Billy Heller	Grower, Pacific Triple E Farms	Crop management
Bob Giampaoli	Grower, Live Oak Farms	Crop management
Cliff Sadoian	Grower	Crop management
Pat McCaa	Manager, Pest Management, Del Monte Foods	Crop management
Mechel S. Paggi (Mickey)	Director, Center for Agricultural Business, California State University, Fresno	Ag Business & economics
Glen Fischer	Ag Representative, Saticoy Foods Inc.	Crop management
John Trumble	Professor of Entomology, University of California Riverside	Pest management
Jeff Mitchell	Extension Specialist, University of California, Davis	Soils & plant nutrition
Pete Goodell	UC IPM Area Advisor, University of California, Davis	Pest management
Terry Prichard	Extension Specialist, University of California, Davis	Irrigation & crop water relations
Bill Peacock	Representing raisin growers via the Raisin Marketing Board and Tree Fruit Growers	Crop management
Troy Elliott	Director of Agronomy, Bolthouse Farms	Crop management

Table 2. Multi-Commodity Project Stakeholder Committee

The second phase of the Multi-Commodity Project began with SureHarvest obtaining a CDFA Specialty Crop Block Grant to finish the self-assessment template with the Multi-Commodity Leadership Team and Stakeholder Committees and then fine-tune the template into workbooks for individual specialty crops working with willing growers and stakeholders from each specialty crop community. The self-assessment workbook for cherries which is presented on the following pages was developed using the Multi-Commodity self-assessment template through a series of reviews and edits by growers, other stakeholders and SureHarvest staff. The Cherry Research Advisory Board was particularly helpful during the review process. The final version was produced by SureHarvest and submitted to CDFA along with their final report in June of 2013.

Air Quality Management

We all appreciate good air quality. Unfortunately, the San Joaquin Valley is out of attainment of the Federal Clean Air Act. Because of this, the region is under threat of losing federal highway dollars if attainment cannot be achieved. Therefore, a lot of pressure is being brought to bear on urban and rural industries, including agriculture, to reduce air pollutants in the Valley in any way possible. This section of the self-assessment will help you identify practices that influence air quality, see where you are doing well, and determine areas that need improvement.

Air Quality Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In Orchard and Adjacent Land					
1.1 To minimize airborne dust and PM10[5] particles, a reduced tillage program is in place					
1.2 Mulch, either plastic or natural material, is used in the orchard to minimize dust (and conserve soil moisture)					
1.3 To minimize airborne dust and PM10 particles, a cover crop is maintained at least every other row					
1.4 An every row permanent cover crop is maintained					
1.5 Vegetation is maintained on non-cropped areas such as headlands, roadsides, and orchard edges to reduce wind erosion causing airborne dust					
1.6 Crop residues or prunings are either chipped and/or incorporated into the soil or composted rather than burned					
1.7 Burning is restricted and only done when necessary, such as when taking out an old orchard or vineyard, and is done in strict accordance with the law					
Roads					
2.1 Vehicle speed is restricted on dirt roads around orchards to minimize airborne dust					
2.2 Dirt roads are treated with an anti-dust agent that meets the 50% PM10 control for a Fugitive PM10 Management Plan[6] 9 (note: committee recommended the list be placed in this document. It will be added to the fine-tuned workbooks. (The list is about 2 pages long, see the website below for copy.)					

[5] PM 10 are particles 10 microns in diameter or smaller and pose a health risk because they pass through the throat and nose and penetrate the lungs.
[6] For details see http://www.airquality.nrcs.usda.gov/Documents/files/Dust_Control_Products.htm

2.3 Dirt roads are graveled, watered, chipped, mulched (crop residues), sanded or seeded					
2.4 Heavily used roads are paved (e.g. main thoroughfares on farm)					
Engines and Fuel Consumption					
3.1 Engines are maintained on a regular schedule to ensure they are running at optimum performance and efficiency and emissions are minimized					
3.2 At least some vehicles are equipped with engines able to use alternative fuels with lower emissions (e.g., compressed natural gas, flex fuel, biodiesel, propane)					
3.3 Some off-road farm vehicles are battery powered (e.g. golf carts)					
3.4 Vehicle miles are tracked on an annual basis					
3.5 Stationary diesel engines have been replaced (or retrofitted) to Tier 3 or better					
3.6 Stationary diesel engines have been replaced (or retrofitted) with technology relying on cleaner burning fuel (e.g. propane, natural gas, biodiesel) or replaced with electric pumps					
3.7 Selection of vehicle power plants and stationary engines is in part determined by lower emissions ratings					
3.8 Some of the farm’s energy requirements are obtained through renewable sources such as wind or solar					
Pesticide Management and Air Quality					
4.1 Soil fumigants are used only when necessary and applied appropriately (e.g. pre-planting where soil sampling has identified a significant pest problem, proper soil moisture conditions exist and that all regulations have been met)					
4.2 When choosing a pesticide to apply, its VOC ‘footprint’ is considered[7]					
4.3 Practices are implemented that reduce pesticide drift such as use of air induction nozzles, turning sprayers off at turn-arounds, not spraying when a temperature inversion exists in the orchard, and when wind exceeds 10 mph or the velocity specified on the label					
Greenhouse Gas Emissions					
5.1 I am aware of the role of CO_2, N_2O, and methane as greenhouse gases and where they are produced in my farming operations					
5.2 CO_2 and N_2O production are calculated and tracked					

What are VOC’s?

[7] A VOC calculator is found at: http://apps.cdpr.ca.gov/voc-calculator/

VOC stands for volatile organic compound. These are carbon based compounds contained in products used on the farm, such as certain pesticides that volatilize (evaporate) when exposed to the air. Ground-based ozone is produced by chemical reactions involving VOC's, nitrogen oxides (NOx) and sunlight. While not direct air pollutants themselves, VOC's are important ozone precursors and considered key targets for reduction in the Central Valley of California, a region where air quality is an issue. The California Department of Pesticide regulation does not know the reactivity of every VOC.Ideally, reactivity should be used to precisely determine VOC emissions. That said, appropriate data and analytical methods do exist at this time to make accurate estimates. The Department does hope to use reactivity at some point in the future. It calculates VOC emissions based on the best available science (Dr Matt Fossen, pers. comm., Environmental Scientist, Calif. Dept. Pesticide Regulation). Air Quality and greenhouse gas emissions are such important topics in the Central Valley of California, it is important to consider the various sources of potential air quality problems.

Energy Management

Energy is essential for crop production and it comes in several forms; as sunlight to power photosynthesis, as fuel to power our internal combustion motorized vehicles and pumps, and as electricity to power our shop, office lights and electronic equipment. Tracking energy is very important because it is getting more and more expensive all the time, increasing our cost of production. Burning of fuel produces GHG's affecting air quality and contributing to climate change. So, minimizing energy consumption saves money and reduces GHG production. Completing this section should help improve your understanding of energy use in your operation and encourage you to consider some forms of energy conservation.

Energy Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 The total amount (gallons) of fuel used annually on the farm in all operations is recorded and year to year comparisons are made. Each fuel type is recorded.					
1.2 The total amount of fuel used annually is calculated for each orchard and year-to-year comparisons are made. Each fuel type is recorded.					
1.3 Annual fuel consumption and/or electrical use for irrigation pumps are recorded and comparisons made from year-to-year.					
1.4 Electrical use for office(s), shop(s), and outdoor security lighting is tracked using energy bills and year-to-year comparisons are made					
1.5 A process is in place to ensure that the most appropriate piece of equipment is used for a given job (e.g. the most appropriate horse power engine for the job)					
1.6 One or more solar energy systems are installed on the property to generate electricity					
1.7 One or more wind generators are installed on the property to generate electricity					
1.78 Engines (stationary and mobile) and motors are maintained on a regular schedule to ensure they are running at an optimum fuel efficiency or optimum efficiency.					
1.9 Pumping plant efficiency (energy per acre foot pumped) is checked every 1 to 3 years (based on use) and adjustments made if necessary (FSU website recommends every 1-3 years based on use)					
1.10 At least some light switches are fitted with motion detectors or photo cells to reduce time of use					
1.11 At least some office and shop lights have been fitted with low					

energy consumption compact florescent bulbs or LED lights.					

Indirect Energy Use/Consumption:

Energy is directly expended when driving a vehicle, operating a pump, photocopying, or turning on and using a light bulb. Energy is also expended to manufacture inputs that are used on the farm, such as fertilizers, compost and pesticides. This type of energy consumption is called imbedded energy. If you want to figure out the total amount of energy consumed to produce a crop, then calculations should also be made to determine the amount of embedded energy that was consumed to produce the fertilizers, compost, and pesticides that were used to produce the crop.

Financial Management

The economic E of sustainable farming is literally where the buck stops. If a farm is not profitable, it is not sustainable. People farm not because they want to be accountants. They farm because they want to grow things. However, while financial management may be a burdensome part of farming, doing it well is one of the keys to a successful and sustainable farm. This chapter will help you recognize where your strengths are in financial management as well as point out areas where improvements are needed.

Financial Management **(The most appropriate person to fill out this section/chapter is the CEO/owner of the farm)**	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Planning and Risk Management					
1.1 A marketing and production plan has been developed for my farm and seasonal outcomes are compared to these plans					
1.2 A succession[8] plan is in place for the farm					
1.3 I have a written will and estate plan for the farm[9]					
1.4 A business continuation plan (disaster[10] management plan) has been developed for the farm					
1.4 A risk management plan has been developed for the farm					
1.5 Key personnel in the company have health insurance					
1.6 Key personnel in the company have disability insurance					
1.7 Key personnel have life or accidental death insurance					
Accounting and Financial Analyses					
2.1 I use a financial accounting system to track and report farm finances and use it to make decisions about my farming operation					
2.2 I meet with a financial advisor on an annual basis					
2.3 Financial profitability analyses for investments are done if investments are made					
2.4 The revenue and returns are tracked for each orchard/management unit in my financial management reports					
2.5 Costs and returns are tracked for all important farming practices					

[8] A succession plan is one where the change in leadership in the company has been determined, whether it is expected, such as the CEO voluntarily stepping down/retiring, or unexpected, such as due to illness or accident.
[9] An estate plan is a plan for the financial assets to pass from one generation to the next. It does not deal with the human and intellectual capital and passing that transition to the next generation. That is succession planning.
[10] Disaster in this case is not just weather, but also unexpected death of one or more key company personnel.

2.6 Costs and returns are tracked for implementing new sustainability practices and compared to costs and returns of practices they replaced					
2.7 Sensitivity analysis, i.e. change in crop prices over time, is used to analyze financial risk over time					
Purchasing and Borrowing					
3.1 More than one quote is obtained for major input purchases such as pesticides and fertilizers					
3.2 Interest rates and services from more than one lending institution are compared before borrowing a significant amount of money					

Food Safety Management

What is safe food? This is a question that is being debated by everyone all along the supply chain. New food safety compliance is costing some growers a lot of money. When you think about it, proving a food to be safe is a very difficult thing to do because in reality, one has to prove that it is not safe.

Food Safety Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Food Safety Management Planning					
1.1 A written food safety policy is in place for the farm that includes a commitment to food safety, how it is implemented, and how it is communicated to the employees.					
1.2 A written food safety plan is in place that identifies all locations of the farm and products covered by the plan. The plan addresses potential physical, chemical, and biological hazards and hazard control procedures, including monitoring, verification and record keeping, for the following areas: water, soil amendments, orchard sanitation, production environment and worker practices					
1.3 The food safety plan is reviewed at least annually					
1.4 Records are kept to demonstrate the food safety plan is being followed					
1.5 A person has been designated as being responsible for food safety functions on the farm					
1.6 All employees are trained in food safety procedures and practices on the farm					
Food Safety Risk Assessment of Orchard					
2.1 An assessment has been made of the production orchard, focusing on the likelihood of intrusions by animals that pose significant food safety risks (e.g. deer, pigs, livestock) and, if necessary, actions are taken to reduce the likelihood of intrusion					
2.2 An evaluation has been made on land and waterways adjacent to the orchard for possible sources of human pathogens of concern (e.g. manure storage, CAFO's, grazing/open range areas, surface water, sanitary facilities and composting operations)					
2.3 An assessment of historical land use has been made to determine any potential issues from these uses that might impact food safety (e.g. hazardous waste sites, landfills, etc.)					

2.4 My company participates in a third party food safety certification program (e.g. Agriculture Marketing Service GAP Certified, Scientific Certification Systems, Primus. Global GAP)					
Water					
3.1 The water system description for the orchard/ranch has been created that indicates, either with drawings or maps, the location of permanent fixtures, such as pumps, wells, underground lines, gates & valves reservoirs, and returns					
3.2 Irrigation water and water used in harvest operations is tested for microbial quality, and if microbial levels are above specific action levels, corrective actions are taken					
3.4 Records of all water tests are retained, along with Certificates of Analysis, for at least 2 years					
3.5 Irrigation pipe and drip tape are stored in a manner that reduces or eliminates the potential for pest infestation					
3.6 Water applied to edible portions of the crop, either as overhead irrigation or pesticide applications, is tested for microbial quality					
Organic Soil Amendments					
4.1 Raw manure or a soil amendment that contains un-composted, or incompletely composted, or non-thermally treated animal manure, is not applied to orchard					
4.2 If compost is applied, it is sourced from a supplier that provided their written Standard Operating Procedures that prevent cross-contamination of finished compost with raw materials through equipment, runoff or wind.					
4.3 If organic soil amendments are used, microbial testing is performed by the supplier prior to application					
Sanitation					
5.1 Toilet facilities are readily available to all orchard employees and are located according to Cal OSHA regulations					
5.2 Toilet facilities are clean and maintained on a regular basis					
5.3 Orchard employees are trained on the importance of sanitation in the orchard					
5.4 Orchard sanitation units are accessible to all employees					
5.5 A response plan is in place in the event of a spill from toilet or sanitation facilities, and employees are trained to implement it					
5.6 Workers are educated on sanitation issues such as not working on the job while sick or injured (e.g. infected cuts)					
Harvesting and Transportation					
6.1 A traceability system is in place and appropriate for my crop					
6.2 A mock recall has been done to check the effectiveness of the traceability system (mock recalls would usually be done in					

conjunction with a packer/shipper or processor)					
6.3 All harvesting containers and bulk hauling vehicles that come into direct contact with the harvested crop are cleaned and/or sanitized on a scheduled basis using a written record system					
6.4 Packaging materials used in orchard operations are properly stored and protected from contamination					
6.5 Harvesting equipment that comes into contact with the crop is kept in good repair					

Soil Management

Soil is the most complex ecosystem on earth. Gaining a greater understanding of the soil resource in your orchards is critical for making informed soil management decisions. Knowing your soil resource gives you greater control over yield and crop quality, and is especially important in determining the long-term sustainability of your farm.

Soil provides the crop with three vital things: water, nutrients and air. These three things are best provided by a soil with good depth and structure, i.e. a soil in which the particles are bound together into small clumps (aggregates) of varying size. Soil aggregation is a measure of soil structure. Soil organic matter is important in maintaining soil structure by gluing soil minerals together into aggregates. Spaces between large aggregates (measured as millimeters) permit rapid drainage and easy root growth, and spaces between small aggregates (measured as less 1 millimeter down to 0.001 millimeter) trap water for use between irrigation and rain events. One of the more important aspects controlling aggregate stability is the amount of microbial activity and soil organic matter. Stable aggregates occur in varying sizes and are created by the cementing action of microbes and their byproduct, and soil organic matter. The assemblage of soil aggregates creates habitat to promote faunal and microbial diversity, an important index of soil quality. Due to the warm to hot California climate, soil organic matter is low in many soils due to rapid breakdown of soil organic matter.

The following self-assessment template will help document the practices producers are using to manage their soil sustainably, as well as suggest areas where improvements might be possible.

Soil Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Knowledge of soil properties					
1.1 The soil types in the orchard has/have been identified using NRCS soils maps					
1.2 The soil types in the orchard has/have been identified using soil samples taken pre-planting (for permanent crops, soil pits were dug to establish soil series)					
1.3 Soil properties for each soil type in the orchard are recorded, including soil moisture holding capacity, texture, and rooting depth					
1.4 A soil sample has been taken in the orchard more than 6 years ago and analyzed for macro and micro nutrients					
1.5 A soil sample has been taken in the orchard within the last 6 years and analyzed for macro and micro nutrients, as well as soil chemistry (e.g. pH, CEC, salts)					
1.6 A soil sample has been taken in the orchard within the last 4 years and analyzed for macro and micro nutrients as well as soil chemistry					

(e.g. pH, CEC, salts)					
1.7 A soil sample has been taken in the orchard within the last 2 years and analyzed for macro and micro nutrients as well as soil chemistry (e.g. pH, CEC, salts)					
1.8 If soil pH is less than 5.5, it is amended with lime, and if it is above 8.0 it is amended with an acidifying agent					
Soil properties management					
2.1 If water infiltration is poor (water puddles and runs off when soil is dry underneath), the soil is amended either chemically (e.g. with gypsum or organic matter such as compost or manure) or physically (e.g. chiseling or shallow ripping)					
2.2 Cover crops are planted to add organic matter and nutrients to the soil and to improve water infiltration					
2.3 For permanent crops, resident vegetation is allowed to grow as a cover crop to add organic matter to the soil and improve water infiltration					
2.4 If soil organic matter is low for the soil series in my orchard, I have an ongoing program to build soil organic matter either through additions of compost, manure and growing cover crops, or a combination of them					
2.5 Equipment is chosen or is modified to minimize soil compaction (e.g. lightest equipment possible, track-layers, wider or bigger diameter tires, tire pressures as low as possible)					
2.6 The soil is never tilled unless a problem develops that requires one pass to alleviate the problem (e.g. soil is too uneven for safe operation of equipment)					
2.7 Tillage is done every 5 years or less (this does not include aerating the soil with equipment like an Aerway)					
2.8 Tillage is done every 3 to 5 years					
2.9 Tillage is done every year					
Crop nutrition management					
3.1 I have a written crop nutrient management plan that uses a 'budgeting approach'[11] in determining the nutrient needs of the crop and takes into consideration factors like crop tissue analyses, soil type, time of year, soil moisture, crop load, etc. (insert an educational box discussing the 4 R's of nutrient management; see http://www.ipni.net/4r)					
3.2 The crop's nutrient management plan is based solely on the recommendations as given by my orchard consultant and/or from the					

[11] A budgeting approach means that the amount of nutrients leaving the orchard in the crop is estimated and the amount of nutrients added back to the orchard is based on this estimate. A one -to-one replacement is not implied or required since factors such as soil type affect nutrient availability to the crop and these factors must also be taken into account.

soil testing lab					
3.3 With the help of my orchard consultant I am able to interpret the lab results from the orchard soil samples and we use them in the crop nutrient management plan					
3.4 Plant tissue are taken and analyzed at least once a season and used to help assess crop nutrient needs					
3.5 I record from year-to-year the amount of nitrogen applied per acre and calculate the amount of N applied per unit of crop production					
3.6 I record from year-to-year the amount of phosphorus applied per acre and calculate the amount of P applied per unit crop of production					
3.7 I record from year-to-year the amount of potassium applied per acre and calculate the amount of K applied per unit crop of production					
3.8 Fertilizers are applied using Fertigation					
3.9 The total amount of nitrogen needed for the season is applied in one application					
3.10 The total amount of nitrogen needed for the season is applied in a split application(s)					
3.11 Fertilizers are applied using a ‘spoon feeding’ approach where only the amount of nutrients required by the crop at the time are applied and multiple applications are made throughout the growing season based on crop growth stage and nutrient demand					
3.12 Micro nutrients are applied on a regular basis without reference to crop needs or crop history					
3.13 Micro nutrients are applied based on past crop history					
3.14 Micro nutrients are applied based on soil sample test results					
3.15 Micro nutrients are applied based on crop tissue sample test results					
Soil erosion					
4.1 Vegetation is maintained along farm roads, on orchard edges, and along irrigation canals not controlled by the irrigation district					
4.2 I know the infiltration/run-off rates of the orchard’s soil and the rate of irrigation water is applied and is adjusted accordingly					
4.3 No tillage is done on orchard borders or along irrigation canals					
4.4 Ditches have been grassed or hardened to prevent downcutting					
4.5 Culverts are properly sized to accommodate high flows, and inlets and outlets have been hardened to prevent scour or energy dissipaters have been installed					

Ecosystem Management

An ecosystem is the complex community of living organisms and their physical environment functioning as an ecological unit. Components of an ecosystem are inseparable and interrelated. An ecosystem management approach to growing specialty crops acknowledges that people are a part of and have a significant impact on ecosystem structures and processes, and that people depend on and must assume responsibility for the ecological, economic, and social systems where they live. Ecosystem management is currently being encouraged and implemented by communities, government agencies, businesses, academics and various conservation organizations throughout the world[12].

Ecosystem Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Habitat maintenance and enhancement					
1.1 Orchard borders, roadsides, and ditch-banks are kept free of vegetation					
1.2 Hedgerows of trees and/or shrubs are maintained on at least some orchard edges					
1.3 Vegetation such as grasses, trees or shrubs are maintained along roadsides, ditch-banks and headlands					
1.4 Vernal pools or swales are preserved and managed with setbacks to reduce probability of soil disturbance					
1.5 Trees have been planted to provide habitat for wildlife					
1.6 Trees are maintained to provide habitat for wildlife					
1.7 Nesting boxes for owls have been placed around the farm					
1.8 If water courses exist on my property, crops are planted up to the edge of water courses					
1.9 If water courses exist on my property, setbacks are in place to minimize disturbance					
1.10 If water courses exist on my property, resident vegetation is maintained on the banks					
1.11 If water courses exist on my property, banks are vegetated with a mix of grasses, trees and shrubs					
Whole farm issues					
2.1 I am an active member in the local watershed coalition					
2.2 I participate in a watershed stewardship planning group if one exists					

[12] Reeves, K. 2008. Chapter 1. Ecosystem Management *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 15- 63.

in my region					
2.3 Invasive pests (e.g. puncture vine, arundo) are monitored for and when found, removed from the farm					
2.4 A formal or informal environmental survey of the farm has been done, noting the presence of sensitive areas, such as vernal pools, swales, oak trees, habitat for endangered species, and other environmental features which affect farming and actual farmable acres, such as an NRCS conservation survey[13]					
2.5 I manage my property to protect and/or enhance habitat for threatened and endangered species					
2.7 Some or all of the natural areas of my property is protected by a conservation easement (see education box below)					
2.8 Some or all of my property is protected by an agricultural easement program					
2.9 The farm is managed to optimize ecosystem services such as wildlife, pollinators, and/or arthropod natural enemies and increased biodiversity (see box below for definition of an ecosystem service)					
2.10 Indicators of biodiversity on the farm are monitored and recorded, such as animal and plant populations, pollinators, or arthropod natural enemies					
2.11 Unfarmed areas are maintained to increase biodiversity on the farm including wildlife, pollinators and/or arthropod natural enemies					

What is an ecosystem service?

The biological communities in an agricultural ecosystem provide benefits over and above the commercial crops they produce. These benefits are known as **ecosystem services**. They include removing carbon dioxide from the atmosphere, reducing greenhouse gases, the recycling of nutrients, regulation of microclimate and local hydrological processes. In some cases, they result in the suppression of pest plants and animals through the production of pest natural enemies, and detoxification of noxious chemicals that enter the environment.

What are Conservation and Agricultural Easements?

Conservation easements for protection of natural resources are legal agreements that allow landowners to donate or sell some "rights" on portions of their land to a public agency, land trust, or conservation organization. In exchange, the owner agrees to restrict development and farming in natural habitat, and assures the easement land remains protected in perpetuity. A 1996 study conducted by the National Wetlands Conservation Alliance indicated that the leading reasons landowners restored wetlands were to provide habitat for wildlife; to leave something to future generations; and to preserve natural beauty. Only 10% of landowners surveyed in the study restored wetlands solely for financial profit. This would also apply to other habitats besides wetlands. A conservation easement can provide you with financial benefits for the protection,

[13] NRCS has a lot of resources available for helping with environmental planning on the farm. Contact your local NRCS office and see if they can help you.

enhancement, and restoration efforts for the natural environments on your property. The belief that natural resources such as wildlife, especially sensitive species, will reduce your land value is not true. Many easement programs include some sort of cash payment for a portion of the costs associated with habitat restoration and enhancement.

Agricultural conservation easements are for the explicit purpose of keeping farmland in production. They are similar to natural resource conservation easements, but, specifically protect farmland and maintain the practice of farming. In 1996, the state established the California Farmland Conservancy Program to protect farmland by funding the purchase of easements. Based on a study conducted by UC Cooperative Extension and published in 2002, there were 34 local conservation organizations, land trusts, and open space districts that protect farmland through conservation easements (see – *Agricultural Easements: New Tool for Farmland Protection California Agriculture,* January-February 2002, Volume 56:No. 1). Local opportunities may exist for one or both kinds of conservation easements on your property.

Pest Management

Integrated pest management (IPM) is a fundamental part of any sustainable farming program. It is cost-effective, flexible, and resilient. IPM was developed to respond to some significant pest management challenges that developed in the 1950's and 1960's. Events such as the development pesticide resistance by many pests, secondary pest outbreaks, and environmental contamination due to the use of certain problematic pesticides, led a forward-looking group of entomologists at the University of California to conclude that agriculture was heading toward a pest management crisis. They realized we had forgotten the fact that pest problems are complex and connected to ecosystem processes. They concluded that the solutions to complex ecological problems must be broad-based and take the farm ecosystem into account. These researchers developed the IPM concept to meet the pest management crisis. Since its inception in 1959, IPM has evolved into the best way to manage pest problems on the farm.

University of California Statewide IPM Program crafted the following as the definition of IPM[14]:
Integrated Pest Management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.

Farming is carried out within the ecosystem and is a long-term endeavor so we want to use management practices that are ecosystem-based and long-term in nature. By using a combination of control techniques to manage a pest problem, we develop a broad-based management strategy that will still be successful even if one particular technique does not work. Also, based on our experience with chemical controls, we know that pest control decisions must take into account not only economic risks, but effects on the environment and people's health, as well[15].

Pest Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pest Management Framework for Farm					
1.1 I have an integrated pest management framework/plan for my farm that takes into account the landscape within which I farm, an					

[14] http://www.ipm.ucdavis.edu/IPMPROJECT/about.html
[15] Ohmart, C. P. and C. P. Storm. 2008. Chapter 6. Pest Management. *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 187- 267.

understanding of the cropping system and how it affects the population levels of key pests, includes monitoring protocols and economic thresholds for key pests, monitoring protocols and important pest natural enemies, and the key biological, cultural and chemical control options available for key pests					
1.2 Each year I review the pest management framework with all those involved in pest management on my farm and make adjustments according to my goals and pest management results from the past year					
Risk Assessment					
2.1 Key pests for my farm have been identified in the following groups: diseases, insects, mites, weeds, mammals and birds; and targeted for management					
2.2 Monitoring protocols have been established and are followed for key pests					
2.3 I and/or my Pest Control Advisor (PCA) have established and use economic thresholds for key pests					
2.4 I and/or my PCA keep written spray records containing the information required by California Department of Pesticide Regulation as well as weather conditions and effectiveness					
2.5 I am aware of the environmentally sensitive areas in and near my orchard such as distance to ground water, surface water, wetlands, vernal pools, swales, houses, schools, public and private roads					
2.6 I have mapped the environmentally sensitive areas in and near my orchard such as distance to ground water, surface water, wetlands, vernal pools, swales, houses, schools, public and private roads					
Monitoring					
3.1 I and/or my PCA follow the UC IPM year round program for my crop if available for my crop					
3.2 I and/or my PCA use the UC IPM pest management guidelines if available for my crop					
3.3 I and/or my PCA use the UC IPM pest management manual if available for my crop					
3.4 I monitor pest populations in my orchards					
3.5 A licensed Pest Control Advisor monitors pest populations in my orchards					
3.6 I and/or my PCA monitor for pest natural enemies if they are important in controlling key pests and take their numbers in consideration when making pest management decisions					
3.7 Cultural factors, such as time to harvest, preexisting plant damage, plant moisture stress, plant health, and crop load, are considered in pest management decision-making if they have significant effects on the risk of damage due to key pests					
3.8 I or my PCA keep qualitative (descriptive) written pest monitoring records and they get shared during the decision making process					

3.9 I and/or my PCA keep quantitative (numeric) written pest monitoring records and they get shared during the decision making process					
3.10 If I rely on pest management recommendations from a PCA, I and/or my farm manager review with them the pest situation before making a decision to take a management action					
3.11 I encourage my crew supervisors and farm managers to report any pest problem that is out of the ordinary (e.g. pests they have never seen before) and report it to the appropriate person					
3.12 Pictures of important invasive pests are posted in convenient places so employees can monitor for their presence					
Pesticide Management					
4.1 'Smart'[16] sprayers are used when applying pesticides to some or all of my orchards					
4.2 Pesticide drift is minimized by using technologies such as air induction nozzles, or some pesticides are applied using chemigation					
4.3 I rotate the use of pesticides according to 'mode of action' to minimize development of resistance					
4.4 I keep a written record of pesticide use by 'mode of action' as a part of my pesticide resistance strategy					
4.5 A written spray drift management plan has been drawn up for each orchard that includes a map of the orchard and location of sensitive areas and sprayer operators follow the plan					
4.6 Calibration and spray coverage tests are done at least once a season on my sprayer and are based on manufacturers' recommendations as well as site characteristics such as crop canopy present					
4.7 Buffer zones have been established for each orchard based on pesticide label specifications, as well as adjacent crops and other sensitive sites					
4.8 Sprays are timed such that there is minimal or no human activity in adjacent areas					
4.9 Dormant season pesticide applications are made when wind speeds exceed 10mph[17]					
4.10 Dormant sprays are not done in dead calm when a temperature inversion exists to avoid long distance pesticide drift					
4.11 Sprayer nozzles are shutoff at row ends near environmentally sensitive areas					
4.12 There is a berm around the wellhead that prevents surface water running from the perimeter to the wellhead					
4.13 Pesticide mixing and loading area is more than 100 feet from the wellhead unless it is protected by a berm or other physical characteristics that prevent surface water running from the perimeter to the wellhead					

[16] A smart sprayer is one equipped with sensors that detect present or absence of target and shuts off when target is not present.
[17] CDPR Rule for Dormant Season Insecticides Fact Sheet

4.14 A separate water supply tank is used for pesticide mixing or, chemicals are added to the tank at least 100 feet away from the well.					
4.15 Either a double-check valve, reduced pressure principal backflow prevention device or an air gap is in place and maintained between the well pump and sprayer tank[18]					
4.16 Pesticide mixing and loading is done using a closed system or with water soluble pesticide packets when available for the pesticide being applied					
4.17 Spray mixing, loading and calibration is planned so that the tank is empty at the end of the spray job					
4.18 I use the following safe pesticide storage practices: dry pesticides stored above liquids, pesticides are stored more than 300 feet from nearest well, storage area has impermeable floor and sump to contain leaks, and only undamaged containers are stored					
4.19 I have an emergency response plan for pesticide and fertilizer spills and exposure posted in the appropriate places					
4.20 Workers are trained to follow the emergency response plan for pesticide spills or exposure					
4.21 A pesticide risk model such as PRiME[19], WIN PST or UC IPM's Water Tox[20] is used when considering which pesticides to apply					
4.22 The VOC 'footprint' of a pesticide is considered when deciding which pesticides to apply[21]					
Prevention and Cultural Practices					
5.1 I use resistance varieties/rootstocks to manage some of my key pests					
Biological control					
6.1 I monitor for pest natural enemies if they are important in controlling my key pests					
6.2 If a pest natural enemy is important for a key pest, I implement practices that augment their populations like planting cover crops, nectar sources and avoid using pesticides that may be harmful to natural enemies					
6.3 I release pest natural enemies that have been proven to be effectivecontrols for a key pest					
6.4 Conservation of pest natural enemies is considered when choosing a pesticide to use in the orchard					
6.5 Conservation of natural enemies is considered when deciding on spray timing					
6.6 I establish areas adjacent to the orchard to augment natural enemies by growing plants that provide shelter, nectar, and pollen for them					

[18] This is a legal requirement
[19] PRiME is the Pesticide Risk Mitigation Engine and can be accessed at http://ipmprime.org/cigipm/
[20] The model output is accessible at http://www.ipm.ucdavis.edu by viewing the webpage for the pest in question and clicking on the link labeled 'Water Quality Compare Treatments)
[21] http://apps.cdpr.ca.gov/voc-calculator/

Effects of Pest Management on Non-Target Sites & Organisms					
7.1 Effects of a pesticide on pollinators are considered when selecting the material to apply					
7.2 I am a member of the local Irrigated Lands Water Quality Coalition					
7.3 Effects of a pesticide on non-target organisms existing on my farm, such as birds and small mammals, are considered when selecting the material to apply					

Social Responsibility

Human Resources Management	Not Familiar	Familiar, not tried	Have tried it	Currently Use	Not applicable
Staffing and Recruiting Strategy					
1.1 A job description exists for each type of job and it is given to the employee and their supervisor					
1.2 Job descriptions are reviewed and updated at least once every two years					
Employee Orientation, Safety Training, and Career Development					
2.1 An orientation program is provided for new non-seasonal employees					
2.2 Safety training is done according to Cal OSHA regulations, i.e. when employee begins a new job assignment, or any new process, procedure or use of a substance or equipment that creates a new hazard					
2.3 All new employees undergo safety training					
2.4 If labor is contracted, a check is made to ensure contract labor company adheres to all relevant Cal OSHA safety regulations					
2.5 Safety statistics such as time lost due to accidents are tracked and retained for at least 2 years					
2.6 Employees are instructed as necessary to attend training seminars or other educational programs at least once a year that enhance their skills in the workplace					
2.7 Employees are encouraged to attend training seminars or other educational programs at least once a year that enhance their skills in the workplace (e.g. SpraySafe)					
2.8 Every non-seasonal employee is provided an employee handbook that includes at a minimum, the company's work standards and policies and an overview of benefits					
2.9 The employee handbook is written in an appropriate language(s)					
2.10 An employee meeting is held at least once a year to discuss company goals and to exchange ideas					
2.11 A meeting of top management is held annually to discuss company goals and exchange ideas					
Staying Informed					
3.1Trade journals/appropriate trade literature (including literature on worker issues, safety issues, Farm Bureau, trade association literature, etc.) are made available for the farm management team (FMT) to read					

3.2 The FMT has current membership in local grower association(s)					
3.3 The FMT regularly attend regional and/or statewide industry meetings (e.g. irrigation district, Farm Bureau, Water Coalition, etc.), trade shows (e.g. World Ag Expo), and seminars (e.g. UC, CDFA, CSU seminars, research meetings from Commodity Boards)					
3.4 The FMT takes a leadership role in local, regional or state industry associations (e.g. Western Growers, California Grape & Tree Fruit League, Grower-Shipper Association)					
Performance, discipline, grievance process, and employee recognition					
4.1 A job performance process is in place and is linked to pay and promotions					
4.2 A form and process is in place for employees to comment on job satisfaction					
4.3 My company has a grievance process in place and it is documented in the employee handbook					
4.4 Filed grievances are recorded and processed in a timely manner					
4.5 A suggestion box is provided in a convenient location so that employees can provide ideas for improvements in company practices, working environment, and other areas.					
Health benefits, paid time off, and other benefits					
5.1 Basic health benefits are provided to non-seasonal employees					
5.2 Non-seasonal employees have paid holidays and vacation time					
5.3 Employees are provided sick leave and/or personal days					
5.4 Non-seasonal employees are provided (or employees are encouraged to) a formal pension plan or a company 401k					

Community Support	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 My company is involved in regional land use planning					
1.2 My company is involved in initiatives, through time commitment and/or donations, that enhance the community, such as the Chamber of Commerce, schools/education programs, churches, public health, affordable housing					
1.3 My company is involved in regional water issues such as the regional water quality coalition, irrigation districts, ground water use planning, and/or the irrigated lands waiver program planning					

Waste Management

Sustainable agriculture provides a strategy for managing all aspects of your farming enterprise, including the management of the crop, soil, water, pests and human resources. It also relates to your farm,s infrastructure as well, such as your offices and shop. While the most interesting part of sustainable farming addresses what happens in the orchard, it is important not to forget important issues like waste management. In a lot of situations, waste management is one of the most straightforward processes to address on the farm.

Waste Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In orchard, shop and office					
1.1 The farm has a written waste management plan that includes waste reduction goals, recycling goals, hazardous material use reduction goals					
1.2 Crop residue or crop byproduct is recycled by either selling to another user (e.g. for cattle feed, co-generator/digester), composted, or returned to the orchard for incorporation into the soil					
1.3 The farm has an established recycling program for metal, cardboard, plastics, paper and glass					
1.4 The value of recycling is part of the orientation and training of employees					
1.5 The amount of metals, cardboard, plastics, paper and glass recycled annually vs. the amounts thrown away is determined and year to year comparisons are made					
1.6 The number of tires, batteries used per year and the amount of lubricants purchased vs. the amount sent back or recycled per year is recorded and year to year comparisons are made					
1.7 All unused or worn out items such as appliances, tractors, ATVs, electrical equipment, are taken to the proper recycling centers for disposal					
1.8 The total amount of hazardous materials, other than pesticides and fertilizers, present on the farm, are known and their use is tracked on an annual basis (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.9 Employees are trained on the proper handling and disposal of hazardous materials (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.10 Employees are trained on legal requirements related to cleaning of					

farm equipment with water or steam cleaners and the resulting runoff					
1.11 Hazardous materials no longer used, as well as their containers, are disposed of according to legal requirements					
1.12 The farm participates in the pesticide container recycling program[22]					
1.13 Dumpsters and/or recycling containers are on cement pads to contain spills					
1.14 Dumpsters and/or recycling containers are covered to keep out rain					
1.15 Dumpsters and/or recycling containers are periodically inspected for leaks, spills, and litter. Problems noticed are corrected					

[22] Use the following link to find out how to participate in an Ag Container recycling program: http://www.acrecycle.org/contact_us.html

Water Management and Water Quality

California is the leading agriculture state in the U.S. by a significant amount. This is due in large part to the high value of the many specialty crops grown in the state. It is also due to the excellent growing conditions such as fertile soils, a Mediterranean climate and the availability of affordable high quality surface and ground water for irrigation. California is also the most populace state in the U.S. and therefore, affordable high quality water is needed to support this population. It is clear that because of the demands for high quality, affordable water, this critical resource needs to be used efficiently and effectively by specialty crop producers. The following template will help document practices producers are using to achieve optimum water quality and use efficiency, as well as bring to their attention areas where improvements can possibly be made.

Irrigation Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pre-plant Planning					
1.1 Pre-plant analyses of the site was done to identify factors that affect quantity of irrigation water delivered and percolation rate such as existence of soil compaction, a root restricting layer, soil type, soil texture, soil chemistry (pH, salinity, etc.) and soil organic matter					
1.2 Ripping, plowing, chiseling, or other practices were implemented if pre-plant soil tests indicated water percolation and/or drainage problems					
1.3 Soil amendments were applied to correct soil chemical or physical issues if sampling identified factors that would affect water percolation					
1.4 Water source was sampled and evaluated for water quality					
1.5 The irrigation system was designed to deliver the quantity of water required for the crop and accommodate for variation in topography as well as in soil texture that affects water percolation and water holding capacity					
Irrigation Scheduling & Rates					
2.1 I measure and record the total amount of water used in each orchard every season and calculate water use per unit of crop production.					
2.2 I have a written water management plan for my orchard(s) that includes goals for the growing season and takes into consideration annual rainfall, crop variety, crop maturity, water-related pest management issues, soil type, soil preparation, slope, water quality, irrigation efficiency, irrigation uniformity, and energy efficiency					

2.3 Irrigation is initiated at the start of the season based on visual cues from the crop					
2.4 Irrigation is initiated at the start of the season based on measured soil moisture depletion					
2.5 Irrigation is initiated at the start of the season based on directly measuring plant moisture stress (e.g. with pressure bomb)					
2.6 Irrigation scheduling is influenced by peak energy pricing					
2.7 Water percolation rate and infiltration depth is monitored during the irrigation season					
2.8 Soil moisture depletion is estimated by visual inspection of the crop (e.g. growth or development) that indicates plant water stress					
2.9 Soil moisture depletion is tracked through soil coring					
2.10 Soil moisture depletion is tracked using soil-installed moisture monitoring devices					
2.11 Soil moisture depletion is tracked by directly measuring plant moisture stress (e.g. with a pressure bomb)					
2.12 Amount of irrigation and timing are dictated by the amount and timing of water available through my Water District					
2.13 Amount of irrigation and timing are based on visual cues of the crop					
2.14 Amount of irrigation and timing are based on irrigation history from past growing seasons					
2.15 Amount of irrigation and timing are based on historical crop evapotranspiration (ET)					
2.16 Water demand of the crop is estimated by determining ETo[23] through using data from the nearest CIMIS weather station and used in irrigation rate and scheduling					
2.17 Water demand from the crop is estimated by converting ETo to Etc by using the appropriate crop coefficient factor (Kc), which takes into account crop canopy and is used in irritation rate and scheduling					
2.18 When appropriate less than full water demand is applied to the crop (deficit irrigation)					
Irrigation Performance and System Maintenance – Pumps & Filters					
3.1 Pumping plant efficiency has been measured within at least the last 3 years (for areas where water table fluctuates considerably, pumping plant efficiency should be checked at least once every 2 years)					
3.2 Pumping plant efficiency has been measured within at least the last 5 years					
3.3 Energy use for irrigation is tracked on an annual basis and related to unit of production					
3.4 Electrical irrigation pumps are on time of use metering					

[23] ETo is the reference evapotranspiration and is calculated using measurements of climatic variables including solar radiation, humidity, temperature and wind speed and is expressed in inches or millimeters of water. It is based on water use for a short mowed full coverage grass crop.

3.5 If pumping efficiency is significantly reduced, I have improved it					
3.6 Diesel irrigation pumps are Tier 2 or higher					
3.7 A flow meter is installed on wells and/or pumps and I monitor and record the flows					
3.8 Pressure check points are installed on key lines from pumps					
3.9 Filter status (and flushing system) is manually checked at least twice a season and corrected if necessary					
3.10 Pressure gauges are installed for measuring pressure drops through filters					
Irrigation Performance & System Maintenance – Drip & Micro-sprinklers (if no drip or micro-sprinkler systems used skip to 5.1)					
4.1 Distribution uniformity of the irrigation system is tested at least every 2 years					
4.2 The system has pressure compensating emitters to help maintain system distribution uniformity					
4.3 The irrigation system is monitored for leaks, breaks, and clogging every irrigation					
4.4 The irrigation system is monitored for leaks, breaks, and clogging at least once a season					
4.5 Fertigation is used to apply most of the fertilizers for the orchard					
4.6 An interlock system is installed so injection pump shuts down if irrigation pump shuts down to prevent water source contamination					
4.7 Irrigation lines are flushed at the start of the season and then again at mid season, or more often as needed					
Irrigation Performance & System Maintenance – Sprinklers (if not sprinkler systems used, skip to 6.1)					
5.1 The irrigation system is monitored for leaks, breaks, and clogging every irrigation					
5.2 The irrigation system is monitored for leaks, breaks, and clogging at least once a season					
5.3 Sprinkler head rotation and nozzle clogging have been checked within the last 12 months and repaired if necessary					
5.4 Sprinkler head rotation and nozzle clogging are checked at least every other irrigation and repaired if necessary					
5.5 Sprinkler heads have been checked for wear in the past 5 years and replaced with the correct nozzle size if necessary to maintain distribution uniformity					
5.6 Fertigation is used to apply most of the fertilizers for the orchard					
5.7 An interlock system is installed so injection pump shuts down if irrigation pump shuts down to prevent water source contamination					
Irrigation Performance & System Maintenance – Flood & Furrow					
6.1 The orchard was laser leveled before planting the crop					
6.2 Levee locations in the orchard are based on observed infiltration rates					

(i.e. each check is appropriately sized for maximum water application uniformity)					
6.3 Irrigation produces no tail-water					
6.4 Irrigation produces tail-water and a tail-water recovery system is in place					
6.5 Flow meters are installed and flow volumes recorded on lines from pumps or in supply pipelines or ditches (e.g. Weir notch or Parshall flume) or a record of flow volumes is provided by the Water District					
Water quality – Source and resource					
7.1 Irrigation water is tested at least every 3 years for quality, including pH, total salt, nitrates, and biological problems. The quality of water in distribution reservoirs is tested if they are present on the farm.					
7.2 If a water quality problem exists it is addressed					
8.3 I have accessed resource maps to determine if my orchard(s) are in Ground Water Protection Areas (GWPA)[24]					
7.4 If an orchard is in a GWPA, I have accessed and read the legal requirements for handling restricted use pesticides in GWPA areas and they are on file in the office					
7.5 I have identified and mapped areas on the farm that are potential sites for pesticides and fertilizers to enter the ground water					
7.6 The wellhead is situated so no surface water can reach it or a berm has been placed around the wellhead that prevents surface water from reaching it					
7.7 Return water wells, older wells and abandoned wells are sealed to prevent ground water contamination					
7.8 Irrigation practices create no off-site movement of chemical residues and sediments					
7.9 If storm water run-off occurs, one or more of the following mitigation practices are implemented: filter fabric fencing; filter strip; straw bale check dam; straw bale water bars; sediment basin; or other containment system					
7.10 Cover crops/vegetation is maintained on drain ditches and non-paved minor roadways to minimize rainfall run-off from orchard					
7.11 Soil percolation problems in the orchard have been addressed to minimize off-site movement of irrigation or storm water					

[24] http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpamaps.htm

Self-Assessment for Fresh Market Tomato Production

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Project History

Over the last 10 years the field of sustainable agriculture has become more and more important in the eyes of food retailers, buyers and consumers. As is often the case when new concerns arise in relation to food and food production, the spot light shines on the grower. Sustainable agriculture is challenging to define, and once defined it can be challenging for a grower to figure out how to implement it on the farm in an economically viable way. To meet these challenges a group of specialty crop trade associations, NGO's, and other specialty crop stakeholders met to discuss the topic of sustainable agriculture. One outcome of these discussions was an application to the California Department of Food and Agriculture Specialty Crop Block grant program for funds to hire sustainable agriculture professionals to help develop a plan to meet the challenges presented by sustainable agriculture. The Great Valley Center coordinated the grant application and engaged SureHarvest to provide the technical expertise. SureHarvest is a company with extensive experience in sustainable agriculture strategic planning, program design, and program implementation. The grant application was successful and began in September of 2009. The Great Valley Center directed the project and contracted with SureHarvest for project design, facilitation and implementation.

The grant had two primary goals. The first was to develop, through a stakeholder process, a sustainable agriculture strategic plan that each of the participating groups could use internally to help lay the foundation for their own sustainable agriculture program specific to their specialty crop. The second was to develop a tool, or tools, that could be used by their member growers to put the strategic plan into action on the farm.

The following paragraphs contain the sustainable agriculture strategic plan developed by the project leadership team, the members of which are listed in Table 1.

Sustainability Strategic Plan for the Multi-Commodity Project

The sustainability strategic plan for the Multi-Commodity Project is based on SureHarvest's 5 P's of sustainability framework. The 5 P's are: Principles, Processes, Practices, Performance Metrics, and Progress. They are defined as follows:

1. Principles – This is the sustainable vision for the project. It consists of the goals that the participants want to achieve from the design and implementation of the project.
2. Processes – These are the resource areas on the farm that need to be addressed in order to meet the principles or goals of the project. For example, this could be water, energy, and human resources management.
3. Practices – These are the practices that are implemented on the farm that impact the processes or resource areas. They are the on-the-ground actions that are carried out to assure that the principles or goals of the sustainable program are met.
4. Performance Metrics – These are the metrics used to measure the outcomes resulting from the practices implemented on the farm. There are many - examples include crop quality, water use, energy use, and worker satisfaction. Performance Metrics are used to measure the level of success in meeting the principles or goals of the project.

5. Progress – The process used to improve performance over time and communicate the results internally and externally. In other words, tracking the degree of progress one is making towards achieving the goals of the project. Measuring progress will require some kind of system for assessing the farm's performance over time, creating action plans to improve particular areas of performance, and reassessment over time to track progress.

Table 1. Multi-Commodity Project Leadership Team

Organization	Representative
Almond Board of California	Gabriele Ludwig*, Robert Curtis*
Bolthouse Farms	Troy Elliott*, Justin Groves*
California Grape & Tree Fruit League	Chris Valadez*, Barry Bedwell
California Specialty Crop Council	Lori Berger*
California Garlic & Onion Research Advisory Board	Robert Ehn
California Olive Council	Patty Darragh
California Pear Advisory Board	Bob McClain
California Pepper Commission	Glen Fischer*
California Pistachio Board	Robert Klein*
California Raisin Marketing Board	Gary Schultz
California Tomato Farmers	Ed Beckman*
California Tree Fruit Agreement	Gary VanSickle*, Lauren Friedman
California Walnut Board	David Ramos
Del Monte Foods	Pat McCaa
Sun-Maid Growers	Rick Stark*

*Leadership Team Member

Multi-Commodity Project Principles (1st P):

The principles for the Multi-Commodity Project were established by the Project Leadership Team. They are:

1. Create a resource area/practice template that:
    a. Will focus on increasing the economic performance for the participant.
    b. Is scalable and can be used by participating groups to accomplish the goals of their own sustainability programs.
    c. Provides the participant the ability to gauge the state of sustainability of the industry and their farm.
    d. Encourages continual improvement on the farm.
    e. As a whole encourages ecological harmony.
    f. Better defines the 3 E's of sustainability (economic viability, environmental soundness and social equity/responsibility) in a way we can all agree upon.
    g. Is open to and usable by any individual or group in the future that was not involved in the original effort.
    h. Benefit the participants and not result in unintended negative consequences.

2. The program should provide the information/data needed for groups to tell their sustainability story better to all their audiences, e.g. buyers, regulators, consumers, NGO's.
3. The outcomes from the project cause no harm to producers.

The Leadership Team of the Multi-Commodity Project decided the best tool for implementing their sustainability strategic plan was a self-assessment of practices template that stakeholders from specific specialty crops could then fine tune for their own use. The team chose to use the model developed by the California Sustainable Almond Program (CASP), which is a California Almond Board program developed in partnership with SureHarvest. The Leadership Team formed a stakeholder committee to draft the self-assessment template that covered the practice areas listed in the Multi-Commodity Project Strategic Plan. The Stakeholder Committee members are listed in Table 2.

Individual Contact	Title	Expertise
Billy Heller	Grower, Pacific Triple E Farms	Crop management
Bob Giampaoli	Grower, Live Oak Farms	Crop management
Cliff Sadoian	Grower	Crop management
Pat McCaa	Manager, Pest Management, Del Monte Foods	Crop management
Mechel S. Paggi (Mickey)	Director, Center for Agricultural Business, California State University, Fresno	Ag Business & economics
Glen Fischer	Ag Representative, Saticoy Foods Inc.	Crop management
John Trumble	Professor of Entomology, University of California Riverside	Pest management
Jeff Mitchell	Extension Specialist, University of California, Davis	Soils & plant nutrition
Pete Goodell	UC IPM Area Advisor, University of California, Davis	Pest management
Terry Prichard	Extension Specialist, University of California, Davis	Irrigation & crop water relations
Bill Peacock	Representing raisin growers via the Raisin Marketing Board and Tree Fruit Growers	Crop management
Troy Elliott	Director of Agronomy, Bolthouse Farms	Crop management

Table 2. Multi-Commodity Project Stakeholder Committee

The second phase of the Multi-Commodity Project began with SureHarvest obtaining a CDFA Specialty Crop Block Grant to finish the self-assessment template with the Multi-Commodity Leadership Team and Stakeholder Committees and then fine-tune the template into workbooks for individual specialty crops working with willing growers and stakeholders from each specialty crop community. The self-assessment workbook for fresh market tomatoes which is presented on the following pages was developed using the Multi-Commodity self-assessment template through a series of reviews and edits by growers, other stakeholders and SureHarvest staff. Members of the California Tomato Farmers were particularly helpful during the review process. The final version was produced by SureHarvest and submitted to CDFA along with their final report in June of 2013.

Air Quality Management

We all appreciate good air quality. Unfortunately, the San Joaquin Valley is out of attainment of the Federal Clean Air Act. Because of this, the region is under threat of losing federal highway dollars if attainment cannot be achieved. Therefore a lot of pressure is being brought to bear on urban and rural industries, including agriculture, to reduce air pollutants in the Valley in any way possible. This section of the self-assessment will help you identify practices that influence air quality, see where you are doing well, and determine areas that need improvement.

Air Quality Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In Field and Adjacent Land					
1.1 To minimize airborne dust and PM10[5] particles, a reduced tillage program is in place, including the use of permanent beds					
1.2 If tillage is done, moisture content of the soil is taken into consideration to minimize dust					
1.3 Vegetation is maintained on non-cropped areas such as headlands, roadsides, and field edges to reduce wind erosion causing airborne dust					
Roads					
2.1 Vehicle speed is restricted on dirt roads around fields to minimize airborne dust					
2.2 Dirt roads are treated with an anti-dust agent that meets the 50% PM10 control for a Fugitive PM10 Management Plan[6]					
2.3 Dirt roads are graveled, watered, chipped, mulched (crop residues), sanded or seeded					
2.4 Heavily used roads are paved (e.g. main thoroughfares on farm)					
Engines and Fuel Consumption					
3.1 Engines are maintained on a regular schedule to ensure they are running at optimum performance and efficiency and emissions are minimized					
3.2 At least some vehicles are equipped with engines able to use alternative fuels with lower emissions (e.g., compressed natural gas, flex fuel, biodiesel, propane)					

[5] PM 10 are particles 10 microns in diameter or smaller and pose a health risk because they pass through the throat and nose and penetrate the lungs.
[6] For details see http://www.airquality.nrcs.usda.gov/Documents/files/Dust_Control_Products.htm

3.3 Some off-road farm vehicles are battery powered (e.g. golf carts)					
3.4 Vehicle miles are tracked on an annual basis					
3.5 Stationary diesel engines have been replaced (or retrofitted) to Tier 3 or better					
3.6 Stationary diesel engines have been replaced (or retrofitted) with technology relying on cleaner burning fuel (e.g. propane, natural gas, biodiesel) or replaced with electric pumps					
3.7 Selection of vehicle power plants and stationary engines is in part determined by lower emissions ratings					
3.8 Some of the farm's energy requirements are obtained through renewable sources such as wind or solar					
Pesticide Management and Air Quality					
4.1 When choosing a pesticide to apply its VOC, 'footprint' is considered[7]					
4.2 Practices are implemented that reduce pesticide drift such as use of air induction nozzles, turning sprayers off at turn-arounds, not spraying when a temperature inversion exists in the field, and when wind exceeds 10 mph or the velocity specified on the label.					
Greenhouse Gas Emissions					
5.1 I am aware of the role of CO_2, N_2O, and methane as greenhouse gases and where they are produced in my farming operations					
5.2 CO_2 and N_2O production are calculated and tracked					

What are VOC's?

VOC stands for volatile organic compound. These are carbon based compounds contained in products used on the farm, such as certain pesticides, that volatilize (evaporate) when exposed to the air. Ground-based ozone is produced by chemical reactions involving VOC's, nitrogen oxides (NOx) and sunlight. While not direct air pollutants themselves, VOC's are important ozone precursors and considered key targets for reduction in the Central Valley of California a region where air quality is an issue. The California Department of Pesticide regulation does not know the reactivity of every VOC, and ideally, reactivity should be used to precisely determine VOC emissions. That said, appropriate data and analytical methods do exist at this time to make accurate estimates. The Department does hope to use reactivity at some point in the future. It calculates VOC emissions based on the best available science (Dr Matt Fossen, pers. comm., Environmental Scientist, Calif. Dept. Pesticide Regulation). Air Quality and greenhouse gas emissions are such important topics in the Central Valley of California, it is important to consider the various sources of potential air quality problems.

[7] A VOC calculator is found at: http://apps.cdpr.ca.gov/voc-calculator/

Energy Management

Energy is essential for crop production and it comes in several forms; as sunlight to power photosynthesis, as fuel to power our internal combustion motorized vehicles and pumps, and as electricity to power our shop, office lights and electronic equipment. Tracking energy is very important because it is getting more and more expensive all the time, increasing our cost of production. Burning of fuel produces GHG's affecting air quality and contributing to climate change. So minimizing energy consumption saves money and reduces GHG production. Completing this section should help improve your understanding of energy use in your operation and encourage you to consider some forms of energy conservation.

Energy Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 The total amount (gallons) of fuel used annually on the farm in all operations is recorded and year to year comparisons are made. Each fuel type is recorded.					
1.2 The total amount of fuel used annually per acre and per unit of crop production is determined and year-to-year comparisons are made[8]					
1.3 The total amount of fuel used annually is calculated for each field and year-to-year comparisons are made. Each fuel type is recorded.					
1.4 Annual fuel consumption and/or electrical use for irrigation pumps are recorded and comparisons made from year-to-year.					
1.5 Electrical use for office(s), shop(s), and outdoor security lighting is tracked using energy bills and year-to-year comparisons are made					
1.6 Fuel and electricity used are converted to a common metric such as British Thermal Units (BTU's) so they can be combined to calculate the total amount of energy used annually for crop production.Year to year comparisons are made.[9]					
1.7 The amount of energy used annually per acre and per unit of crop production is calculated and year to year comparisons are made					
1.8 The amount of energy used annually in each field is calculated and year-to-year comparisons are made					

[8] This can be a simple calculation of dividing the total gallons of fuel used for the year divided by the total amount of crops produced for the year.

[9] Energy conversion calculators for kilowatt hours to BTU',s and gas or diesel to BTU's, are readily and freely available on the Internet. For example, using Google, type 'convert gas to BTU's and you will be directed to a website where a calculator is available to make your conversion. Simply type in the number of gallons of gas and the calculator will produce the number of BTU's it represents.

1.9 An energy management plan is being implemented on the farm that includes yearly goals for overall energy use as well as energy used per unit of crop production.[10]					
1.10 A process is in place to ensure that the most appropriate piece of equipment is used for a given job (e.g. the most appropriate horse power engine for the job)					
1.11 One or more solar energy systems are installed on the property to generate electricity					
1.12 One or more wind generators are installed on the property to generate electricity					
1.13 Engines (stationary and mobile) and motors are maintained on a regular schedule to ensure they are running at an optimum fuel efficiency or optimum efficiency					
1.14 Pumping plant efficiency (energy per acre foot pumped) is checked every 1 to 3 years (based on use) and adjustments made if necessary (FSU website recommends every 1-3 years based on use)					
1.14 At least some light switches are fitted with motion detectors or photo cells to reduce time of use					
1.15 At least some office and shop lights have been fitted with low energy consumption compact florescent bulbs or LED lights.					

Indirect Energy Use/Consumption:

Energy is directly expended when driving a vehicle, operating a pump, photocopying, or turning on and using a light bulb. Energy is also expended to manufacture inputs that are used on the farm, such as fertilizers, compost and pesticides. This type of energy consumption is called imbedded energy. If you want to figure out the total amount of energy consumed to produce a crop, then calculations should also be made to determine the amount of embedded energy that was consumed to produce the fertilizers, compost, and pesticides that were used to produce the crop.

[10] Ideally one would convert all energy consumption to BTU's (British Thermal Units), but initial energy management plans could start with using gallons of gasoline and diesel and kilowatt hours for electricity.

Financial Management

The economic E of sustainable farming is literally where the buck stops. If a farm is not profitable, it is not sustainable. People farm not because they want to be accountants. They farm because they want to grow things. However, while financial management may be a challenging part of farming, doing it well is one of the keys to a successful and sustainable farm. This chapter will help the grower recognize strengths in financial management as well as point out areas where improvements are needed.

Financial Management **(The most appropriate person to fill out this section/chapter is the CEO/owner of the farm)**	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Planning and Risk Management					
1.1 A marketing and production plan has been developed for my farm and seasonal outcomes are compared to these plans					
1.2 A succession[11] plan is in place for the farm					
1.3 I have a written will and estate plan for the farm[12]					
1.4 A business continuation plan (disaster[13] management plan) has been developed for the farm					
1.4 A risk management plan has been developed for the farm					
1.5 Key personnel in the company have health insurance					
1.6 Key personnel in the company have disability insurance					
1.7 Key personnel have life or accidental death insurance					
Accounting and Financial Analyses					
2.1 I use a financial accounting system to track and report farm finances and use it to make decisions about my farming operation					
2.2 I understand how to interpret both cash and accrual financial statements including a balance sheet, income statement, cash flow, and financial ratios					
2.3 I meet with a financial advisor on an annual basis					
2.4 Financial profitability analyses for investments are done if investments are made					

[11] A succession plan is one where the change in leadership in the company has been determined, whether it is expected, such as the CEO voluntarily stepping down/retiring, or unexpected, such as due to illness or accident.
[12] An estate plan is a plan for the financial assets to pass from one generation to the next. It does not deal with the human and intellectual capital and making that transition to the next generation. That is succession planning.
[13] Disaster in this case is not just weather, but also unexpected death of one or more key company personnel.

2.5 The revenue and returns are tracked for each field/management unit in my financial management reports					
2.6 Costs and returns are tracked for all important farming practices					
2.7 Costs and returns are tracked for implementing new sustainability practices and compared to costs and returns of practices they replaced					
2.8 Sensitivity analysis, i.e. change in crop prices over time, is used to analyze financial risk over time					
Purchasing and Borrowing					
3.1 More than one quote is obtained for major input purchases such as pesticides and fertilizers					
3.2 Interest rates and services from more than one lending institution are compared before borrowing a significant amount of money					

Food Safety Management

How do we ensure that fresh food is safe? This is a question that is being debated by everyone all along the supply chain. Compliance with food safety production requirements is becoming a necessary requirement for many specialty crops. This section lists practices that are related to food safety management.

Food Safety Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Food Safety Management Planning					
1.1 A written food safety policy is in place for the farm that includes a commitment to food safety, how it is implemented, and how it is communicated to the employees.					
1.2 A written food safety plan is in place that identifies all locations of the farm and products covered by the plan. The plan addresses potential physical, chemical, and biological hazards and hazard control procedures, including monitoring, verification and record keeping, for the following areas: water, soil amendments, field sanitation, production environment and worker practices					
1.3 The food safety plan is reviewed at least annually					
1.4 Record keeping is kept to demonstrate the food safety plan is being followed					
1.5 A person has been designated as being responsible for food safety functions on the farm					
1.6 All employees are trained in food safety procedures and practices on the farm					
Food Safety Risk Assessment of Field					
2.1 An assessment has been made of the production field, focusing on the likelihood of intrusions by animals that pose significant food safety risks (e.g. deer, pigs, livestock) and, if necessary, actions are taken to reduce the likelihood of intrusion					
2.2 An evaluation has been made on land and waterways adjacent to the field for possible sources of human pathogens of concern (e.g. manure storage, CAFO's, grazing/open range areas, surface water, sanitary facilities and composting operations)					
2.3 An assessment of historical land use has been made to determine any potential issues from these uses that might impact food safety (e.g. hazardous waste sites, landfills, etc.)					

2.4 My company participates in a third party food safety certification program (e.g. Agriculture Marketing Service GAP Certified, Scientific Certification Systems, Primus. Global GAP)					
Water					
3.1 The water system description for the field/ranch has been created that indicates, either with drawings or maps, the location of permanent fixtures, such as pumps, wells, underground lines, gates & valves reservoirs, and returns					
3.2 Irrigation water and water used in harvest operations is tested for microbial quality, and if microbial levels are above specific action levels, corrective actions are taken					
3.4 Records of all water tests are retained, along with Certificates of Analysis, for at least 2 years					
3.5 Irrigation pipe and drip tape are stored in a manner that reduces or eliminates the potential for pest infestation					
3.6 Water applied to edible portions of the crop, either as overhead irrigation or pesticide applications, is tested for microbial quality					
Organic Soil Amendments					
4.1 Raw manure or a soil amendment that contains un-composted or incompletely composted or non-thermally treated animal manure is not applied to field					
4.2 If compost is applied, it is sourced from a supplier that provided their written Standard Operating Procedures that prevents cross-contamination of finished compost with raw materials through equipment, runoff or wind.					
4.3 If organic soil amendments are used, microbial testing is performed by the supplier prior to application					
Sanitation					
5.1 Toilet facilities are readily available to all field employees and are located according to Cal OSHA regulations					
5.2 Toilet facilities are clean and maintained on a regular basis					
5.3 Field employees are trained on the importance of sanitation in the field					
5.4 Field sanitation units are accessible to all employees					
5.5 A response plan is in place in the event of a spill from toilet or sanitation facilities and employees are trained to implement it					
5.6 Workers are educated on sanitation issues such as not working on the job while sick or injured (e.g. infected cuts)					
Harvesting and Transportation					
6.1 A traceability system is in place and appropriate for my crop					
6.2 A mock recall has been done to check the effectiveness of the traceability system (mock recalls would usually be done in					

conjunction with a packer/shipper or processor)					
6.3 All harvesting containers and bulk hauling vehicles that come into direct contact with the harvested crop are cleaned and/or sanitized on a scheduled basis using a written record system					
6.4 Packaging materials used in field operations are properly stored and protected from contamination					
6.5 Harvesting equipment that comes into contact with the crop is kept in good repair					

Soil Management

Soil is the most complex ecosystem on earth. Gaining a greater understanding of the soil resource in your fields is critical for making informed soil management decisions. Knowing your soil resource gives you greater control over yield and crop quality and is especially important in determining the long-term sustainability of your farm.

Soil provides the crop with three vital things: water, nutrients and air. These three things are best provided by a soil with good depth and structure, i.e. a soil in which the particles are bound together into small clumps (aggregates) of varying size. Soil aggregation is a measure of soil structure. Soil organic matter is important in maintaining soil structure by gluing soil minerals together into aggregates. Spaces between large aggregates (measured as millimeters) permit rapid drainage and easy root growth, and spaces between small aggregates (measured as less 1 millimeter down to 0.001 millimeter) trap water for use between irrigation and rain events. One of the more important aspects controlling aggregate stability is the amount of microbial activity and soil organic matter. Stable aggregates occur in varying sizes and are created by the cementing action of microbes and their byproduct and soil organic matter. The assemblage of soil aggregates creates habitat to promote faunal and microbial diversity, an important index of soil quality. Due to the warm to hot California climate, soil organic matter is low in many soils due to rapid breakdown of soil organic matter.

The following self-assessment template will help document the practices producers are using to managing their soil sustainably, as well as suggest areas where improvements might be possible.

Soil Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Knowledge of soil properties					
1.1 The soil types in the field has/have been identified using NRCS soils maps					
1.2 The soil types in the field has/have been identified using soil samples taken pre-planting					
1.3 Soil properties for each soil type in the field are recorded, including soil moisture holding capacity, texture, and rooting depth					
1.4 A soil sample has been taken in the field more than 6 years ago and analyzed for macro and micro nutrients					
1.5 A soil sample has been taken in the field within the last 6 years and analyzed for macro and micro nutrients, as well as soil chemistry (e.g. pH, CEC, salts)					
1.6 A soil sample has been taken in the field within the last 4 years and analyzed for macro and micro nutrients, as well as soil chemistry (e.g. pH, CEC, salts)					

1.7 A soil sample has been taken in the field within the last 2 years and analyzed for macro and micro nutrients, as well as soil chemistry (e.g. pH, CEC, salts)					
1.8 If soil pH is less than 5.5, it is amended with lime and if it is above 8.0, it is amended with an acidifying agent					
Soil properties management					
2.1 If water infiltration is poor (water puddles and runs off when soil is dry underneath) the soil is amended either chemically (e.g. with gypsum or organic matter such as compost or manure) or physically (e.g. chiseling or shallow ripping)					
2.2 Soil is tested for organic matter content at least every 2 years					
2.3 If soil organic matter is low for the soil series, I have an ongoing program to build soil organic matter such as rotating tomatoes with high residue crops, cover cropping, and/or adding organic amendments					
2.4 Equipment is chosen, or is modified, to minimize soil compaction (e.g. lightest equipment possible, track-layers, wider or bigger diameter tires, tire pressures as low as possible)					
2.5 Tillage is never done when soil is too wet					
2.6 Reduced tillage is practiced and permanent beds are used					
Crop nutrition management					
3.1 I have a written crop nutrient management plan that uses a 'budgeting approach'[14] in determining the nutrient needs of the crop and takes into consideration factors like crop tissue analyses, soil type, time of year, soil moisture, crop load, etc. (insert an educational box discussing the 4 R's of nutrient management; see http://www.ipni.net/4r)					
3.2 The crop's nutrient management plan is based solely on the recommendations as given by my field consultant and/or from the soil testing lab					
3.3 Soil samples are taken to a depth of 12 inches annually at permanent monitoring sites based on soil type and analyzed by an accredited laboratory					
3.4 Soil samples are taken to a depth of 12 inches at least every two years and analyzed by an accredited laboratory					
3.5 Soil samples are taken and analyzed every 3 years, or less often or never taken					
3.6 Plant tissue or plant sap samples are taken at key growth stages during the year and analyzed by an accredited laboratory to fine-tune nutrient applications for each field and soil type					

[14] A budgeting approach means that the amount of nutrients leaving the field in the crop is estimated and the amount of nutrients added back to the field is based on this estimate. A one -to-one replacement is not implied or required since factors such as soil type affect nutrient availability to the crop and these factors must also be taken into account.

3.3 With the help of my field consultant I am able to interpret the lab results from the field soil samples and we use them in the crop nutrient management plan					
3.4 I am able to interpret the lab results from the soil samples and I use them in my crop nutrient management plan					
3.5 Plant tissues are taken and analyzed at least once a season and used to help assess crop nutrient needs					
3.6 I record from year-to-year the amount of nitrogen applied per acre and calculate the amount of N applied per unit of crop production					
3.7 I record from year-to-year the amount of phosphorus applied per acre and calculate the amount of P applied per unit of crop production					
3.8 I record from year-to-year the amount of potassium applied per acre and calculate the amount of K applied per unit of crop production					
3.9 Fertilizers are applied using fertigation					
3.10 The total amount of nitrogen needed for the season is applied in one application					
3.11 The total amount of nitrogen needed for the season is applied in a split application(s)					
3.12 Fertilizers are applied using a 'spoon feeding' approach where only the amount of nutrients required by the crop at the time are applied, and multiple applications are made throughout the growing season based on crop growth stage and nutrient demand					
3.13 Fertilizer application records are kept for each block that include date, fertilizer type and amount, and method of application					
3.14 Micro nutrients are applied on a regular basis without reference to crop needs or crop history					
3.15 Micro nutrients are applied based on past crop history					
3.16 Micro nutrients are applied based on soil sample test results					
3.17 Micro nutrients are applied based on crop tissue sample test results					
Soil erosion					
4.1 Vegetation is maintained along farm roads, on field edges, and along irrigation canals not controlled by the irrigation district					
4.2 I know the infiltration/run-off rates of the field's soil and the rate of irrigation water is applied and adjusted according					
4.3 No tillage is done on field borders or along irrigation canals					
4.4 Ditches have been grassed or hardened to prevent downcutting					
4.5 Culverts are properly sized to accommodate high flows, and inlets and outlets have been hardened to prevent scour or energy dissipaters have been installed					
4.6 Cover crops are planted on beds between seasons to minimize erosion					

Ecosystem Management

An ecosystem is the complex community of living organisms and their physical environment functioning as an ecological unit. Components of an ecosystem are inseparable and interrelated. An ecosystem management approach to growing specialty crops acknowledges that people are a part of, and have a significant impact on, ecosystem structures and processes, and that people depend on and must assume responsibility for the ecological, economic, and social systems where they live. Ecosystem management is currently being encouraged and implemented by communities, government agencies, businesses, academics and various conservation organizations throughout the world[15].

Ecosystem Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Habitat maintenance and enhancement					
1.1 Field borders, roadsides, and ditch-banks are kept free of vegetation					
1.2 Hedgerows of trees and/or shrubs are maintained on at least some field edges					
1.3 Vegetation such as grasses, trees or shrubs are maintained along roadsides, ditch-banks and headlands					
1.5 Trees have been planted to provide habitat for wildlife					
1.6 Trees are maintained to provide habitat for wildlife					
1.7 Nesting boxes for owls have been placed around the farm and they are cleaned annually					
1.8 Perches for raptors have been placed around the farm					
1.9 If water courses exist on my property, crops are planted up to the edge of water courses					
1.10 If water courses exist on my property, setbacks are in place to minimize disturbance					
1.11 If water courses exist on my property, resident vegetation is maintained on the banks					
1.12 If water courses exist on my property, banks are vegetated with a mix of grasses, trees and shrubs					
Whole farm issues					
2.1 I am an active member in the local watershed coalition					
2.2 I participate in a watershed stewardship planning group if one exists in my region					

[15] Reeves, K. 2008. Chapter 1. Ecosystem Management *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 15- 63.

2.3 Invasive pests (e.g. puncture vine, arundo) are monitored for and when found, removed from the farm					
2.4 An environmental survey of the farm has been done noting the presence of sensitive areas, such oak trees, habitat for endangered species, and other environmental features which affect farming and actual farmable acres such as an NRCS conservation survey[16]					
2.5 I manage my property to protect and/or enhance habitat for threatened and endangered species					
2.6 Some or all of the natural areas of my property is protected by a conservation easement (see education box below)					
2.7 Some or all of my property are protected by an agricultural easement program					
2.8 The farm is managed to optimize ecosystem services such as wildlife, pollinators, and/or arthropod natural enemies and increased biodiversity (see box below for definition of an ecosystem service)					
2.9 Indicators of biodiversity on the farm are monitored and recorded, such as animal and plant populations, pollinators, or arthropod natural enemies					
2.10 Unfarmed areas are maintained to increase biodiversity on the farm including wildlife, pollinators and/or arthropod natural enemies					

What is an ecosystem service?

The biological communities in an agricultural ecosystem provide benefits over and above the commercial crops they produce. These benefits are known as ecosystem services. They include removing carbon dioxide from the atmosphere, reducing greenhouse gases, the recycling of nutrients, regulation of microclimate and local hydrological processes, in some cases they result in the suppression of pest plants and animals through the production of pest natural enemies, and detoxification of noxious chemicals that enter the environment.

Conservation and Agricultural Easements

Conservation easements for protection of natural resources are legal agreements that allow landowners to donate or sell some "rights" on portions of their land to a public agency, land trust, or conservation organization. In exchange, the owner agrees to restrict development and farming in natural habitat, and assures the easement land remains protected in perpetuity. A 1996 study conducted by the National Wetlands Conservation Alliance indicated that the leading reasons landowners restored wetlands were to provide habitat for wildlife, to leave something to future generations, and to preserve natural beauty. Only 10% of landowners surveyed in the study restored wetlands solely for financial profit. This would also apply to other habitats besides wetlands. A conservation easement can provide you with financial benefits for the protection, enhancement, and restoration efforts for the natural environments on your property. The belief that natural resources such as wildlife, especially sensitive species, will reduce your land value is

[16] NRCS has a lot of resources available for helping with environmental planning on the farm. Contact your local NRCS office and see if they can help you.

not true. Many easement programs include some sort of cash payment for a portion of the costs associated with habitat restoration and enhancement.

Agricultural conservation easements are for the explicit purpose of keeping farmland in production. They are similar to natural resource conservation easements, but specifically protect farmland and maintain the practice of farming. In 1996, the state established the California Farmland Conservancy Program to protect farmland by funding the purchase of easements. Based on a study conducted by UC Cooperative Extension and published in 2002, there were 34 local conservation organizations, land trusts, and open space districts that protect farmland through conservation easements (see – *Agricultural Easements: New Tool for Farmland Protection California Agriculture*, January-February 2002, Volume 56:No. 1). Local opportunities may exist for one or both kinds of conservation easements on your property.

Pest Management

Integrated pest management (IPM) is a fundamental part of any sustainable farming program. It is cost-effective, flexible, and resilient. IPM was developed to respond to some significant pest management challenges that developed in the 1950's and 1960's. Events such as the development of pesticide resistance by many pests, secondary pest outbreaks, and environmental contamination due to the use of certain problematic pesticides, led a forward-looking group of entomologists at the University of California to conclude that agriculture was heading toward a pest management crisis. They realized we had forgotten the fact that pest problems are complex and connected to ecosystem processes. They concluded that the solutions to complex ecological problems must be broad-based and take the farm ecosystem into account. These researchers developed the IPM concept to meet the pest management crisis. Since its inception in 1959, IPM has evolved into the best way to manage pest problems on the farm.

University of California Statewide IPM Program crafted the following as the definition of IPM[17]:
Integrated Pest Management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests, or their damage, through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.

Farming is carried out within the ecosystem and is a long-term endeavor, so we want to use management practices that are ecosystem-based and long-term in nature. By using a combination of control techniques to manage a pest problem, we develop a broad-based management strategy that will still be successful even if one particular technique does not work. Also, based on our experience with chemical controls, we know that pest control decisions must take into account not only economic risks, but effects on the environment and people's health as well[18].

Pest Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pest Management Framework for Farm					
1.1 I have an integrated pest management framework/plan for my farm that takes into account the landscape within which I farm, an					

[17] http://www.ipm.ucdavis.edu/IPMPROJECT/about.html
[18] Ohmart, C. P. and C. P. Storm. 2008. Chapter 6. Pest Management. *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 187- 267.

understanding of the cropping system and how it affects the population levels of key pests, includes monitoring protocols and economic thresholds for key pests, monitoring protocols and important pest natural enemies, and the key biological, cultural and chemical control options available for key pests					
1.2 Each year I review the pest management framework with all those involved in pest management on my farm and make adjustments according to my goals and pest management results from the past year					
Risk Assessment					
2.1 Key pests for my farm have been identified in the following groups: diseases, insects, mites, weeds, mammals and birds; and targeted for management					
2.2 Monitoring protocols have been established and are followed for key pests					
2.3 I and/or my Pest Control Advisor (PCA) have established and use economic thresholds for key pests					
2.4 I and/or my PCA keep written spray records containing the information required by California Department of Pesticide Regulation, as well as weather conditions and effectiveness					
2.5 I am aware of the environmentally sensitive areas in and near my field such as distance to ground water, surface water, wetlands, houses, schools, public and private roads					
2.6 I have mapped the environmentally sensitive areas in and near my field, such as distance to ground water, surface water, wetlands, houses, schools, public and private roads					
Monitoring					
3.1 I and/or my PCA follow the UC IPM year round program for processing tomatoes[19]					
3.2 I and/or my PCA use the UC IPM pest management guidelines for tomatoes[20]					
3.3 I and/or my PCA use the UC IPM pest management manual for tomato production[21]					
3.4 I monitor pest populations in my fields					
3.5 A licensed Pest Control Advisor monitors pest populations in my fields					
3.6 I and/or my PCA monitor for pest natural enemies if they are important in controlling key pests and take their numbers in consideration when making pest management decisions					
3.7 Cultural factors, such as time to harvest, preexisting plant damage, plant moisture stress, plant health, and crop load, are considered in					

[19] http://www.ipm.ucdavis.edu/PMG/selectnewpest.tomatoes.html
[20] http://www.ipm.ucdavis.edu/PMG/selectnewpest.tomatoes.html
[21] http://www.ipm.ucdavis.edu/IPMPROJECT/ADS/manual_tomato.html

pest management decision-making if they have significant effects on the risk of damage due to key pests					
3.8 I or my PCA keep qualitative (descriptive) written pest monitoring records and they get shared during the decision making process					
3.9 I and/or my PCA keep quantitative (numeric) written pest monitoring records and they get shared during the decision making process					
3.10 If I rely on pest management recommendations from a PCA, I and/or my farm manager review with them the pest situation before making a decision to take a management action					
3.11 I encourage my crew supervisors and farm managers to report any pest problem that is out of the ordinary (e.g. pests they have never seen before) and report it to the appropriate person					
3.12 Pictures of important invasive pests are posted in convenient places so employees can monitor for their presence					
Pesticide Management					
4.1 Pesticide drift is minimized by using technologies such as air induction nozzles, or some pesticides are applied using chemigation					
4.2 I rotate the use of pesticides according to ‘mode of action’ to minimize development of resistance					
4.3 I keep a written record of pesticide use by ‘mode of action’ as a part of my pesticide resistance strategy					
4.4 A written spray drift management plan has been drawn up for each field that includes a map of the field and location of sensitive areas.Sprayer operators follow the plan.					
4.5 Calibration and spray coverage tests are done at least once a season on my sprayer and are based on manufacturers’ recommendations as well as site characteristics such as crop canopy present					
4.6 Buffer zones have been established for each field based on pesticide label specifications as well as adjacent crops and other sensitive sites					
4.7 Sprays are timed such that there is minimal or no human activity in adjacent areas					
4.8 Dormant season pesticide applications are not made when wind speeds exceed 10mph[22]					
4.9 Dormant sprays are not done in dead calm when a temperature inversion exists to avoid long distance pesticide drift					
4.10 Sprayer nozzles are shutoff at row ends near environmentally sensitive areas					
4.11 There is a berm around the wellhead that prevents surface water running from the perimeter to the wellhead					
4.12 Pesticide mixing and loading area is more than 100 feet from the wellhead unless it is protected by a berm or other physical characteristics that prevent surface water running from the perimeter to the wellhead					

[22] CDPR Rule for Dormant Season Insecticides Fact Sheet

4.13 A separate water supply tank is used for pesticide mixing or chemicals are added to the tank at least 100 feet away from the well.					
4.14 Either a double-check valve, reduced pressure principle backflow prevention device, or an air gap is in place and maintained between the well pump and sprayer tank[23]					
4.15 Pesticide mixing and loading is done using a closed system or with water soluble pesticide packets when available for the pesticide being applied					
4.16 Spray mixing, loading and calibration is planned so that the tank is empty at the end of the spray job					
4.18 I use the following safe pesticide storage practices: dry pesticides stored above liquids, pesticides are stored more than 300 feet from nearest well, storage area is locked and has impermeable floor and sump to contain leaks, and only undamaged containers are stored					
4.17 I have an emergency response plan for pesticide and fertilizer spills and exposure and it is posted in the appropriate places					
4.18 Workers are trained to follow the emergency response plan for pesticide spills or exposure					
4.19 A pesticide risk model such as PRiME[24], WIN PST or UC IPM's Water Tox[25] is used when considering which pesticides to apply					
4.20 The VOC 'footprint' of a pesticide is considered when deciding which pesticides to apply[26]					
Prevention and Cultural Practices					
5.1 I use crop rotation to manage some of my key pests					
5.2 Planting of crop in time to avoid key pests					
Biological control					
6.1 I monitor for pest's natural enemies if they are important in controlling my key pests					
6.2 If a pest natural enemy is important for a key pest, I implement practices that augment their populations like planting nectar sources and avoid using pesticides that may be harmful to natural enemies					
6.3 I release pest natural enemies that have been proven to be effective controls for a key pest					
6.4 Conservation of pest natural enemies is considered when choosing a pesticide to use in the field					
6.5 Conservation of natural enemies is considered when deciding on spray timing					
6.6 I establish areas adjacent to the field to augment natural enemies by growing plants that provide shelter, nectar, and pollen for them					

[23] This is a legal requirement
[24] PRiME is the Pesticide Risk Mitigation Engine and can be accessed at http://ipmprime.org/cigipm/
[25] The model output is accessible at http://www.ipm.ucdavis.edu by viewing the webpage for the pest in question and clicking on the link labeled 'Water Quality Compare Treatments)
[26] http://apps.cdpr.ca.gov/voc-calculator/

Effects of Pest Management on Non-Target Sites & Organisms					
7.1 Effects of a pesticide on pollinators are considered when selecting the material to apply					
7.2 I am a member of the local Irrigated Lands Water Quality Coalition					
7.3 Effects of a pesticide on non-target organisms existing on my farm, such as birds and small mammals, are considered when selecting the material to apply					

Social Responsibility

Each specialty crop will add an introductory paragraph to this section to reflect their goals as they relate to Social Responsibility.

Human Resources Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Staffing and Recruiting Strategy					
1.1 A long term (2-5 years) staffing and recruiting strategy is in place					
1.2 A variety of recruiting methods is used depending on job opening, e.g. word of mouth, newspaper, web recruiting, job fair, temporary or contract services					
1.3 A standard interviewing process is used in recruitment which includes a specific set of review questions					
1.4 A job description exists for each type of job and it is given to the employee and their supervisor					
1.5 Job descriptions are reviewed and updated at least once every two years					
1.6 For non-seasonal employees, an exit interview is conducted to determine why employees left the company					
Employee Orientation, Safety Training, and Career Development					
2.1 An orientation program is provided for new non-seasonal employees					
2.2 Safety training is done according to Cal OSHA regulations, i.e. when employee begins a new job assignment, or any new process, procedure or use of a substance or equipment that creates a new hazard					
2.3 All new employees undergo safety training					
2.4 If labor is contracted, a check is made to ensure contract labor company adheres to all relevant Cal OSHA safety regulations					
2.5 Safety statistics such as time lost due to accidents are tracked and retained for at least 2 years					
2.6 Employees are instructed as necessary to attend training seminars or other educational programs at least once a year that enhance their skills in the workplace					
2.7 Employees are encouraged to attend training seminars or other educational programs at least once a year that enhance their skills in the workplace (e.g. SpraySafe)					
2.8 My company pays for training when required and/or provides tuition reimbursement for work-related college classes					
2.9 A formal career planning process is in place for non-seasonal					

employees					
2.10 Every non-seasonal employee is provided an employee handbook that includes, at a minimum, the company's work standards and policies and an overview of benefits					
2.11 The employee handbook is written in an appropriate language(s)					
2.12 An employee meeting is held at least once a year to discuss company goals and to exchange ideas					
2.13 A meeting of top management is held annually to discuss company goals and exchange ideas					
Staying Informed					
3.1 Trade journals/appropriate trade literature (including literature on worker issues, safety issues, Farm Bureau, trade association literature, etc.) are made available for the farm management team (FMT) to read					
3.2 The FMT has current membership in local grower association(s)					
3.3 The FMT regularly attend regional and/or statewide industry meetings (e.g. irrigation district, Farm Bureau, Water Coalition, etc.), trade shows (e.g. World Ag Expo), and seminars (e.g. UC, CDFA, CSU seminars, research meetings from Commodity Boards)					
3.4 The FMT takes a leadership role in local, regional or state industry associations (e.g. Western Growers, California Grape & Tree Fruit League, Grower-Shipper Association)					
Performance, discipline, grievance process, and employee recognition					
4.1 A job performance process is in place and is linked to pay and promotions					
4.2 A form and process is in place for employees to comment on job satisfaction					
4.3 My company has a grievance process in place and it is documented in the employee handbook					
4.4 Filed grievances are recorded and processed in a timely manner					
4.5 A formal process is in place by which employees are recognized for good job performance and/or years of service					
4.6 A suggestion box is provided in a convenient location so that employees can provide ideas for improvements in company practices, working environment, and other areas.					
Health benefits, paid time off, and other benefits					
5.1 Basic health benefits are provided to non-seasonal employees					
5.2 Non-seasonal employees have paid holidays and vacation time					
5.3 Employees are provided sick leave and/or personal days					
5.4 Non-seasonal employees are provided (or employees are encouraged to) a formal pension plan or a company 401k					

Community Support	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 My company is involved in regional land use planning					
1.2 My company is involved in initiatives, through time commitment and/or donations, that enhance the community such as the Chamber of Commerce, schools/education programs, churches, public health, affordable housing					
1.3 My company is involved in regional water issues such as the regional water quality coalition, irrigation districts, ground water use planning, and/or the irrigated lands waiver program planning					

Waste Management

Sustainable agriculture provides a strategy for managing all aspects of your farming enterprise, including the management of the crop, soil, water, pests and human resources. It also relates to your farm's infrastructure as wel,l such as your offices and shop. While the most interesting part of sustainable farming addresses what happens in the field, it is important not to forget important issues like waste management. In a lot of situations, waste management is one of the most straightforward processes to address on the farm.

Waste Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In field, shop and office					
1.1 The farm has a written waste management plan that includes waste reduction goals, recycling goals, hazardous material use reduction goals					
1.3 The farm has an established recycling program for metal, cardboard, plastics, paper and glass					
1.4 The value of recycling is part of the orientation and training of employees					
1.5 The amount of metals, cardboard, plastics, paper and glass recycled annually vs. the amounts thrown away is determined and year to year comparisons are made					
1.6 The number of tires, batteries used per year and the amount of lubricants purchased vs. the amount sent back or recycled per year is recorded and year to year comparisons are made					
1.7 All unused or worn out items such as appliances, tractors, ATVs, electrical equipment, are taken to the proper recycling centers for disposal					
1.8 The total amount of hazardous materials, other than pesticides and fertilizers, present on the farm is known and their use is tracked on an annual basis (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.9 Employees are trained on the proper handling and disposal of hazardous materials (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.10 Employees are trained on legal requirements related to cleaning of farm equipment with water or steam cleaners and the resulting runoff					
1.11 Hazardous materials no longer used, as well as their containers, are disposed of according to legal requirements					

1.12 The farm participates in the pesticide container recycling program[27]					
1.13 Dumpsters and/or recycling containers are on cement pads to contain spills					
1.14 Dumpsters and/or recycling containers are covered to keep out rain					
1.15 Dumpsters and/or recycling containers are periodically inspected for leaks, spills, and litter. Problems noticed are corrected					
1.16 Bi-lingual signs are posted near the dumpster and/or recycling containers indicating what can or cannot be put in the container					

[27] Use the following link to find out how to participate in an Ag Container recycling program: http://www.acrecycle.org/contact_us.html

Water Management and Water Quality

California is the leading agriculture state in the U.S. by a significant amount. This is due in large part to the high value of the many specialty crops grown in the state. It is also due to the excellent growing conditions such as fertile soils, a Mediterranean climate and the availability of affordable high quality surface and ground water for irrigation. California is also the most populace state in the U.S. and therefore affordable high quality water is needed to support this population. It is clear that because of the demands for high quality, affordable water, this critical resource needs to be used efficiently and effectively by specialty crop producers. The following template will help document practices producers are using to achieve optimum water quality and use efficiency as well as bring to their attention areas where improvements can possibly be made.

Irrigation Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pre-plant Planning					
1.1 Pre-plant analyses of the site was done to identify factors that affect quantity of irrigation water delivery and percolation rate such as existence of soil compaction, a root restricting layer, soil type, soil texture, soil chemistry (pH, salinity, etc.) and soil organic matter					
1.2 Ripping, plowing, chiseling, or other practices were implemented if pre-plant soil tests indicated water percolation and/or drainage problems					
1.3 Soil amendments were applied to correct soil chemical or physical issues if sampling identified factors that would affect water percolation					
1.4 Water source was sampled and evaluated for water quality					
1.5 The irrigation system was designed to deliver the quantity of water required for the crop and accommodation of variation in topography as well as in soil texture that affects water percolation and water holding capacity					
Irrigation Scheduling & Rates					
2.1 I have a written water management plan for my field(s) that includes goals for the growing season and takes into consideration annual rainfall, crop variety, crop maturity, water-related pest management issues, soil type, soil preparation, slope, water quality, irrigation efficiency, irrigation uniformity, energy efficiency					
2.2 I measure and record the total amount of water used in each field every season and calculate water use per unit of crop production.					
2.3 Irrigation is initiated at the start of the season based on visual cues from the crop					

2.4 Irrigation is initiated at the start of the season based on measured soil moisture depletion					
2.5 Irrigation scheduling is influenced by peak energy pricing					
2.6 Water percolation rate and infiltration depth is monitored during the irrigation season and used in making decisions on rates of water applied					
2.7 Soil moisture depletion is estimated by visual inspection of the crop (e.g. growth or development) that indicates plant water stress and used in irrigation scheduling					
2.8 Soil moisture depletion is tracked through soil coring and used in irrigation scheduling					
2.9 Soil moisture depletion is tracked using soil-installed moisture monitoring devices and used in irrigation scheduling					
2.10 Amount of irrigation and timing are dictated by the amount and timing of water available through my Water District					
2.11 Amount of irrigation and timing are based on historical crop evapotranspiration (ET)					
2.12 Water demand of the crop is estimated by determining ETo[28] through using data from the nearest CIMIS weather station and used in irrigation rate and scheduling					
2.13 Water demand from the crop is estimated by converting ETo to Etc by using the appropriate crop coefficient factor (Kc) which takes into account crop canopy and used in irritation rate and scheduling					
Irrigation Performance and System Maintenance – Pumps & Filters					
3.1 Pumping plant efficiency has been measured within at least the last 3 years (for areas where water table fluctuates considerably, pumping plant efficiency should be checked at least once every 2 years) and corrective actions taken if low					
3.2 Pumping plant efficiency has been measured within at least the last 5 years and corrective action taken if low					
3.3 Energy use for irrigation is tracked on an annual basis and related to unit of production					
3.4 Electrical irrigation pumps are on time of use metering					
3.6 Diesel irrigation pumps are Tier 2 or higher					
3.7 A flow meter is installed on wells and/or pumps and I monitor and record the flows					
3.8 Pressure check points are installed on key lines from pumps					
3.9 Filter status (and flushing system) is manually checked at least twice a season and corrected if necessary					
3.10 Pressure gauges are installed for measuring pressure drops through filters					

[28] ETo is the reference evapotranspiration and is calculated using measurements of climatic variables including solar radiation, humidity, temperature and wind speed and is expressed in inches or millimeters of water. It is based on water use for a short mowed full coverage grass crop.

Irrigation Performance & System Maintenance – Drip (If do not use drip skip to 5.1)					
4.1 Distribution uniformity of the irrigation system is tested at least every 2 years					
4.2 The irrigation system is monitored for leaks, breaks, and clogging every irrigation					
4.3 The irrigation system is monitored for leaks, breaks, and clogging at least once a season					
4.4 Fertigation is used to apply most of the fertilizers for the field					
4.5 An interlock system is installed so injection pump shuts down if irrigation pump shuts down to prevent water source contamination					
4.6 Irrigation lines are flushed at the start of the season and then again at mid season, or more often as needed					
Irrigation Performance & System Maintenance – Flood & Furrow					
5.1 The field was laser leveled before planting the crop					
5.2 Levee locations in the field are based on observed infiltration rates (i.e. each check is appropriately sized for maximum water application uniformity)					
5.3 Irrigation produces no tail-water					
5.4 Irrigation produces tail-water and a tail-water recovery system is in place					
5.5 Flow meters are installed and flow volumes recorded on lines from pumps or in supply pipelines or ditches (e.g. Weir notch or Parshall flume) or a record of flow volumes is provided by the Water District					
Water quality – Source and resource					
6.1 Irrigation water is tested at least every 3 years for quality, including pH, total salt, nitrates, and biological problems. The quality of water in distribution reservoirs is tested if they are present on the farm.					
6.2 If a water quality problem exists, it is addressed					
6.3 I have accessed resource maps to determine if my field(s) are in Ground Water Protection Areas (GWPA)[29]					
6.4 If a field is in a GWPA I have accessed and read the legal requirements for handling restricted use pesticides in GWPA areas and they are on file in the office					
6.5 I have identified and mapped areas on the farm that are potential sites for pesticides and fertilizers to enter the ground water					
6.6 The wellhead is situated so no surface water can reach it or a berm has been placed around the wellhead that prevents surface water from reaching it					
6.7 Return water wells, older wells and abandoned wells are sealed to prevent ground water contamination					
6.8 Irrigation practices create no off-site movement of chemical residues and sediments					

[29] http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpamaps.htm

6.9 If storm water run-off occurs, one or more of the following mitigation practices are implemented: filter fabric fencing; filter strip; straw bale check dam; straw bale water bars; sediment basin; or other containment system					
6.10 Cover crops/vegetation is maintained on drain ditches and non-paved minor roadways to minimize rainfall run-off from field					
6.11 Soil percolation problems in the field have been addressed to minimize off-site movement of irrigation or storm water					

Self-Assessment for Fresh Market Onion Production

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Funded by a California Department of Food and Agriculture
Specialty Crop Block Grant to SureHarvest

[1] SureHarvest, 2901 Park Ave Suite A2, Soquel CA 95073
[2] Triple Crown Consulting, Fresno CA
[3] Environmental Consulting for Agriculture, Davis CA
[4] Sustainable Conservation, 201 Needham St, Modesto CA 95354

Project History

Over the last 10 years the field of sustainable agriculture has become more and more important in the eyes of food retailers, buyers and consumers. As is often the case when new concerns arise in relation to food and food production, the spot light shines on the grower. Sustainable agriculture is challenging to define, and once defined it can be challenging for a grower to figure out how to implement it on the farm in an economically viable way. To meet these challenges a group of specialty crop trade associations, NGO's, and other specialty crop stakeholders met to discuss the topic of sustainable agriculture. One outcome of these discussions was an application to the California Department of Food and Agriculture Specialty Crop Block grant program for funds to hire sustainable agriculture professionals to help develop a plan to meet the challenges presented by sustainable agriculture. The Great Valley Center coordinated the grant application and engaged SureHarvest to provide the technical expertise. SureHarvest is a company with extensive experience in sustainable agriculture strategic planning, program design, and program implementation. The grant application was successful and began in September of 2009. The Great Valley Center directed the project and contracted with SureHarvest for project design, facilitation and implementation.

The grant had two primary goals. The first was to develop, through a stakeholder process, a sustainable agriculture strategic plan that each of the participating groups could use internally to help lay the foundation for their own sustainable agriculture program specific to their specialty crop. The second was to develop a tool, or tools, that could be used by their member growers to put the strategic plan into action on the farm.

The following paragraphs contain the sustainable agriculture strategic plan developed by the project leadership team, the members of which are listed in Table 1.

Sustainability Strategic Plan for the Multi-Commodity Project
June 2011

The sustainability strategic plan for the Multi-Commodity Project is based on SureHarvest's 5 P's of sustainability framework. The 5 P's are: Principles, Processes, Practices, Performance Metrics, and Progress. They are defined as follows:

1. Principles – This is the sustainable vision for the project. It consists of the goals that the participants want to achieve from the design and implementation of the project.
2. Processes – These are the resource areas on the farm that need to be addressed in order to meet the principles or goals of the project. For example, this could be water, energy, and human resources management.
3. Practices – These are the practices that are implemented on the farm that impact the processes or resource areas. They are the on-the-ground actions that are carried out to assure that the principles or goals of the sustainable program are met.
4. Performance Metrics – These are the metrics used to measure the outcomes resulting from the practices implemented on the farm. There are many - examples include crop quality, water use, energy use, and worker satisfaction. Performance Metrics are used to measure the level of success in meeting the principles or goals of the project.

5. Progress – The process used to improve performance over time and communicate the results internally and externally. In other words, tracking the degree of progress one is making towards achieving the goals of the project. Measuring progress will require some kind of system for assessing the farm's performance over time, creating action plans to improve particular areas of performance, and reassessment over time to track progress.

Table 1. Multi-Commodity Project Leadership Team

Organization	Representative
Almond Board of California	Gabriele Ludwig*, Robert Curtis*
Bolthouse Farms	Troy Elliott*, Justin Groves*
California Grape & Tree Fruit League	Chris Valadez*, Barry Bedwell
California Specialty Crop Council	Lori Berger*
California Garlic & Onion Research Advisory Board	Robert Ehn
California Olive Council	Patty Darragh
California Pear Advisory Board	Bob McClain
California Pepper Commission	Glen Fischer*
California Pistachio Board	Robert Klein*
California Raisin Marketing Board	Gary Schultz
California Tomato Farmers	Ed Beckman*
California Tree Fruit Agreement	Gary VanSickle*, Lauren Friedman
California Walnut Board	David Ramos
Del Monte Foods	Pat McCaa
Sun-Maid Growers	Rick Stark*

*Leadership Team Member

Multi-Commodity Project Principles (1st P):

The principles for the Multi-Commodity Project were established by the Project Leadership Team. They are:

1. Create a resource area/practice template that:
    a. Will focus on increasing the economic performance for the participant.
    b. Is scalable and can be used by participating groups to accomplish the goals of their own sustainability programs.
    c. Provides the participant the ability to gauge the state of sustainability of the industry and their farm.
    d. Encourages continual improvement on the farm.
    e. As a whole encourages ecological harmony.
    f. Better defines the 3 E's of sustainability (economic viability, environmental soundness and social equity/responsibility) in a way we can all agree upon.
    g. Is open to and usable by any individual or group in the future that was not involved in the original effort.
    h. Benefit the participants and not result in unintended negative consequences.

2. The program should provide the information/data needed for groups to tell their sustainability story better to all their audiences, e.g. buyers, regulators, consumers, NGO's.
3. The outcomes from the project cause no harm to producers.

The Leadership Team of the Multi-Commodity Project decided the best tool for implementing their sustainability strategic plan was a self-assessment of practices template that stakeholders from specific specialty crops could then fine tune for their own use. The team chose to use the model developed by the California Sustainable Almond Program (CASP), which is a California Almond Board program developed in partnership with SureHarvest. The Leadership Team formed a stakeholder committee to draft the self-assessment template that covered the practice areas listed in the Multi-Commodity Project Strategic Plan. The Stakeholder Committee members are listed in Table 2.

Individual Contact	Title	Expertise
Billy Heller	Grower, Pacific Triple E Farms	Crop management
Bob Giampaoli	Grower, Live Oak Farms	Crop management
Cliff Sadoian	Grower	Crop management
Pat McCaa	Manager, Pest Management, Del Monte Foods	Crop management
Mechel S. Paggi (Mickey)	Director, Center for Agricultural Business, California State University, Fresno	Ag Business & economics
Glen Fischer	Ag Representative, Saticoy Foods Inc.	Crop management
John Trumble	Professor of Entomology, University of California Riverside	Pest management
Jeff Mitchell	Extension Specialist, University of California, Davis	Soils & plant nutrition
Pete Goodell	UC IPM Area Advisor, University of California, Davis	Pest management
Terry Prichard	Extension Specialist, University of California, Davis	Irrigation & crop water relations
Bill Peacock	Representing raisin growers via the Raisin Marketing Board and Tree Fruit Growers	Crop management
Troy Elliott	Director of Agronomy, Bolthouse Farms	Crop management

Table 2. Multi-Commodity Project Stakeholder Committee

The second phase of the Multi-Commodity Project began with SureHarvest obtaining a CDFA Specialty Crop Block Grant to finish the self-assessment template with the Multi-Commodity Leadership Team and Stakeholder Committees and then fine-tune the template into workbooks for individual specialty crops working with willing growers and stakeholders from each specialty crop community. The self-assessment workbook for fresh market onions which is presented on the following pages was developed using the Multi-Commodity self-assessment template through a series of reviews and edits by growers, other stakeholders and SureHarvest staff. Gills Onions and Dr. Richard Smith, University of California Cooperative Extension was particularly helpful during the review process. The final version was produced by SureHarvest and submitted to CDFA along with their final report in June of 2013.

Air Quality Management

Pressure is being brought to bear on urban and rural industries, including agriculture, to reduce air pollutants in the Great Central Valley of California. This section of the self-assessment will help the grower identify practices that influence air quality, highlight where the grower is doing well, and determine areas that need improvement.

Air Quality Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In Field and Adjacent Land					
1.1 To minimize airborne dust and PM10[5] particles a reduced tillage program is in place					
1.2 If tillage is done, moisture content of the soil is taken into consideration to minimize dust					
1.3 Vegetation is maintained on non-cropped areas such as headlands, roadsides, and field edges to reduce wind erosion causing airborne dust (may need to remove due to food safety concerns)					
1.4 Crop residues are incorporated into the soil post-harvest					
Roads					
2.1 Vehicle speed is restricted on dirt roads around fields to minimize airborne dust					
2.2 Dirt roads are treated with an anti-dust agent that meet the 50% PM10 control for a Fugitive PM10 Management Plan[6] 9 (note: committee recommended put the list in this document, it will be added to the fine-tuned workbooks. The list is about 2 pages long, see the website below for copy)					
2.3 Dirt roads are graveled, watered, chipped, mulched (crop residues), sanded or seeded					
2.4 Heavily used roads are paved (e.g. main thoroughfares on farm)					
Engines and Fuel Consumption					
3.1 Engines are maintained on a regular schedule to ensure they are running at optimum performance and efficiency and emissions are minimized					
3.2 At least some vehicles are equipped with engines able to use					

[5] PM 10 are particles 10 microns in diameter or smaller and pose a health risk because they pass through the throat and nose and penetrate the lungs.
[6] For details see http://www.airquality.nrcs.usda.gov/Documents/files/Dust_Control_Products.htm

alternative fuels with lower emissions (e.g., compressed natural gas, flex fuel, biodiesel, propane)					
3.3 Some off-road farm vehicles are battery powered (e.g. golf carts)					
3.4 Vehicle miles are tracked on an annual basis					
3.5 Stationary diesel engines have been replaced (or retrofitted) to Tier 3 or better (e.g. 2007 or newer)					
3.6 Stationary diesel engines have been replaced (or retrofitted) with technology relying on cleaner burning fuel (e.g. propane, natural gas, biodiesel) or replaced with electric pumps					
3.7 Selection of vehicle power plants and stationary engines is in part determined by lower emissions ratings					
3.8 Some of the farm's energy requirements are obtained through renewable sources such as wind, solar, bio-methane, and/or biofuels					
Pesticide Management and Air Quality					
4.1 Soil fumigants are used only when necessary and applied appropriately (e.g. pre-planting where soil sampling has identified a significant pest problem, proper soil moisture conditions exist and that all regulations have been met)					
4.2 When choosing a pesticide to apply its VOC 'footprint' is considered[7]					
4.3 Practices are implemented that reduce pesticide drift such as use of air induction nozzles, , not spraying when a temperature inversion exists in the field, and when wind exceeds 10 mph or the velocity specified on the label.					
Greenhouse Gas Emissions					
5.1 CO_2 and N_2O production on the farm are calculated and tracked					

What are VOC's?

VOC stands for volatile organic compound. These are carbon based compounds contained in products used on the farm, such certain pesticides, that volatilize (evaporate) when exposed to the air. Ground-based ozone is produced by chemical reactions involving VOC's, nitrogen oxides (NOx) and sunlight. While not direct air pollutants themselves, VOC's are important ozone precursors, and are considered key targets for reduction in the Central Valley of California in regions where air quality is an issues. The California Department of Pesticide regulation does not know the reactivity of every VOC and ideally reactivity should be used to precisely determine VOC emissions. That said, appropriate data and analytical methods do exist at this time to make accurate estimates. The Department does hope to use reactivity at some point in the future. It calculates VOC emissions based on the best available science (Dr Matt Fossen, pers. comm., Environmental Scientist, Calif. Dept. Pesticide Regulation). Air Quality and greenhouse gas emissions are such important topics in the Central Valley of California it is important to consider the various sources of potential air quality problems.

[7] A VOC calculator is found at: http://apps.cdpr.ca.gov/voc-calculator/

Energy Management

Energy is essential for crop production and it comes in several forms; as sunlight to power photosynthesis, as fuel to power our internal combustion motorized vehicles and pumps, and as electricity to power our shop and office lights and electronic equipment. Tracking energy is very important because it is getting more and more expensive all the time, increasing our cost of production. Burning of fuel produces greenhouse gases (GHG's) affecting air quality and possibly contributing to climate change. So minimizing energy consumption saves money and reduces GHG production. Completing this section should help improve your understanding of energy use in your operation and encourage you to consider some forms of energy conservation.

Energy Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 The total amount (gallons) of fuel used annually on the farm in all operations is recorded and year to year comparisons are made. Each fuel type is recorded.					
1.2 The total amount of fuel used annually per acre and per unit of crop production is determined and year-to-year comparisons are made[8]					
1.3 The total amount of fuel used annually is calculated for each field (i.e. management unit) and year-to-year comparisons are made. Each fuel type is recorded.					
1.4 Annual fuel consumption and/or electrical use for irrigation pumps are recorded and comparisons made from year-to-year.					
1.5 Electrical use for office(s), shop(s), and outdoor security lighting is tracked using energy bills and year-to-year comparisons are made					
1.6 Fuel and electricity used are converted to a common metric such as British thermal units (Btu's) so they can be combined to calculate the total amount of energy used annually for crop production and year to year comparisons are made[9]					
1.7 The amount of energy used <u>annually per acre and per unit of crop production</u> is calculated and year to year comparisons are made					
1.8 The amount of energy used annually in each field is calculated and					

[8] This can be a simple calculation of dividing the total gallons of fuel used for the year divided by the total amount of crops produced for the year

[9] Energy conversion calculators for kilowatt hours to BTU's and gas or diesel to BTU's are readily and freely available on the Internet. For example using Google type 'convert gas to BTU's and you will be directed to a website where a calculator is available to make your conversion. Simply type in the number of gallons of gas and the calculator will produce the number of BTU's it represents.

year-to-year comparisons are made					
1.9 An energy management plan is being implemented on the farm that includes yearly goals for overall energy use as well as energy used per unit of crop production[10]					
1.10 A process is in place to ensure that the most appropriate piece of equipment is used for a given job (e.g. the most appropriate horse power engine for the job)					
1.11 One or more solar energy systems are installed on the property to generate electricity					
1.12 One or more wind generators are installed on the property to generate electricity					
1.13 Residue from crop production is used in a cogeneration plant					
1.14 Engines (stationary and mobile) and motors are maintained on a regular schedule to ensure they are running at an optimum fuel efficiency or optimum efficiency					
1.12 Pumping plant efficiency (energy per acre foot pumped) is checked every 1 to 3 years (based on use) and adjustments made if necessary (FSU website recommends every 1-3 years based on use)					
1.13 At least some light switches are fitted with motion detectors or photo cells to reduce time of use					
1.14 At least some office and shop lights have been fitted with low energy consumption compact florescent bulbs or LED lights.					

Indirect Energy Use/Consumption:

Energy is directly expended when driving a vehicle, operating a pump, photocopying, or turning on and using a light bulb. Energy is also expended to manufacture inputs that are used on the farm, such as fertilizers, compost and pesticides. This type of energy consumption is called imbedded energy. If you want to figure out the total amount of energy consumed to produce a crop then calculations should also be made to determine the amount of embedded energy that was consumed to produce the fertilizers, compost, and pesticides that were used to produce the crop.

[10] Ideally one would convert all energy consumption to BTU's (British Thermal Units) but initial energy management plans could start with using gallons of gasoline and diesel and kilowatt hours for electricity.

Financial Management

The economic E of sustainable farming is literally where the buck stops. If a farm is not profitable, it is not sustainable. People farm not because they want to be accountants. They farm because they want to grow things. However, while financial management may be a challenging part of farming, doing it well is one of the keys to a successful and sustainable farm. This chapter will help the grower recognize strengths in financial management as well as point out areas where improvements are needed.

Financial Management **(The most appropriate person to fill out this section/chapter is the CEO/owner of the farm)**	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Planning and Risk Management					
1.1 A marketing and production plan has been developed for my farm and seasonal outcomes are compared to these plans					
1.2 A succession[11] plan is in place for the farm					
1.3 I have a written will and estate plan for the farm[12]					
1.4 A disaster[13] management plan has been developed for the farm to provide guidance in the event of a disaster such as earthquake, fire, or flood.					
1.5 Key personnel in the company have health insurance					
1.6 Key personnel in the company have disability insurance					
1.7 Key personnel have life or accidental death insurance					
Accounting and Financial Analyses					
2.1 I use a financial accounting system to track and report farm finances and use it to make decisions about my farming operation					
2.2 I understand how to interpret both cash and accrual financial statements including a balance sheet, income statement, cash flow, and financial ratios					
2.3 I meet with a financial advisor on an annual basis					
2.4 Financial profitability analyses for investments are done if investments are made					
2.5 The revenue and returns are tracked for each field/management unit					

[11] A succession plan is one where the change in leadership in the company has been determined, whether it is expected such as the CEO voluntarily stepping down/retiring, or unexpected such as due to illness or accident.
[12] An estate plan is a plan for the financial assets to pass from one generation to the next. It does not deal with the human and intellectual capital and passing that transition to the next generation. That is succession planning.
[13] Disaster in this case is not just weather but also unexpected death of one or more key company personnel.

in my financial management reports					
2.6 Costs and returns are tracked for all important farming practices					
2.7 Costs and returns are tracked for implementing new sustainability practices and compared to costs and returns of practices they replaced					
2.8 Sensitivity analysis, i.e. change in crop prices over time, is used to analyze financial risk over time					
Purchasing and Borrowing					
3.1 More than one quote is obtained for major input purchases such as pesticides and fertilizers					
3.2 Interest rates and services from more than one lending institution are compared before borrowing a significant amount of money					

Food Safety Management

How do we ensure that fresh food is safe? This is a question that is being debated by everyone all along the supply chain. Compliance with food safety production requirements is becoming a necessary requirement for many specialty crops. This section lists practices that are related to food safety management and planning.

Food Safety Management	Not Familiar	Familiar, not tried	Have tried it	Currently Use	Not applicable
Food Safety Management Planning					
1.1 A written food safety policy is in place for the farm that includes a commitment to food safety, how it is implemented, and how it is communicated to the employees.					
1.2 A written food safety plan is in place that identifies all locations of the farm and products covered by the plan. The plan addresses potential physical, chemical, and biological hazards and hazard control procedures, including monitoring, verification and record keeping, for the following areas: water, soil amendments, field sanitation, production environment and worker practices					
1.3 The food safety plan is reviewed at least annually					
1.4 Record keeping is kept to demonstrate the food safety plan is being followed					
1.5 A person has been designated as being responsible for food safety functions on the farm					
1.6 All employees are trained in food safety procedures and practices on the farm					
Food Safety Risk Assessment of Field					
2.1 An assessment has been made of the production field focusing on the likelihood of intrusions by animals that pose significant food safety risks (e.g. deer, pigs, livestock) and, if necessary, actions are taken to reduce the likelihood of intrusion					
2.2 An evaluation has been made on land and waterways adjacent to the field for possible sources of human pathogens of concern (e.g. manure storage, CAFO's, grazing/open range areas, surface water, sanitary facilities and composting operations)					
2.3 An assessment of historical land use has been made to determine any potential issues from these uses that might impact food safety (e.g. hazardous waste sites, landfills, etc.)					
2.4 My company participates in a third party food safety certification					

program (e.g. Agriculture Marketing Service GAP Certified, Scientific Certification Systems, Primus. Global GAP)					
Water					
3.1 The water system description for the field/ranch has been created that indicates, either with drawings or maps, the location of permanent fixtures, such as pumps, wells, underground lines, gates & valves reservoirs, and returns					
3.2 Irrigation water and water used in harvest operations is tested for microbial quality, and if microbial levels are above specific action levels, corrective actions are taken					
3.4 Records of all water tests are retained, along with Certificates of Analysis, for at least 2 years					
3.5 Irrigation pipe and drip tape are stored in a manner that reduces or eliminates the potential for pest infestation					
3.6 Water applied to edible portions of the crop, either as overhead irrigation or pesticide applications, is tested for microbial quality					
Organic Soil Amendments					
4.1 Raw manure or a soil amendment that contains un-composted or incompletely composted or non-thermally treated animal manure is not applied to field					
4.2 If compost is applied, it is sourced from a supplier that provided their written Standard Operating Procedures that prevents cross-contamination of finished compost with raw materials through equipment, runoff or wind.					
4.3 If organic soil amendments are used microbial testing is performed by the supplier prior to application					
Sanitation					
5.1 Toilet facilities are readily available to all field employees and are located according to Cal OSHA regulations					
5.2 Toilet facilities are clean and maintained on a regular basis					
5.3 Field employees are trained on the importance of sanitation in the field					
5.4 Field sanitation units are accessible to all employees					
5.5 A response plan is in place in the event of a spill from toilet or sanitation facilities and employees are trained to implement it					
5.6 Workers are educated on sanitation issues such as not working on the job while sick or injured (e.g. infected cuts)					
Harvesting and Transportation					
6.1 A traceability system is in place and appropriate for my crop					
6.2 A mock recall has been done to check the effectiveness of the traceability system (mock recalls would usually be done in conjunction with a packer/shipper or processor)					

6.3 All harvesting containers and bulk hauling vehicles that come into direct contact with the harvest crop are cleaned and/or sanitized on a scheduled basis using a written record system					
6.4 Packaging materials used in field operations are properly stored and protected from contamination					
6.5 Harvesting equipment that comes into contact with the crop is kept in good repair					

Land Resources

Soil Management

Soil is the most complex ecosystem on earth. Gaining a greater understanding of the soil resource in your fields is critical for making informed soil management decisions. Knowing your soil resource gives you greater control over yield and crop quality and is especially important in determining the long-term sustainability of your farm.

Soil provides the crop with three vital things: water, nutrients and air. These three things are best provided by a soil with good depth and structure i.e. a soil in which the particles are bound together into small clumps (aggregates) of varying size. Soil aggregation is a measure of soil structure. Soil organic matter is important in maintaining soil structure by gluing soil minerals together into aggregates. Spaces between large aggregates (measured as millimeters) permit rapid drainage and easy root growth, and spaces between small aggregates (measured as less 1 millimeter down to 0.001 millimeter) trap water for use between irrigation and rain events. One of the more important aspects controlling aggregate stability is the amount of microbial activity and soil organic matter. Stable aggregates occur in varying sizes and are created by the cementing action of microbes and their byproduct and soil organic matter. The assemblage of soil aggregates creates habitat to promote faunal and microbial diversity, an important index of soil quality. Due to the warm to hot California climate soil organic matter is low in many soils due to rapid breakdown of soil organic matter.
The following self-assessment template will help document the practices producers are using to managing their soil sustainably as well as suggest areas where improvements might be possible.

Soil Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Knowledge of soil properties					
1.1 A soil map has been created for the field with the soil types identified using NRCS soils maps or other mapping tool					
1.2 Soil properties for each soil type in the field is recorded, including soil moisture holding capacity, texture, and rooting depth					
1.3 A soil sample has been taken in the field more than 6 years ago and analyzed for macro and micro nutrients					
1.4 A soil sample has been taken in the field within the last 6 years and analyzed for macro and micro nutrients as well as soil chemistry (e.g. pH, CEC, salts)					
1.5 A soil sample has been taken in the field within the last 4 years and analyzed for macro and micro nutrients as well as soil chemistry (e.g. pH, CEC, salts)					

1.6 A soil sample has been taken in the field within the last 2 years and analyzed for macro and micro nutrients as well as soil chemistry (e.g. pH, CEC, salts)					
1.7 If soil pH is less than 5.5 it is amended with lime and if it is above 8.0 it is amended with an acidifying agent					
Soil properties management					
2.1 If water infiltration is poor (water puddles and runs off when soil is dry underneath) the soil is amended either chemically (e.g. with gypsum or organic matter such as compost or manure) or physically (e.g. chiseling or shallow ripping)					
2.2 Cover crops are grown during fallow periods on at least a portion of the production acreage to add organic matter and nutrients to the soil and to improve water infiltration[14]					
2.3 If soil organic matter is low for the soil series in my field I have an ongoing program to build soil organic matter either through additions of compost, manure and growing cover crops or a combination of them					
2.4 Equipment is chosen or is modified to minimize soil compaction (e.g. lightest equipment possible, track-layers, wider or bigger diameter tires, tire pressures as low as possible)					
2.5 Tillage passes are fewer than most neighboring farms producing the same commodity					
2.6 Tillage passes are about the same as most neighboring farms producing the same commodity.					
2.7 GPS technology is used to minimize the overlap of tillage which saves fuel and minimizes tillage passes					
Crop nutrition management					
3.1 I have a written crop nutrient management plan that uses a 'budgeting approach'[15] in determining the nutrient needs of the crop and takes into consideration factors like crop tissue analyses, soil type, time of year, soil moisture, yield, nutrient content of any organic amendments, etc. (insert an educational box discussing the 4 R's of nutrient management; see http://www.ipni.net/4r)					
3.2 The crop's nutrient management plan is based solely on the recommendations as given by my field consultant and/or from the soil testing lab					
3.3 With the help of my field consultant I am able to interpret the lab results from the field soil samples and we use them in the crop nutrient management plan					

[14] Smith R.., R. L. Bugg, M. Gakell, O. Daugovish, M. Van Horn. 2011. Cover cropping for vegetable production: A grower's handbook. Univ. Calif. Ag. Nat. Res. Publ. 3517. 90pp.

[15] A budgeting approach means that the amount of nutrients leaving the field in the crop is estimated and the amount of nutrients added back to the field is based on this estimate. A one -to-one replacement is not implied or required since factors such as soil type affect nutrient availability to the crop and these factors must also be taken into account.

3.4 I am able to interpret the lab results from the soil samples and I use them in my crop nutrient management plan, particularly for phosphorus and potassium[11]					
3.5 Plant tissue are taken and analyzed at least once a season and used to help assess crop nitrogen needs[16]					
3.6 I record from year-to-year the amount of nitrogen applied per acre and calculate the amount of N applied per unit crop production					
3.7 I record from year-to-year the amount of phosphorus applied per acre and calculate the amount of P applied per unit crop production					
3.8 I record from year-to-year the amount of potassium applied per acre and calculate the amount of K applied per unit crop production					
3.9 Fertilizers are applied using Fertigation					
3.10 No more than one third of total amount of nitrogen needed for the crop is applied pre-planting or at planting.					
3.11 The total amount of post-planting nitrogen needed for the season is applied in a split application(s), which the minimum being two applications of 1/3 the season's requirements, one at early season and the other mid-season					
3.12 Fertilizers are applied using a 'spoon feeding' approach where only the amount of nutrients required by the crop at the time are applied and multiple applications are made throughout the growing season based on crop growth stage and nutrient demand					
3.13 Micro nutrients are applied on a regular basis without reference to crop needs or crop history					
3.14 Micro nutrients are applied based on past crop history					
3.15 Micro nutrients are applied based on soil sample test results					
3.16 Micro nutrients are not applied because there is already an adequate amount in the soil					
3.17 I use the following safe fertilizer storage practices: fertilizers are stored more than 300 feet from nearest well, storage area has impermeable floor and sump to contain leaks, an only undamaged containers are stored					
3.18 Fertilizers are stored separately from pesticides to prevent contamination between them; this can be a physical barrier like a wall.					
3.19 Organic fertilizers are stored in a manner to prevent contamination of surface water.					
Soil erosion					
4.1 Vegetation is maintained along farm roads, on field edges, and along irrigation canals not controlled by the irrigation district					
4.2 I know the infiltration/run-off rates of the field's soil and the rate of irrigation water is applied and is adjusted according					

[16] Voss, R. E. and K. S. Mayberry. Dehydrator bulb onion production in California. Univ. Calif. Div. Ag. Nat. Res. Publ. 7239. 3pp.

4.3 No tillage is done on field borders or along irrigation canals					
4.4 Ditches have been grassed or hardened to prevent down-cutting					
4.5 Culverts are properly sized to accommodate high flows, and inlets and outlets have been hardened to prevent scour or energy dissipaters have been installed					

Ecosystem Management

An ecosystem is the complex community of living organisms and their physical environment functioning as an ecological unit. Components of an ecosystem are inseparable and interrelated. An ecosystem management approach to growing specialty crops acknowledges that people are a part of and have a significant impact on ecosystem structures and processes, and that people depend on and must assume responsibility for the ecological, economic, and social systems where they live. Ecosystem management is currently being encouraged and implemented by communities, government agencies, businesses, academics and various conservation organizations throughout the world[17].

Ecosystem Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Habitat maintenance and enhancement[18]					
1.1 Field borders, roadsides, and ditch-banks are kept free of vegetation					
1.2 Hedgerows of trees and/or shrubs are maintained on at least some field edges					
1.3 Vegetation such as grasses, trees or shrubs are maintained along roadsides, ditch-banks and headlands					
1.4 Trees have been planted to provide habitat for wildlife					
1.5 Trees are maintained to provide habitat for wildlife					
1.6 Nesting boxes for owls have been placed around the farm and they are cleaned annually					
1.7 Perches for raptors have been placed around the farm					
1.8 If water courses exist on my property crops are planted up to the edge of water courses					

[17] Reeves, K. 2008. Chapter 1. Ecosystem Management *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 15- 63.
[18] Food safety rules do not allow these practices for the processing industry. These could be OK for smaller growers. The National Onion Association does not have rules, but buyers make companies adhere to the Leafy Green Marketing Agreement and other food safety rules. (comment from Gills Onions reviewers)

1.9 If water courses exist on my property setbacks are in place to minimize disturbance					
1.10 If water courses exist on my property resident vegetation is maintained on the banks					
1.11 If water courses exist on my property banks are vegetated with a mix of grasses, trees and shrubs					
Whole farm issues					
2.1 I am an active member in the local watershed coalition					
2.2 I participate in a watershed stewardship planning group if one exists in my region					
2.3 Invasive pests (e.g. puncture vine, arundo) are monitored for and when found removed from the farm					
2.4 A formal or informal environmental survey of the farm has been done noting the presence of sensitive areas, such as vernal pools, swales, oak trees, habitat for endangered species, and other environmental features which affect farming and actual farmable acres such as an NRCS conservation survey[19]					
2.5 I manage my property to protect and/or enhance habitat for threatened and endangered species					
2.7 Some or all of the natural areas of my property is protected by a conservation easement (see education box below)					
2.8 Some or all of my property are protected by an agricultural easement program					
2.9 The farm is managed to optimize ecosystem services such as wildlife, pollinators, and/or arthropod natural enemies and increased biodiversity (see box below for definition of an ecosystem service)					
2.10 Indicators of biodiversity on the farm are monitored and recorded, such as animal and plant populations , pollinators, or arthropod natural enemies					
2.11 Unfarmed areas are maintained to increase biodiversity on the farm including wildlife, pollinators and/or arthropod natural enemies					

What is an ecosystem service?

The biological communities in an agricultural ecosystem provide benefits over and above the commercial crops they produce. These benefits are known as ecosystem services. They include removing carbon dioxide from the atmosphere, reducing greenhouse gases, the recycling of nutrients, regulation of microclimate and local hydrological processes, in some cases they result in the suppression of pest plants and animals through the production of pest natural enemies, and detoxification of noxious chemicals that enter the environment.

What are Conservation and Agricultural Easements?

[19] NRCS has a lot of resources available for helping with environmental planning on the farm. Contact your local NRCS office and see if they can help you.

Conservation and Agricultural Easements

Conservation easements for protection of natural resources are legal agreements that allow landowners to donate or sell some "rights" on portions of their land to a public agency, land trust, or conservation organization. In exchange, the owner agrees to restrict development and farming in natural habitat, and assures the easement land remains protected in perpetuity. A 1996 study conducted by the National Wetlands Conservation Alliance indicated that the leading reasons landowners restored wetlands were to provide habitat for wildlife; to leave something to future generations; and to preserve natural beauty. Only 10% of landowners surveyed in the study restored wetlands solely for financial profit. This would also apply to other habitats besides wetlands. A conservation easement can provide you with financial benefits for the protection, enhancement, and restoration efforts for the natural environments on your property. The belief that natural resources such as wildlife, especially sensitive species, will reduce your land value is not true. Many easement programs include some sort of cash payment for a portion of the costs associated with habitat restoration and enhancement.

Agricultural conservation easements are for the explicit purpose of keeping farmland in production. They are similar to natural resource conservation easements, but, specifically protect farmland and maintain the practice of farming. In 1996, the state established the California Farmland Conservancy Program to protect farmland by buying easements. Based on a study conducted by UC Cooperative Extension and published in 2002, there were 34 local conservation organizations, land trusts, and open space districts that protect farmland through conservation easements (see – *Agricultural Easements: New Tool for Farmland Protection California Agriculture*, January-February 2002, Volume 56:No. 1). Local opportunities may exist for one or both kinds of conservation easements on your property.

Pest Management

Integrated pest management (IPM) is a fundamental part of any sustainable farming program. It is cost-effective, flexible, and resilient. IPM was developed to respond to some significant pest management challenges that developed in the 1950's and 1960's. Events such as the development pesticide resistance by many pests, secondary pest outbreaks, and environmental contamination due to the use of certain problematic pesticides led a forward-looking group of entomologists at the University of California to conclude that agriculture was heading toward a pest management crisis. They realized we had forgotten the fact that pest problems are complex and connected to ecosystem processes. They concluded that the solutions to complex ecological problems must be broad-based and take the farm ecosystem into account. These researchers developed the IPM concept to meet the pest management crisis. Since its inception in 1959, IPM has evolved into the best way to manage pest problems on the farm.

University of California Statewide IPM Program crafted the following as the definition of IPM[20]:
Integrated Pest Management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.

Farming is carried out within the ecosystem and is a long-term endeavor so we want to use management practices that are ecosystem-based and long-term in nature. By using a combination of control techniques to manage a pest problem, one develops a broad-based management strategy that will still be successful even if one particular technique does not work. Also, based on our experience with chemical controls, we know that pest control decisions must take into account not only economic risks, but effects on the environment and people's health, as well[21].

Pest Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pest Management Framework for Farm					
1.1 I have an integrated pest management framework/plan for my farm that takes into account the landscape within which I farm, an					

[20] http://www.ipm.ucdavis.edu/IPMPROJECT/about.html
[21] Ohmart, C. P. and C. P. Storm. 2008. Chapter 6. Pest Management. *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 187- 267.

understanding of the cropping system and how it affects the population levels of key pests, includes monitoring protocols and economic thresholds for key pests, monitoring protocols and important pest natural enemies, and the key biological, cultural and chemical control options available for key pests					
1.2 Each year I review the pest management framework with all those involved in pest management on my farm and make adjustments according to my goals and pest management results from the past year					
Risk Assessment					
2.1 Key pests for my farm have been identified in the following groups: diseases, insects, mites, weeds, mammals and birds; and targeted for management					
2.2 Monitoring protocols have been established and are followed for key pests					
2.3 I and/or my Pest Control Advisor (PCA) have established and use economic thresholds for key pests					
2.4 I and/or my PCA keep written spray records containing the information required by California Department of Pesticide Regulation as well as weather conditions and effectiveness					
2.5 I am aware of the environmentally sensitive areas in and near my field such as distance to ground water, surface water, wetlands, vernal pools, swales, houses, schools, public and private roads					
2.6 I have mapped the environmentally sensitive areas in and near my field such as distance to ground water, surface water, wetlands,vernal pools, swales, houses, schools, public and private roads					
Monitoring					
3.1 I and/or my PCA use the UC IPM pest management guidelines for onions[22]					
3.2 I monitor pest populations in my fields					
3.3 A licensed Pest Control Advisor monitors pest populations in my fields					
3.4 Cultural factors, such as time to harvest, preexisting plant damage, plant moisture stress, plant health, and crop load, are considered in pest management decision-making if they have significant effects on the risk of damage due to key pests					
3.5 I or my PCA keeps qualitative (descriptive) written pest monitoring records and they get shared during the decision making process					
3.6 I and/or my PCA keeps quantitative (numeric) written pest monitoring records and they get shared during the decision making process					
3.7 If I rely on pest management recommendations from a PCA, I and/or my farm manager review with them the pest situation before making					

[22] http://www.ipm.ucdavis.edu/PMG/selectnewpest.onion-and-garlic.html

a decision to take a management action					
3.8 I encourage my crew supervisors and farm managers to report any pest problem that is out of the ordinary (e.g. pests they have never seen before) and report it to the appropriate person					
3.9 Pictures of important invasive pests are posted in convenient places so employees can monitor for their presence					
Pesticide Management					
4.1 The pH of water used with the pesticide is within an accepted range (pH of 6 is optimum for many pesticides, check with your PCA, chemical company or input supply company representative)					
4.2 Pesticide drift is minimized by using technologies such as air induction nozzles, or some pesticides are applied using chemigation					
4.3 I rotate the use of pesticides according to 'mode of action' to minimize development of resistance					
4.4 I keep a written record of pesticide use by 'mode of action' as a part of my pesticide resistance strategy					
4.5 A written spray drift management plan has been drawn up for each field that includes a map of the field and location of sensitive areas and sprayer operators follow the plan					
4.6 Calibration and spray coverage tests are done at least once a season on my sprayer and are based on manufacturers' recommendations as well as site characteristics					
4.7 Buffer zones have been established for each field based on pesticide label specifications as well as adjacent crops and other sensitive sites					
4.8 Sprays are timed such that there is minimal or no human activity in adjacent areas					
4.9 Sprayer nozzles are shutoff at row ends near environmentally sensitive areas					
4.10 There is a berm around the wellhead that prevents surface water running from the perimeter to the wellhead					
4.11 Pesticide mixing and loading area is more than 100 feet from the wellhead unless it is protected by a berm or other physical characteristics that prevent surface water running from the perimeter to the wellhead					
4.12 A separate water supply tank is used for pesticide mixing or chemicals are added to the tank at least 100 feet away from the well.					
4.13 Either a double-check valve, reduced pressure principle backflow prevention device or an air gap is in place and maintained between the well pump and sprayer tank[23]					
4.14 Pesticide mixing and loading is done using a closed system or with water soluble pesticide packets when available for the pesticide being applied					
4.15 Spray mixing, loading and calibration is planned so that the tank is					

[23] This is a legal requirement (may want to mark more above that are required)

empty at the end of the spray job					
4.16 I use the following safe pesticide storage practices: storage is well lit, secured, well ventilated, dry pesticides stored above liquids, pesticides are stored more than 300 feet from nearest well, storage area has impermeable floor and sump to contain leaks, an only undamaged containers are stored					
4.17 I have an emergency response plan for pesticide and fertilizer spills and exposure posted in the appropriate places					
4.18 Workers are trained to follow the emergency response plan for pesticide spills or exposure					
4.19 A pesticide risk model such as PRiME[24], WIN PST or UC IPM's Water Tox[25] is used when considering which pesticides to apply					
4.20 The VOC 'footprint' of a pesticide is considered when deciding which pesticides to apply[26]					
Prevention and Cultural Practices					
5.1 I use resistance varieties/rootstocks to manage some of my key pests					
5.2 I use crop rotation to manage some of my key pests					
5.3 Timing of planting of crops to avoid key pests					
5.4 Non-decomposed organic matter in the soil is avoided to reduced bulb mite and onion maggot problems					
Biological control					
6.1 Conservation of pest natural enemies is considered when choosing a pesticide to use in the field[27]					
6.2 I establish areas adjacent to the field to augment natural enemies by growing plants that provide shelter, nectar, and pollen for them					
Effects of Pest Management on Non-Target Sites & Organisms					
7.1 Effects of a pesticide on pollinators are considered when selecting the material to apply[22]					
7.2 I am a member of the local Irrigated Lands Water Quality Coalition					
7.3 Effects of a pesticide on non-target organisms existing on my farm, such as birds and small mammals, are considered when selecting the material to apply					

[24] PRiME is the Pesticide Risk Mitigation Engine and can be accessed at http://ipmprime.org/cigipm/
[25] The model output is accessible at http://www.ipm.ucdavis.edu by viewing the webpage for the pest in question and clicking on the link labeled 'Water Quality Compare Treatments)
[26] http://apps.cdpr.ca.gov/voc-calculator/
[27] The UC IPM website has a list of natural enemy and pollinator sensitivity to common pesticides used on onions http://www.ipm.ucdavis.edu/PMG/r584310111.html

Social Responsibility

Human Resources Management	Not Familiar	Familiar, not tried	Have tried it	Currently Use	Not applicable
Staffing and Recruiting Strategy					
1.1 A long term (2-5 years) staffing and recruiting strategy is in place					
1.2 A variety of recruiting methods is used depending on job opening, e.g. word of mouth, newspaper, web recruiting, job fair, temporary or contract services					
1.3 A standard interviewing process is used in recruitment which includes a specific set of review questions					
1.4 A job description exists for each type of job and it is given to the employee and their supervisor					
1.5 Job descriptions are reviewed and updated at least once every two years					
1.6 For non-seasonal employees, an exit interview is conducted to determine why employees left the company					
Employee Orientation, Safety Training, and Career Development					
2.1 An orientation program is provided for new non-seasonal employees					
2.2 Safety training is done according to Cal OSHA regulations, i.e. when employee begins a new job assignment, or any new process, procedure or use of a substance or equipment that creates a new hazard					
2.3 All new employees undergo safety training					
2.4 If labor is contracted, a check is made to ensure contract labor company adheres to all relevant Cal OSHA safety regulations					
2.5 Safety statistics such as time lost due to accidents are tracked and retained for at least 2 years					
2.6 Employees are instructed as necessary to attend training seminars or other educational programs at least once a year that enhance their skills in the workplace					
2.7 Employees are encouraged to attend training seminars or other educational programs at least once a year that enhance their skills in the workplace (e.g. SpraySafe)					
2.8 My company pays for training when required and/or provides tuition reimbursement for work-related college classes					
2.9 A formal career planning process is in place for non-seasonal employees					
2.10 Every non-seasonal employee is provided an employee handbook					

that includes at a minimum the company's work standards and policies and an overview of benefits					
2.11 The employee handbook is written in an appropriate language(s)					
2.12 An employee meeting is held at least once a year to discuss company goals and to exchange ideas					
2.13 A meeting of top management is held annually to discuss company goals and exchange ideas					
Staying Informed					
3.1 Trade journals/appropriate trade literature (including literature on worker issues, safety issues, Farm Bureau, trade association literature, etc.) are made available for the farm management team (FMT) to read					
3.2 The FMT has current membership in local grower association(s)					
3.3 The FMT regularly attend regional and/or statewide industry meetings (e.g. irrigation district, Farm Bureau, Water Coalition, etc), trade shows (e.g. World Ag Expo), and seminars (e.g. UC, CDFA, CSU seminars, research meetings from Commodity Boards)					
3.4 The FMT takes a leadership role in local, regional or state industry associations (e.g. Western Growers, California Grape & Tree Fruit League, Grower-Shipper Association)					
Performance, discipline, grievance process, and employee recognition					
4.1 A job performance process is in place and is linked to pay and promotions					
4.2 A form and process is in place for employees to comment on job satisfaction					
4.3 My company has a grievance process in place and it is documented in the employee handbook					
4.4 Filed grievances are recorded and processed in a timely manner					
4.5 A formal process is in place by which employees are recognized for good job performance and/or years of service					
4.6 A suggestion box is provided in a convenient location so that employees can provide ideas for improvements in company practices, working environment, and other areas.					
Health benefits, paid time off, and other benefits					
5.1 Basic health benefits are provided to non-seasonal employees					
5.2 Non-seasonal employees have paid holidays and vacation time					
5.3 Employees are provided sick leave and/or personal days					
5.4 Non-seasonal employees are provided (or employees are encouraged to) a formal pension plan or a company 401k					

Community Support	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 My company is involved in regional land use planning					
1.2 My company is involved in initiatives, through time commitment and/or donations, that enhance the community such as the Chamber of Commerce, schools/education programs, churches, public health, affordable housing, and food banks					
1.3 My company is involved in regional water issues such as the regional water quality coalition, irrigation districts, ground water use planning, and/or the irrigated lands waiver program planning					

Waste Management

Waste Management	Not Familiar	Familiar, not tried	Have tried it	Currently Use	Not applicable
In field, shop and office					
1.1 The farm has a written waste management plan that includes waste reduction goals, recycling goals, donation to food banks, hazardous material use reduction goals					
1.2 Crop residue or crop byproduct is recycled by either selling to another user (e.g. for cattle feed, co-generator/digester), composted, or returned to the field for incorporation into the soil					
1.3 The farm has an established recycling program for metal, cardboard, plastics, paper and glass					
1.4 The value of recycling is part of the orientation and training of employees					
1.5 The amount of metals, cardboard, plastics, paper and glass recycled annually vs. the amounts thrown away is determined and year to year comparisons are made					
1.6 The number of tires, batteries used per year and the amount of lubricants purchased vs the amount sent back or recycled per year is recorded and year to year comparisons are made					
1.7 All unused or worn out items such as appliances, tractors, ATVs, electrical equipment, are taken to the proper recycling centers for disposal					
1.8 The total amount of hazardous materials, other than pesticides and fertilizers, present on the farm is known and their use is tracked on an annual basis (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.9 Employees are trained on the proper handling and disposal of hazardous materials (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.10 Employees are trained on legal requirements related to cleaning of farm equipment with water or steam cleaners and the resulting runoff					
1.11 Hazardous materials no longer used, as well as their containers, are disposed of according to legal requirements					
1.12 The farm participates in the pesticide container recycling program[28]					
1.13 Dumpsters and/or recycling containers are on cement pads to					

[28] Use the following link to find out how to participate in an Ag Container recycling program: http://www.acrecycle.org/contact_us.html

contain spills					
1.14 Dumpsters and/or recycling containers are covered to keep out rain					
1.15 Dumpsters and/or recycling containers are periodically inspected for leaks, spills, and litter. Problems noticed are corrected					
1.16 Bi-lingual signs are posted near the dumpster and/or recycling containers indicating what can or cannot be put in the container					

Water Management and Water Quality

California is the leading agriculture state in the US by a significant amount. This is due in large part to the high value of the many specialty crops grown in the state. It is also due to the excellent growing conditions such as fertile soils, a Mediterranean climate and the availability of affordable high quality surface and ground water for irrigation. California is also the most populace state in the US and therefore affordable high quality water is needed to support this population. It is clear that because of the demands for high quality, affordable water, this critical resource needs to be used efficiently and effectively by specialty crop producers. The following template will help document practices producers are using to achieve optimum water quality and use efficiency as well as bring to their attention areas where improvements can possibly be made.

Irrigation Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pre-plant Planning					
1.1 Pre-plant analyses of the site was done to identify factors that affect quantity of irrigation water delivery and percolation rate such as existence of soil compaction, a root restricting layer, soil type, soil texture, soil chemistry (pH, salinity, etc.) and soil organic matter					
1.2 Ripping, plowing, chiseling, or other practices were implemented if pre-plant soil tests indicated water percolation and/or drainage problems					
1.3 Soil amendments were applied to correct soil chemical or physical issues if sampling identified factors that would affect water percolation					
1.4 Water source was sampled and evaluated for water quality					
1.5 The irrigation system was designed to deliver the quantity of water required for the crop and accommodate for variation in topography as well as in soil texture that affects water percolation and water holding capacity					
Irrigation Scheduling & Rates					
2.1 I measure and record the total amount of water used in one or more fields every season and calculate water use per unit of crop production.					
2.2 I have a written water management plan for my field(s) that includes goals for the growing season and takes into consideration annual rainfall, crop variety, crop maturity, water-related pest management issues, soil type, soil preparation, slope, water quality, irrigation efficiency, irrigation uniformity, energy efficiency					

2.3 Irrigation is initiated at the start of the season based on visual cues from the crop					
2.4 Irrigation is initiated at the start of the season based on measured soil moisture depletion					
2.5 Irrigation scheduling is influenced by peak energy pricing					
2.6 Water percolation rate and infiltration depth is monitored during the irrigation season					
2.7 Soil moisture depletion is estimated by visual inspection of the crop (e.g. growth or development) that indicates plant water stress					
2.8 Soil moisture depletion is tracked through soil coring					
2.9 Soil moisture depletion is tracked using soil-installed moisture monitoring devices					
2.10 For dehydrator bulb onions irrigate is initiated when approximately 25% of available water has been depleted in top 24 inches of soil[29]					
2.11 Amount of irrigation and timing are dictated by the amount and timing of water available through my Water District					
2.12 Amount of irrigation and timing are based on visual cues of the crop					
2.13 Amount of irrigation is and timing are based on irrigation history from past growing seasons					
2.14 Amount of irrigation and timing are based on historical crop evapotranspiration (ET)					
2.15 Water demand of the crop is estimated by determining ETo[30] through using data from the nearest CIMIS weather station and used in irrigation rate and scheduling					
2.16 Water demand from the crop is estimated by converting ETo to Etc by using the appropriate crop coefficient factor (Kc) which takes into account crop canopy and used in irritation rate and scheduling					
Irrigation Performance and System Maintenance – Pumps & Filters					
3.1 Pumping plant efficiency has been measured within at least the last 3 years (for areas where water table fluctuates considerably pumping plant efficiency should be checked at least once very 2 years)					
3.2 Pumping plant efficiency has been measured within at least the last 5 years					
3.3 Energy use for irrigation is tracked on an annual basis and related to unit of production					
3.4 Electrical irrigation pumps are on time of use metering					
3.5 If pumping efficiency is significantly reduced I have improved it					
3.6 Diesel irrigation pumps are Tier 2 or higher					

[29] Voss, R. E. and K. S. Mayberry. Dehydrator bulb onion production in California. Univ. Calif. Div. Ag. Nat. Res. Publ. 7239. 3pp.
[30] ETo is the reference evapotranspiration and is calculated using measurements of climatic variables including solar radiation, humidity, temperature and wind speed and is expressed in inches or millimeters of water. It is based on water use for a short mowed full coverage grass crop.

3.7 A flow meter is installed on wells and/or pumps and I monitor and record the flows					
3.8 Pressure check points are installed on key lines from pumps					
3.9 Filters status (and flushing system) is manually checked at least twice a season and corrected if necessary					
3.10 Pressure gauges are installed for measuring pressure drops through filters					
Irrigation Performance & System Maintenance – Drip & Micro-sprinklers					
4.1 Distribution uniformity of the irrigation system is tested at least every 2 years					
4.2 The system has pressure compensating emitters to help maintain system distribution uniformity					
4.3 The irrigation system is monitored for leaks, breaks, and clogging every irrigation					
4.4 The irrigation system is monitored for leaks, breaks, and clogging at least once a season					
4.5 Fertigation is used to apply most of the fertilizers for the field					
4.6 An interlock system is installed so injection pump shuts down if irrigation pump shuts down to prevent water source contamination					
4.7 Irrigation lines are flushed at the start of the season and then again at mid season, or more often as needed					
Irrigation Performance & System Maintenance – Sprinklers					
5.1 The irrigation system is monitored for leaks, breaks, and clogging every irrigation					
5.2 The irrigation system is monitored for leaks, breaks, and clogging at least once a season					
5.3 Sprinkler head rotation and nozzle clogging have been checked within the last 12 months and repaired if necessary					
5.4 Sprinkler head rotation and nozzle clogging are checked at least every other irrigation and repaired if necessary					
5.5 Sprinkler heads have been checked for wear in the past 5 years and replaced with the correct nozzle size if necessary to maintain distribution uniformity					
5.6 Fertigation is used to apply most of the fertilizers for the field					
5.7 An interlock system is installed so injection pump shuts down if irrigation pump shuts down to prevent water source contamination					
Irrigation Performance & System Maintenance – Flood & Furrow					
6.1 The field was laser leveled before planting the crop					
6.2 Levee locations in the field are based on observed infiltration rates (i.e. each check is appropriately sized for maximum water application uniformity)					
6.3 Irrigation produces no tail-water					
6.4 Irrigation produces tail-water and a tail-water recovery system is in					

place					
6.5 Flow meters are installed and flow volumes recorded on lines from pumps or in supply pipelines or ditches (e.g. Weir notch or Parshall flume) or a record of flow volumes is provided by the water district					
Water quality – Source and resource					
7.1 Irrigation water is tested at least every 3 years for quality, including pH, total salt, nitrates, and biological problems. The quality of water in distribution reservoirs is tested if they are present on the farm.					
7.2 If a water quality problem exists it is addressed					
7.3 I have accessed resource maps to determine if my field(s) are in Ground Water Protection Areas (GWPA)[31]					
7.4 If a field is in a GWPA I have accessed and read the legal requirements for handling restricted use pesticides in GWPA areas and they are on file in the office					
7.5 I have identified and mapped areas on the farm that are potential sites for pesticides and fertilizers to enter the ground water					
7.6 The wellhead is situated so no surface water can reach it or a berm has been placed around the wellhead that prevents surface water from reaching it					
7.7 Return water wells, older wells and abandoned wells are sealed to prevent ground water contamination					
7.8 Irrigation practices create no off-site movement of chemical residues and sediments					
7.9 If storm water run-off occurs one or more of the following mitigation practices are implemented: filter fabric fencing; filter strip; straw bale check dam; straw bale water bars; sediment basin; or other containment system					
7.10 Cover crops/vegetation is maintained on drain ditches and non-paved minor roadways to minimize rainfall run-off from field					
7.11 Soil percolation problems in the field have been addressed to minimize off-site movement of irrigation or storm water					

[31] http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpamaps.htm

24. Financial Management: Accounting and Financial Analyses

1. A financial accounting system is used to track and report farm finances and to make decisions about the farming operation:

○ Yes ○ No ○ Not Applicable

Comment:

2. I understand how to interpret both cash and accrual financial statements including a balance sheet, income statement, cash flow, and financial ratios:

○ Yes ○ No ○ Not Applicable

Comment:

3. A financial advisor is consulted on an annual basis:

○ Yes ○ No ○ Not Applicable

Comment:

4. Financial profitability analyses for investments are done if investments are made:

○ Yes ○ No ○ Not Applicable

Comment:

5. The revenue and returns are tracked for each orchard/management unit in financial management reports:

○ Yes ○ No ○ Not Applicable

Comment:

6. The costs for important inputs, such as fertilizers, pesticides, water and energy are tracked for each orchard/management unit:

○ Yes ○ No ○ Not Applicable

Comment:

7. Costs and returns are tracked for all important farming practices:

◯ Yes ◯ No ◯ Not Applicable

Comment:

8. Costs and returns are tracked for implementing new sustainability practices and compared to costs and returns of practices they replaced:

◯ Yes ◯ No ◯ Not Applicable

Comment:

9. Sensitivity analysis, i.e. change in crop prices over time, is used to analyze financial risk over time:

◯ Yes ◯ No ◯ Not Applicable

Comment:

25. Financial Management: Purchasing and Borrowing

1. More than one quote is obtained for major input purchases such as pesticides and fertilizers:

◯ Yes ◯ No ◯ Not Applicable

Comment:

2. Interest rates and services from more than one lending institution are compared before borrowing a significant amount of money:

◯ Yes ◯ No ◯ Not Applicable

Comment:

26. Food Safety Planning & Management

1. A written food safety policy is in place for the farm that includes a commitment to food safety, how it is implemented, and how it is communicated to the employees:

○ Yes ○ No ○ Not Applicable

Comment:

2. A written food safety plan is on file and implemented on the farm:

○ Yes ○ No ○ Not Applicable

Comment:

3. If so, the plan meets Global Food Safety Initiative (GFSI) guidelines:

○ Yes ○ No ○ Not Applicable

Comment:

4. The food safety plan is reviewed and updated at least annually:

○ Yes ○ No ○ Not Applicable

Comment:

5. Records are kept to demonstrate the food safety plan is being followed:

○ Yes ○ No ○ Not Applicable

Comment:

6. A person has been designated as being responsible for food safety functions on the farm:

○ Yes ○ No ○ Not Applicable

Comment:

7. All employees are trained in food safety procedures and practices on the farm:

○ Yes ○ No ○ Not Applicable

Comment:

8. My company participates in a third- party food safety certification/verification program (e.g. Agriculture Marketing Service GAP Certified, Scientific Certification Systems, PrimusGFS, GLOBALG.A.P.):

○ Yes ○ No ○ Not Applicable

Comment:

9. If so, the program is Global Food Safety Initiative (GFSI) compliant or approved:

○ Yes ○ No ○ Not Applicable

Comment:

27. Waste Management

1. The farm has an established recycling program for metal, cardboard, plastics, paper and glass:

◯ Yes ◯ No ◯ Not Applicable

Comment:

2. All unused or worn out items such as appliances and electrical equipment, are taken to the proper recycling centers for disposal:

◯ Yes ◯ No ◯ Not Applicable

Comment:

3. Tires, batteries and lubricants are recycled:

◯ Yes ◯ No ◯ Not Applicable

Comment:

4. Employees are trained on the proper handling and disposal of hazardous materials (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants):

◯ Yes ◯ No ◯ Not Applicable

Comment:

5. Employees are trained on legal requirements related to cleaning of farm equipment with water or steam cleaners and the resulting runoff:

◯ Yes ◯ No ◯ Not Applicable

Comment:

6. Hazardous materials no longer used, as well as their containers, are disposed of according to legal requirements:

◯ Yes ◯ No ◯ Not Applicable

Comment:

7. The farm participates in the pesticide container recycling program:

◯ Yes ◯ No ◯ Not Applicable

Comment:

8. Dumpsters and/or recycling containers are on cement pads to contain spills:

◯ Yes ◯ No ◯ Not Applicable

Comment:

9. Dumpsters and/or recycling containers are periodically inspected for leaks, spills, and litter. Problems noticed are corrected:

◯ Yes ◯ No ◯ Not Applicable

Comment:

10. Bi-lingual signs are posted near the dumpster and/or recycling containers indicating what can or cannot be put in the container:

◯ Yes ◯ No ◯ Not Applicable

Comment:

28. Neighbors & Community

1. My company is involved in regional land use planning:

○ Yes ○ No ○ Not Applicable

Comment:

2. My company is involved in initiatives, through time commitment and/or donations, that enhance the community such as the Chamber of Commerce, schools/education programs, churches, public health, affordable housing:

○ Yes ○ No ○ Not Applicable

Comment:

3. My company is involved in regional water issues such as the regional water quality coalition, irrigation districts, ground water use planning, and/or the irrigated lands waiver program planning:

○ Yes ○ No ○ Not Applicable

Comment:

Self-Assessment for Pepper Production

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Funded by a California Department of Food and Agriculture
Specialty Crop Block Grant to SureHarvest

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Project History

Over the last 10 years the field of sustainable agriculture has become more and more important in the eyes of food retailers, buyers and consumers. As is often the case when new concerns arise in relation to food and food production, the spot light shines on the grower. Sustainable agriculture is challenging to define, and once defined it can be challenging for a grower to figure out how to implement it on the farm in an economically viable way. To meet these challenges a group of specialty crop trade associations, NGO's, and other specialty crop stakeholders met to discuss the topic of sustainable agriculture. One outcome of these discussions was an application to the California Department of Food and Agriculture Specialty Crop Block grant program for funds to hire sustainable agriculture professionals to help develop a plan to meet the challenges presented by sustainable agriculture. The Great Valley Center coordinated the grant application and engaged SureHarvest to provide the technical expertise. SureHarvest is a company with extensive experience in sustainable agriculture strategic planning, program design, and program implementation. The grant application was successful and began in September of 2009. The Great Valley Center directed the project and contracted with SureHarvest for project design, facilitation and implementation.

The grant had two primary goals. The first was to develop, through a stakeholder process, a sustainable agriculture strategic plan that each of the participating groups could use internally to help lay the foundation for their own sustainable agriculture program specific to their specialty crop. The second was to develop a tool, or tools, that could be used by their member growers to put the strategic plan into action on the farm.

The following paragraphs contain the sustainable agriculture strategic plan developed by the project leadership team, the members of which are listed in Table 1.

Sustainability Strategic Plan for the Multi-Commodity Project

The sustainability strategic plan for the Multi-Commodity Project is based on SureHarvest's 5 P's of sustainability framework. The 5 P's are: Principles, Processes, Practices, Performance Metrics, and Progress. They are defined as follows:

1. Principles – This is the sustainable vision for the project. It consists of the goals that the participants want to achieve from the design and implementation of the project.
2. Processes – These are the resource areas on the farm that need to be addressed in order to meet the principles or goals of the project. For example, this could be water, energy, and human resources management.
3. Practices – These are the practices that are implemented on the farm that impact the processes or resource areas. They are the on-the-ground actions that are carried out to assure that the principles or goals of the sustainable program are met.
4. Performance Metrics – These are the metrics used to measure the outcomes resulting from the practices implemented on the farm. There are many - examples include crop quality, water use, energy use, and worker satisfaction. Performance Metrics are used to measure the level of success in meeting the principles or goals of the project.

5. Progress – The process used to improve performance over time and communicate the results internally and externally. In other words, tracking the degree of progress one is making towards achieving the goals of the project. Measuring progress will require some kind of system for assessing the farm's performance over time, creating action plans to improve particular areas of performance, and reassessment over time to track progress.

Table 1. Multi-Commodity Project Leadership Team

Organization	**Representative**
Almond Board of California	Gabriele Ludwig*, Robert Curtis*
Bolthouse Farms	Troy Elliott*, Justin Groves*
California Grape & Tree Fruit League	Chris Valadez*, Barry Bedwell
California Specialty Crop Council	Lori Berger*
California Garlic & Onion Research Advisory Board	Robert Ehn
California Olive Council	Patty Darragh
California Pear Advisory Board	Bob McClain
California Pepper Commission	Glen Fischer*
California Pistachio Board	Robert Klein*
California Raisin Marketing Board	Gary Schultz
California Tomato Farmers	Ed Beckman*
California Tree Fruit Agreement	Gary VanSickle*, Lauren Friedman
California Walnut Board	David Ramos
Del Monte Foods	Pat McCaa
Sun-Maid Growers	Rick Stark*

*Leadership Team Member

Multi-Commodity Project Principles (1st P):

The principles for the Multi-Commodity Project were established by the Project Leadership Team. They are:

1. Create a resource area/practice template that:
    a. Will focus on increasing the economic performance for the participant.
    b. Is scalable and can be used by participating groups to accomplish the goals of their own sustainability programs.
    c. Provides the participant the ability to gauge the state of sustainability of the industry and their farm.
    d. Encourages continual improvement on the farm.
    e. As a whole encourages ecological harmony.
    f. Better defines the 3 E's of sustainability (economic viability, environmental soundness and social equity/responsibility) in a way we can all agree upon.
    g. Is open to and usable by any individual or group in the future that was not involved in the original effort.
    h. Benefit the participants and not result in unintended negative consequences.
2. The program should provide the information/data needed for groups to tell their sustainability story better to all their audiences, e.g. buyers, regulators, consumers, NGO's.

3. The outcomes from the project cause no harm to producers.

The Leadership Team of the Multi-Commodity Project decided the best tool for implementing their sustainability strategic plan was a self-assessment of practices template that stakeholders from specific specialty crops could then fine tune for their own use. The team chose to use the model developed by the California Sustainable Almond Program (CASP), which is a California Almond Board program developed in partnership with SureHarvest. The Leadership Team formed a stakeholder committee to draft the self-assessment template that covered the practice areas listed in the Multi-Commodity Project Strategic Plan. The Stakeholder Committee members are listed in Table 2.

Individual Contact	Title	Expertise
Billy Heller	Grower, Pacific Triple E Farms	Crop management
Bob Giampaoli	Grower, Live Oak Farms	Crop management
Cliff Sadoian	Grower	Crop management
Pat McCaa	Manager, Pest Management, Del Monte Foods	Crop management
Mechel S. Paggi (Mickey)	Director, Center for Agricultural Business, California State University, Fresno	Ag Business & economics
Glen Fischer	California Pepper Commission; Ag Representative, Saticoy Foods Inc.	Crop management
John Trumble	Professor of Entomology, University of California Riverside	Pest management
Jeff Mitchell	Extension Specialist, University of California, Davis	Soils & plant nutrition
Pete Goodell	UC IPM Area Advisor, University of California, Davis	Pest management
Terry Prichard	Extension Specialist, University of California, Davis	Irrigation & crop water relations
Bill Peacock	Representing raisin growers via the Raisin Marketing Board and Tree Fruit Growers	Crop management
Troy Elliott	Director of Agronomy, Bolthouse Farms	Crop management

Table 2. Multi-Commodity Project Stakeholder Committee

The second phase of the Multi-Commodity Project began with SureHarvest obtaining a CDFA Specialty Crop Block Grant to finish the self-assessment template with the Multi-Commodity Leadership Team and Stakeholder Committees and then fine-tune the template into workbooks for individual specialty crops working with willing growers and stakeholders from each specialty crop community. The self-assessment workbook for peppers which is presented on the following pages was developed using the Multi-Commodity self-assessment template through a series of reviews and edits by growers, other stakeholders and SureHarvest staff. The California Pepper Commission and Glen Fischer were particularly helpful during the review process. The final version was produced by SureHarvest and submitted to CDFA along with their final report in June of 2013.

Air Quality Management

Pressure is being brought to bear on urban and rural industries, including agriculture, to reduce air pollutants in the Great Central Valley of California. This section of the self-assessment will help the grower identify practices that influence air quality, highlight where the grower is doing well, and determine areas that need improvement.

Air Quality Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In Field and Adjacent Land					
1.1 To minimize airborne dust and PM10[5] particles, a reduced tillage program is in place					
1.2 To minimize airborne dust and PM10 particles, a no-till program is in place					
1.3 If tillage is done, moisture content of the soil is taken into consideration to minimize dust					
1.4 Mulch, either plastic or natural material, is used in the field to minimize dust (and conserve soil moisture)					
1.5 Vegetation is maintained on non-cropped areas such as headlands, roadsides, and field edges to reduce wind erosion causing airborne dust					
1.6 Crop residues or prunings are either chipped and/or incorporated into the soil or composted rather than burned					
Roads					
2.1 Vehicle speed is restricted on dirt roads around fields to minimize airborne dust					
2.2 Dirt roads are treated with an anti-dust agent that meets the 50% PM10 control for a Fugitive PM10 Management Plan[6] 9 (note: committee recommended that the list be placed in this document, it will be added to the fine-tuned workbooks. The list is about 2 pages long, see the website below for copy)					
2.3 Dirt roads are graveled, watered, chipped, mulched (crop residues), sanded or seeded					
2.4 Heavily used roads are paved (e.g. main thoroughfares on farm)					

[5] PM 10 are particles 10 microns in diameter or smaller and pose a health risk because they pass through the throat and nose and penetrate the lungs.
[6] For details see http://www.airquality.nrcs.usda.gov/Documents/files/Dust_Control_Products.htm

Engines and Fuel Consumption					
3.1 Engines are maintained on a regular schedule to ensure they are running at optimum performance and efficiency and emissions are minimized					
3.2 At least some vehicle is equipped with an engine able to use alternative fuels with lower emissions (e.g., compressed natural gas, flex fuel, biodiesel, propane)					
3.3 Some off-road farm vehicles are battery powered (e.g. golf carts)					
3.4 Vehicle miles are tracked on an annual basis					
3.5 Stationary diesel engines have been replaced (or retrofitted) to Tier 3 or better					
3.6 Stationary diesel engines have been replaced (or retrofitted) with technology relying on cleaner burning fuel (e.g. propane, natural gas, biodiesel) or replaced with electric pumps					
3.7 Selection of vehicle power plants and stationary engines is in part determined by lower emissions ratings					
3.8 Some of the farm's energy requirements are obtained through renewable sources such as wind or solar					
Pesticide Management and Air Quality					
4.1 Soil fumigants are used only when necessary and applied appropriately (e.g. pre-planting where soil sampling has identified a significant pest problem, proper soil moisture conditions exist and all regulations have been met)					
4.2 When choosing a pesticide to apply, its VOC 'footprint' is considered[7]					
4.3 Practices are implemented that reduce pesticide drift such as use of air induction nozzles, turning sprayers off at turn-arounds, not spraying when a temperature inversion exists in the field, and when wind exceeds 10 mph or the velocity specified on the label					
Greenhouse Gas Emissions					
5.1 I am aware of the role of CO_2, N_2O, and methane as greenhouse gases and where they are produced in my farming operations					
5.2 CO_2 and N_2O production are calculated and tracked					

What are VOC's?

VOC stands for volatile organic compound. These are carbon based compounds contained in products used on the farm, such certain pesticides, that volatilize (evaporate) when exposed to the air. Ground-based ozone is produced by chemical reactions involving VOC's, nitrogen oxides (NOx) and sunlight. While not direct air pollutants themselves, VOC's are important

[7] A VOC calculator is found at: http://apps.cdpr.ca.gov/voc-calculator/

ozone precursors and considered key targets for reduction in the Central Valley of California in a region where air quality is an issue. The California Department of Pesticide regulation does not know the reactivity of every VOC. Ideally, reactivity should be used to precisely determine VOC emissions. That said, appropriate data and analytical methods do exist at this time to make accurate estimates. The Department does hope to use reactivity at some point in the future. It calculates VOC emissions based on the best available science (Dr. Matt Fossen, pers. comm., Environmental Scientist, Calif. Dept. Pesticide Regulation). Air Quality and greenhouse gas emissions are such important topics in the Central Valley of California, it is important to consider the various sources of potential air quality problems.

Energy Management

Energy is essential for crop production and it comes in several forms; as sunlight to power photosynthesis, as fuel to power our internal combustion motorized vehicles and pumps, and as electricity to power our shop, office lights and electronic equipment. Tracking energy is very important because it is getting more and more expensive all the time, increasing our cost of production. Burning of fuel produces GHGs affecting air quality and contributing to climate change. So minimizing energy consumption saves money and reduces GHG production. Completing this section should help improve your understanding of energy use in your operation and encourage you to consider some forms of energy conservation.

Energy Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 The total amount (gallons) of fuel used annually on the farm in all operations is recorded and year to year comparisons are made. Each fuel type is recorded.					
1.2 The total amount of fuel used annually per acre and per unit of crop production is determined and year-to-year comparisons are made[8]					
1.3 The total amount of fuel used annually is calculated for each field and year-to-year comparisons are made. Each fuel type is recorded.					
1.4 Annual fuel consumption and/or electrical use for irrigation pumps are recorded and comparisons made from year-to-year					
1.5 Electrical use for office(s), shop(s), and outdoor security lighting is tracked using energy bills and year-to-year comparisons are made					
1.6 Fuel and electricity used are converted to a common metric such as British Thermal Units (BTU's) so they can be combined to calculate the total amount of energy used annually for crop production and year to year comparisons are made[9]					
1.7 The amount of energy used annually per acre and per unit of crop production is calculated and year to year comparisons are made					
1.8 The amount of energy used annually in each field is calculated and year-to-year comparisons are made					

[8] This can be a simple calculation of dividing the total gallons of fuel used for the year divided by the total amount of crops produced for the year

[9] Energy conversion calculators for kilowatt hours to BTU's and gas or diesel to BTU's are readily and freely available on the Internet. For example, using Google type 'convert gas to BTU's and you will be directed to a website where a calculator is available to make your conversion. Simply type in the number of gallons of gas and the calculator will produce the number of BTU's it represents.

1.9 An energy management plan is being implemented on the farm that includes yearly goals for overall energy use as well as energy used per unit of crop production.[10]					
1.10 A process is in place to ensure that the most appropriate piece of equipment is used for a given job (e.g. the most appropriate horse power engine for the job)					
1.11 One or more solar energy systems are installed on the property to generate electricity					
1.12 One or more wind generators are installed on the property to generate electricity					
1.13 Residue from crop production is used in a cogeneration plant					
1.14 Engines (stationary and mobile) and motors are maintained on a regular schedule to ensure they are running at an optimum fuel efficiency or optimum efficiency.					
1.15 Pumping plant efficiency (energy per acre foot pumped) is checked every 1 to 3 years (based on use) and adjustments made if necessary (FSU website recommends every 1-3 years based on use)					
1.16 At least some light switches are fitted with motion detectors or photo cells to reduce time of use					
1.17 At least some office and shop lights have been fitted with low energy consumption compact florescent bulbs or LED lights.					

Indirect Energy Use/Consumption:

Energy is directly expended when driving a vehicle, operating a pump, photocopying, or turning on and using a light bulb. Energy is also expended to manufacture inputs that are used on the farm, such as fertilizers, compost and pesticides. This type of energy consumption is called imbedded energy. If you want to figure out the total amount of energy consumed to produce a crop then calculations should also be made to determine the amount of embedded energy that was consumed to produce the fertilizers, compost, and pesticides that were used to produce the crop.

[10] Ideally one would convert all energy consumption to BTU's (British Thermal Units) but initial energy management plans could start with using gallons of gasoline and diesel and kilowatt hours for electricity.

Financial Management

The economic E of sustainable farming is literally where the buck stops. If a farm is not profitable, it is not sustainable. People farm not because they want to be accountants. They farm because they want to grow things. However, while financial management may be a challenging part of farming, doing it well is one of the keys to a successful and sustainable farm. This chapter will help the grower recognize strengths in financial management as well as point out areas where improvements are needed.

Financial Management **(The most appropriate person to fill out this section/chapter is the CEO/owner of the farm)**	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Planning and Risk Management					
1.1 A marketing and production plan has been developed for my farm and seasonal outcomes are compared to these plans					
1.2 A succession[11] plan is in place for the farm					
1.3 I have a written will and estate plan for the farm[12]					
1.4 A business continuation plan (disaster[13] management plan) has been developed for the farm					
1.5 A risk management plan has been developed for the farm					
1.6 Key personnel in the company have health insurance					
1.7 Key personnel in the company have disability insurance					
1.8 Key personnel have life or accidental death insurance					
Accounting and Financial Analyses					
2.1 I use a financial accounting system to track and report farm finances and use it to make decisions about my farming operation					
2.2 I understand how to interpret both cash and accrual financial statements, including a balance sheet, income statement, cash flow, and financial ratios					
2.3 I meet with a financial advisor on an annual basis					
2.4 Financial profitability analyses for investments are done if investments are made					

[11] A succession plan is one where the change in leadership in the company has been determined, whether it is expected, such as the CEO voluntarily stepping down/retiring, or unexpected, such as due to illness or accident.
[12] An estate plan is a plan for the financial assets to pass from one generation to the next. It does not deal with the human and intellectual capital and passing that transition to the next generation. That is succession planning.
[13] Disaster in this case is not just weather, but also unexpected death of one or more key company personnel.

2.5 The revenue and returns are tracked for each field/management unit in my financial management reports					
2.6 Costs and returns are tracked for all important farming practices					
2.7 Costs and returns are tracked for implementing new sustainability practices and compared to costs and returns of practices they replaced					
2.8 Sensitivity analysis, i.e. change in crop prices over time, is used to analyze financial risk over time					
Purchasing and Borrowing					
3.1 More than one quote is obtained for major input purchases such as pesticides and fertilizers					
3.2 Interest rates and services from more than one lending institution are compared before borrowing a significant amount of money					

Food Safety Management

How do we ensure that fresh food is safe? This is a question that is being debated by everyone all along the supply chain. Compliance with food safety production requirements is becoming a necessary requirement for many specialty crops. This section lists practices that are related to food safety management.

Food Safety Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Food Safety Management Planning					
1.1 A written food safety policy is in place for the farm that includes a commitment to food safety, how it is implemented, and how it is communicated to the employees.					
1.2 A written food safety plan is in place that identifies all locations of the farm and products covered by the plan. The plan addresses potential physical, chemical, and biological hazards and hazard control procedures, including monitoring, verification and record keeping, for the following areas: water, soil amendments, field sanitation, production environment and worker practices					
1.3 The food safety plan is reviewed at least annually					
1.4 Record keeping is kept to demonstrate the food safety plan is being followed					
1.5 A person has been designated as being responsible for food safety functions on the farm					
1.6 All employees are trained in food safety procedures and practices on the farm					
Food Safety Risk Assessment of Field					
2.1 An assessment has been made of the production field focusing on the likelihood of intrusions by animals that pose significant food safety risks (e.g. deer, pigs, livestock) and, if necessary, actions are taken to reduce the likelihood of intrusion					
2.2 An evaluation has been made on land and waterways adjacent to the field for possible sources of human pathogens of concern (e.g. manure storage, CAFO's, grazing/open range areas, surface water, sanitary facilities and composting operations)					
2.3 An assessment of historical land use has been made to determine any potential issues from these uses that might impact food safety (e.g. hazardous waste sites, landfills, etc.)					
2.4 My company participates in a third party food safety certification					

program (e.g. Agriculture Marketing Service GAP Certified, Scientific Certification Systems, Primus, Global GAP)					
Water					
3.1 The water system description for the field/ranch has been created that indicates, either with drawings or maps, the location of permanent fixtures, such as pumps, wells, underground lines, gates & valves reservoirs, and returns					
3.2 Irrigation water and water used in harvest operations is tested for microbial quality, and if microbial levels are above specific action levels, corrective actions are taken					
3.4 Records of all water tests are retained, along with Certificates of Analysis, for at least 2 years					
3.5 Irrigation pipe and drip tape are stored in a manner that reduces or eliminates the potential for pest infestation					
3.6 Water applied to edible portions of the crop, either as overhead irrigation or pesticide applications, is tested for microbial quality					
Organic Soil Amendments					
4.1 Raw manure or a soil amendment that contains un-composted or incompletely composted or non-thermally treated animal manure is not applied to field					
4.2 If compost is applied, it is sourced from a supplier that provided their written Standard Operating Procedures which prevents cross-contamination of finished compost with raw materials through equipment, runoff or wind.					
4.3 If organic soil amendments are used microbial testing is performed by the supplier prior to application					
Sanitation					
5.1 Toilet facilities are readily available to all field employees and are located according to Cal OSHA regulations					
5.2 Toilet facilities are clean and maintained on a regular basis					
5.3 Field employees are trained on the importance of sanitation in the field					
5.4 Field sanitation units are accessible to all employees					
5.5 A response plan is in place in the event of a spill from toilet or sanitation facilities and employees are trained to implement it					
5.6 Workers are educated on sanitation issues such as not working on the job while sick or injured (e.g. infected cuts)					
Harvesting and Transportation					
6.1 A traceability system is in place and appropriate for my crop					
6.2 A mock recall has been done to check the effectiveness of the traceability system (mock recalls would usually be done in conjunction with a packer/shipper or processor)					

6.3 All harvesting containers and bulk hauling vehicles that come into direct contact with the harvested crop are cleaned and/or sanitized on a scheduled basis using a written record system					
6.4 Packaging materials used in field operations are properly stored and protected from contamination					
6.5 Harvesting equipment that comes into contact with the crop is kept in good repair					

Soil Management

Soil is the most complex ecosystem on earth. Gaining a greater understanding of the soil resource in your fields is critical for making informed soil management decisions. Knowing your soil resource gives you greater control over yield and crop quality and is especially important in determining the long-term sustainability of your farm.

Soil provides the crop with three vital things: water, nutrients and air. These three things are best provided by a soil with good depth and structure, i.e. a soil in which the particles are bound together into small clumps (aggregates) of varying size. Soil aggregation is a measure of soil structure. Soil organic matter is important in maintaining soil structure by gluing soil minerals together into aggregates. Spaces between large aggregates (measured as millimeters) permit rapid drainage and easy root growth, and spaces between small aggregates (measured as less 1 millimeter down to 0.001 millimeter) trap water for use between irrigation and rain events. One of the more important aspects controlling aggregate stability is the amount of microbial activity and soil organic matter. Stable aggregates occur in varying sizes and are created by the cementing action of microbes and their byproduct and soil organic matter. The assemblage of soil aggregates creates habitat to promote faunal and microbial diversity, an important index of soil quality. Due to the warm to hot California climate, soil organic matter is low in many soils due to rapid breakdown of soil organic matter.

The following self-assessment template will help document the practices producers are using to manage their soil sustainably as well as suggest areas where improvements might be possible.

Soil Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Knowledge of soil properties					
1.1 The soil types in the field has/have been identified using NRCS soils maps					
1.2 The soil types in the field has/have been identified using soil samples taken pre-planting					
1.3 Soil properties for each soil type in the field is recorded, including soil moisture holding capacity, texture, and rooting depth					
1.4 A soil sample has been taken in the field more than 6 years ago and analyzed for macro and micro nutrients					
1.5 A soil sample has been taken in the field within the last 6 years and analyzed for macro and micro nutrients as well as soil chemistry (e.g. pH, CEC, salts)					
1.6 A soil sample has been taken in the field within the last 4 years and analyzed for macro and micro nutrients as well as soil chemistry (e.g. pH, CEC, salts)					

1.7 A soil sample has been taken in the field within the last 2 years and analyzed for macro and micro nutrients as well as soil chemistry (e.g. pH, CEC, salts)					
1.8 If soil pH is less than 5.5, it is amended with lime. If it is above 8.0, it is amended with an acidifying agent					
Soil properties management					
2.1 If water infiltration is poor (water puddles and runs off when soil is dry underneath) the soil is amended either chemically (e.g. with gypsum or organic matter such as compost or manure) or physically (e.g. chiseling or shallow ripping)					
2.2 Cover crops are planted to add organic matter and nutrients to the soil and improve water infiltration					
2.3 If soil organic matter is low for the soil series in my field, I have an ongoing program to build soil organic matter, either through additions of compost, manure and growing cover crops or a combination of them					
2.4 Equipment is chosen or is modified to minimize soil compaction (e.g. lightest equipment possible, track-layers, wider or bigger diameter tires, tire pressures as low as possible)					
2.5 For annual crops, conservation tillage is practiced					
2.6 For annual crops, tillage passes are about the same as most neighboring farms producing the same commodity.					
2.7 Surface tillage is practiced on a regular basis					
2.8 Deep tillage is practiced on a regular basis					
Crop nutrition management					
3.1 I have a written crop nutrient management plan that uses a 'budgeting approach'[14] in determining the nutrient needs of the crop and takes into consideration factors like crop tissue analyses, soil type, time of year, soil moisture, crop load, etc. (insert an educational box discussing the 4 R's of nutrient management; see http://www.ipni.net/4r)					
3.2 The crop's nutrient management plan is based solely on the recommendations as given by my field consultant and/or from the soil testing lab					
3.3 With the help of my field consultant, I am able to interpret the lab results from the field soil samples and we use them in the crop nutrient management plan					
3.4 I am able to interpret the lab results from the soil samples and I use them in my crop nutrient management plan					
3.5 Plant tissue samples are taken and analyzed at least once a season and					

[14] A budgeting approach means that the amount of nutrients leaving the field in the crop is estimated and the amount of nutrients added back to the field is based on this estimate. A one -to-one replacement is not implied or required since factors such as soil type affect nutrient availability to the crop and these factors must also be taken into account.

used to help assess crop nutrient needs					
3.6 I record from year-to-year the amount of nitrogen applied per acre and calculate the amount of N applied per unit crop production					
3.7 I record from year-to-year the amount of phosphorus applied per acre and calculate the amount of P applied per unit crop production					
3.8 I record from year-to-year the amount of potassium applied per acre and calculate the amount of K applied per unit crop production					
3.9 Fertilizers are applied using Fertigation					
3.10 The total amount of nitrogen needed for the season is applied in one application					
3.11 The total amount of nitrogen needed for the season is applied in a split application(s)					
3.12 Fertilizers are applied using a 'spoon feeding' approach where only the amount of nutrients required by the crop at the time are applied and multiple applications are made throughout the growing season based on crop growth stage and nutrient demand					
3.13 Micro nutrients are applied on a regular basis without reference to crop needs or crop history					
3.14 Micro nutrients are applied based on past crop history					
3.15 Micro nutrients are applied based on soil sample test results					
3.16 Micro nutrients are applied based on crop tissue sample test results					
Soil erosion					
4.1 Vegetation is maintained along farm roads, on field edges, and along irrigation canals not controlled by the irrigation district					
4.2 I know the infiltration/run-off rates of the field's soil and the rate of irrigation water is applied and adjusted according					
4.3 No tillage is done on field borders or along irrigation canals					
4.4 Ditches have been grassed or hardened to prevent downcutting					
4.5 Culverts are properly sized to accommodate high flows, and inlets and outlets have been hardened to prevent scour or energy dissipaters have been installed					

Ecosystem Management

An ecosystem is the complex community of living organisms and their physical environment functioning as an ecological unit. Components of an ecosystem are inseparable and interrelated. An ecosystem management approach to growing specialty crops acknowledges that people are a part of, and have a significant impact on, ecosystem structures and processes, and that people depend on and must assume responsibility for the ecological, economic, and social systems where they live. Ecosystem management is currently being encouraged and implemented by communities, government agencies, businesses, academics and various conservation organizations throughout the world[15].

Ecosystem Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Habitat maintenance and enhancement					
1.1 Field borders, roadsides, and ditch-banks are kept free of vegetation					
1.2 Hedgerows of trees and/or shrubs are maintained on at least some field edges					
1.3 Vegetation such as grasses, trees or shrubs are maintained along roadsides, ditch-banks and headlands					
1.4 Vernal pools or swales are preserved and managed with setbacks to reduce probability of soil disturbance					
1.5 Trees have been planted to provide habitat for wildlife					
1.6 Trees are maintained to provide habitat for wildlife					
1.7 Nesting boxes for owls have been placed around the farm and are cleaned annually					
1.8 Perches for raptors have been placed around the farm					
1.9 If water courses exist on my property, crops are planted up to the edge of water courses					
1.10 If water courses exist on my property, setbacks are in place to minimize disturbance					
1.11 If water courses exist on my property, resident vegetation is maintained on the banks					
1.12 If water courses exist on my property, banks are vegetated with a mix of grasses, trees and shrubs					
Whole farm issues					
2.1 I am an active member in the local watershed coalition					
2.2 I participate in a watershed stewardship planning group, if one exists in my region					
2.3 Invasive pests (e.g. puncture vine, arundo) are monitored for and when found, removed from the farm					
2.4 A formal or informal environmental survey of the farm has been done noting the presence of sensitive areas, such as vernal pools, swales, oak trees, habitat for endangered species, and other					

[15] Reeves, K. 2008. Chapter 1. Ecosystem Management *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 15- 63.

environmental features which affect farming and actual farmable acres, such as an NRCS conservation survey[16]					
2.5 I manage my property to protect and/or enhance habitat for threatened and endangered species					
2.6 Some or all of the natural areas of my property are protected by a conservation easement (see education box below)					
2.7 Some or all of my property is protected by an agricultural easement					
2.8 The farm is managed to optimize ecosystem services such as wildlife, pollinators, and/or arthropod natural enemies and increased biodiversity (see box below for definition of an ecosystem service)					
2.9 Indicators of biodiversity on the farm are monitored and recorded, such as animal and plant populations, pollinators, or arthropod natural enemies					
2.10 Unfarmed areas are maintained to increase biodiversity on the farm including wildlife, pollinators and/or arthropod natural enemies					

Education box: What is an ecosystem service?

The biological communities in an agricultural ecosystem provide benefits over and above the commercial crops they produce. These benefits are known as ecosystem services. They include removing carbon dioxide from the atmosphere, reducing greenhouse gases, the recycling of nutrients, regulation of microclimate and local hydrological processes. In some cases, they result in the suppression of pest plants and animals through the production of pest natural enemies, and detoxification of noxious chemicals that enter the environment.

Education Box: What are Conservation and Agricultural Easements?

Conservation easements for protection of natural resources are legal agreements that allow landowners to donate or sell some "rights" on portions of their land to a public agency, land trust, or conservation organization. In exchange, the owner agrees to restrict development and farming in natural habitat, and assures the easement land remains protected in perpetuity. A 1996 study conducted by the National Wetlands Conservation Alliance indicated that the leading reasons landowners restored wetlands were to provide habitat for wildlife, to leave something to future generations, and to preserve natural beauty. Only 10% of landowners surveyed in the study restored wetlands solely for financial profit. This would also apply to other habitats besides wetlands. A conservation easement can provide you with financial benefits for the protection, enhancement, and restoration efforts for the natural environments on your property. The belief that natural resources such as wildlife, especially sensitive species, will reduce your land value is not true. Many easement programs include some sort of cash payment for a portion of the costs associated with habitat restoration and enhancement.

Agricultural conservation easements are for the explicit purpose of keeping farmland in production. They are similar to natural resource conservation easements, but, specifically protect

[16] NRCS has a lot of resources available for helping with environmental planning on the farm. Contact your local NRCS office and see if they can help you.

farmland and maintain the practice of farming. In 1996, the state established the California Farmland Conservancy Program to protect farmland by buying easements. Based on a study conducted by UC Cooperative Extension and published in 2002, there were 34 local conservation organizations, land trusts, and open space districts that protect farmland through conservation easements (see – Agricultural Easements: New Tool for Farmland Protection, California Agriculture, January-February 2002, Volume 56:No. 1). Local opportunities may exist for one or both kinds of conservation easements on your property.

Pest Management

Integrated pest management (IPM) is a fundamental part of any sustainable farming program. It is cost-effective, flexible, and resilient. IPM was developed to respond to some significant pest management challenges that developed in the 1950's and 1960's. Events such as the development of pesticide resistance by many pests, secondary pest outbreaks, and environmental contamination due to the use of certain problematic pesticides, led a forward-looking group of entomologists at the University of California to conclude that agriculture was heading toward a pest management crisis. They realized we had forgotten the fact that pest problems are complex and connected to ecosystem processes. They concluded that the solutions to complex ecological problems must be broad-based and take the farm ecosystem into account. These researchers developed the IPM concept to meet the pest management crisis. Since its inception in 1959, IPM has evolved into the best way to manage pest problems on the farm.

University of California Statewide IPM Program crafted the following as the definition of IPM[17]:
Integrated Pest Management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.

Farming is carried out within the ecosystem and is a long-term endeavor, so we want to use management practices that are ecosystem-based and long-term in nature. By using a combination of control techniques to manage a pest problem, we develop a broad-based management strategy that will still be successful even if one particular technique does not work. Also, based on our experience with chemical controls, we know that pest control decisions must take into account not only economic risks, but effects on the environment and people's health, as well[18].

Pest Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pest Management Framework for Farm					
1.1 I have an integrated pest management framework/plan for my farm that takes into account the landscape within which I farm, an					

[17] http://www.ipm.ucdavis.edu/IPMPROJECT/about.html
[18] Ohmart, C. P. and C. P. Storm. 2008. Chapter 6. Pest Management. *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 187- 267.

understanding of the cropping system and how it affects the population levels of key pests, includes monitoring protocols and economic thresholds for key pests, monitoring protocols and important pest natural enemies, and the key biological, cultural and chemical control options available for key pests					
1.2 Each year I review the pest management framework with all those involved in pest management on my farm and make adjustments according to my goals and pest management results from the past year					
Risk Assessment					
2.1 Key pests for my farm have been identified in the following groups: diseases, insects, mites, weeds, mammals and birds; and targeted for management					
2.2 Monitoring protocols have been established and are followed for key pests					
2.3 I and/or my Pest Control Advisor (PCA) have established and use economic thresholds for key pests					
2.4 I and/or my PCA keep written spray records containing the information required by California Department of Pesticide Regulation, as well as weather conditions and effectiveness					
2.5 I am aware of the environmentally sensitive areas in and near my field such as distance to ground water, surface water, wetlands, vernal pools, swales, houses, schools, public and private roads					
2.6 I have mapped the environmentally sensitive areas in and near my field such as distance to ground water, surface water, wetlands, vernal pools, swales, houses, schools, public and private roads					
Monitoring					
3.1 I and/or my PCA follow the UC IPM year round program for my crop, if available					
3.2 I and/or my PCA use the UC IPM pest management guidelines if available for my crop					
3.3 I and/or my PCA use the UC IPM pest management manual if available for my crop					
3.4 I monitor pest populations in my fields					
3.5 A licensed Pest Control Advisor monitors pest populations in my fields					
3.6 I and/or my PCA monitor for pest natural enemies if they are important in controlling key pests and take their numbers in consideration when making pest management decisions					
3.7 Cultural factors, such as time to harvest, preexisting plant damage, plant moisture stress, plant health, and crop load, are considered in pest management decision-making if they have significant effects on the risk of damage due to key pests					
3.8 I or my PCA keep qualitative (descriptive) written pest monitoring records and they get shared during the decision making process					

3.9 I and/or my PCA keeps quantitative (numeric) written pest monitoring records and they get shared during the decision making process					
3.10 If I rely on pest management recommendations from a PCA, I and/or my farm manager review with them the pest situation before making a decision to take a management action					
3.11 I encourage my crew supervisors and farm managers to report any pest problem that is out of the ordinary (e.g. pests they have never seen before), and report it to the appropriate person					
3.12 Pictures of important invasive pests are posted in convenient places so employees can monitor for their presence					
Pesticide Management					
4.1 'Smart'[19] sprayers are used when applying pesticides to some or all of my fields					
4.2 Pesticide drift is minimized by using technologies such as air induction nozzles, or some pesticides are applied using chemigation					
4.3 I rotate the use of pesticides according to 'mode of action' to minimize development of resistance					
4.4 I keep a written record of pesticide use by 'mode of action' as a part of my pesticide resistance strategy					
4.5 A written spray drift management plan has been drawn up for each field that includes a map of the field and location of sensitive areas. Sprayer operators follow the plan					
4.6 Calibration and spray coverage tests are done at least once a season on my sprayer and are based on manufacturers' recommendations as well as site characteristics such as crop canopy present					
4.7 Buffer zones have been established for each field based on pesticide label specifications, as well as adjacent crops and other sensitive sites					
4.8 Sprays are timed such that there is minimal or no human activity in adjacent areas					
4.9 Dormant season pesticide applications are not made when wind speeds exceed 10mph[20]					
4.10 Dormant sprays are not done in dead calm when a temperature inversion exists to avoid long distance pesticide drift					
4.11 Sprayer nozzles are shutoff at row ends near environmentally sensitive areas					
4.12 There is a berm around the wellhead that prevents surface water running from the perimeter to the wellhead					
4.13 Pesticide mixing and loading area is more than 100 feet from the wellhead, unless it is protected by a berm or other physical characteristics that prevent surface water running from the perimeter to the wellhead					

[19] A smart sprayer is one equipped with sensors that detect presense or absence of target and shuts off when target is not present.
[20] CDPR Rule for Dormant Season Insecticides Fact Sheet

4.14 A separate water supply tank is used for pesticide mixing, or chemicals are added to the tank at least 100 feet away from the well.					
4.15 Either a double-check valve, reduced pressure principle backflow prevention device, or an air gap is in place and maintained between the well pump and sprayer tank[21]					
4.16 Pesticide mixing and loading is done using a closed system, or with water soluble pesticide packets when available, for the pesticide being applied					
4.17 Spray mixing, loading and calibration is planned so that the tank is empty at the end of the spray job					
4.18 I use the following safe pesticide storage practices: dry pesticides stored above liquids, pesticides are stored more than 300 feet from nearest well, storage area has impermeable floor and sump to contain leaks, and only undamaged containers are stored					
4.19 I have an emergency response plan for pesticide and fertilizer spills and exposure posted in the appropriate places					
4.20 Workers are trained to follow the emergency response plan for pesticide spills or exposure					
4.21 A pesticide risk model such as PRiME[22], WIN PST or UC IPM's Water Tox[23] is used when considering which pesticides to apply					
4.22 The VOC 'footprint' of a pesticide is considered when deciding which pesticides to apply[24]					
Prevention and Cultural Practices					
5.1 I use resistance varieties/rootstocks to manage some of my key pests					
5.2 I use crop rotation to manage some of my key pests					
5.3 I consider timing of planting crops to avoid key pests					
Biological control					
6.1 I monitor for pest natural enemies if they are important in controlling my key pests					
6.2 If a pest natural enemy is important for a key pest, I implement practices that augment their populations like planting cover crops, nectar sources and avoid using pesticides that may be harmful to natural enemies					
6.3 I release pest natural enemies that have been proven to be effect controls for a key pest					
6.4 Conservation of pest natural enemies is considered when choosing a pesticide to use in the field					
6.5 Conservation of natural enemies is considered when deciding on spray timing					

[21] This is a legal requirement
[22] PRiME is the Pesticide Risk Mitigation Engine and can be accessed at http://ipmprime.org/cigipm/
[23] The model output is accessible at http://www.ipm.ucdavis.edu by viewing the webpage for the pest in question and clicking on the link labeled 'Water Quality Compare Treatments
[24] http://apps.cdpr.ca.gov/voc-calculator/

6.6 I establish areas adjacent to the field to augment natural enemies by growing plants that provide shelter, nectar, and pollen for them					
Effects of Pest Management on Non-Target Sites & Organisms					
7.1 Effects of a pesticide on pollinators are considered when selecting the material to apply					
7.2 I am a member of the local Irrigated Lands Water Quality Coalition					
7.3 Effects of a pesticide on non-target organisms existing on my farm, such as birds and small mammals, are considered when selecting the material to apply					

Social Responsibility

Human Resources Management	Not Familiar	Familiar, not tried	Have tried it	Currently Use	Not applicable
Staffing and Recruiting Strategy					
1.1 A long term (2-5 years) staffing and recruiting strategy is in place					
1.2 A variety of recruiting methods is used depending on job opening, e.g. word of mouth, newspaper, web recruiting, job fair, temporary or contract services					
1.3 A standard interview process is used in recruitment which includes a specific set of review questions					
1.4 A job description exists for each type of job and it is given to the employee and their supervisor					
1.5 Job descriptions are reviewed and updated at least once every two years					
1.6 For non-seasonal employees, an exit interview is conducted to determine why employees left the company					
Employee Orientation, Safety Training, and Career Development					
2.1 An orientation program is provided for new non-seasonal employees					
2.2 Safety training is done according to Cal OSHA regulations, i.e. when employee begins a new job assignment, or any new process, procedure or use of a substance or equipment that creates a new hazard					
2.3 All new employees undergo safety training					
2.4 If labor is contracted, a check is made to ensure contract labor company adheres to all relevant Cal OSHA safety regulations					
2.5 Safety statistics, such as time lost due to accidents, are tracked and retained for at least 2 years					
2.6 Employees are instructed as necessary to attend training seminars or other educational programs at least once a year that enhance their skills in the workplace					
2.7 Employees are encouraged to attend training seminars or other educational programs at least once a year that enhance their skills in the workplace (e.g. SpraySafe)					
2.8 My company pays for training when required and/or provides tuition reimbursement for work-related college classes					
2.9 A formal career planning process is in place for non-seasonal employees					
2.10 Every non-seasonal employee is provided an employee handbook					

that includes at a minimum, the company's work standards and policies and an overview of benefits					
2.11 The employee handbook is written in an appropriate language(s)					
2.12 An employee meeting is held at least once a year to discuss company goals and to exchange ideas					
2.13 A meeting of top management is held annually to discuss company goals and exchange ideas					
Staying Informed					
3.1Trade journals/appropriate trade literature (including literature on worker issues, safety issues, Farm Bureau, trade association literature, etc.) are made available for the farm management team (FMT) to read					
3.2 The FMT has current membership in local grower association(s)					
3.3 The FMT regularly attend regional and/or statewide industry meetings (e.g. irrigation district, Farm Bureau, Water Coalition, etc.), trade shows (e.g. World Ag Expo), and seminars (e.g. UC, CDFA, CSU seminars, research meetings from Commodity Boards)					
3.4 The FMT takes a leadership role in local, regional or state industry associations (e.g. Western Growers, California Grape & Tree Fruit League, Grower-Shipper Association)					
Performance, discipline, grievance process, and employee recognition					
4.1 A job performance process is in place and is linked to pay and promotions					
4.2 A form and process is in place for employees to comment on job satisfaction					
4.3 My company has a grievance process in place and it is documented in the employee handbook					
4.4 Filed grievances are recorded and processed in a timely manner					
4.5 A formal process is in place by which employees are recognized for good job performance and/or years of service					
4.6 A suggestion box is provided in a convenient location so that employees can provide ideas for improvements in company practices, working environment, and other areas.					
Health benefits, paid time off, and other benefits					
5.1 Basic health benefits are provided to non-seasonal employees					
5.2 Non-seasonal employees have paid holidays and vacation time					
5.3 Employees are provided sick leave and/or personal days					
5.4 Non-seasonal employees are provided (or employees are encouraged to participate) a formal pension plan or a company 401k					

Community Support	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 My company is involved in regional land use planning					
1.2 My company is involved in initiatives, through time commitment and/or donations, that enhance the community such as the Chamber of Commerce, schools/education programs, churches, public health, affordable housing					
1.3 My company is involved in regional water issues such as the regional water quality coalition, irrigation districts, ground water use planning, and/or the irrigated lands waiver program planning					

Waste Management

Sustainable agriculture provides a strategy for managing all aspects of your farming enterprise, including the management of the crop, soil, water, pests and human resources. It also relates to your farm's infrastructure and your office and shop areas. While the most interesting part of sustainable farming addresses what happens in the field, it is important not to forget important issues like waste management. In a lot of situations, waste management is one of the most straightforward processes to address on the farm.

Waste Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In field, shop and office					
1.1 The farm has a written waste management plan that includes waste reduction goals, recycling goals, hazardous material use reduction goals					
1.2 Crop residue or crop byproduct is recycled by either selling to another user (e.g. for cattle feed, co-generator/digester), composted, or returned to the field for incorporation into the soil					
1.3 The farm has an established recycling program for metal, cardboard, plastics, paper and glass					
1.4 The value of recycling is part of the orientation and training of employees					
1.5 The amount of metals, cardboard, plastics, paper and glass recycled annually vs. the amounts thrown away is determined and year to year comparisons are made					
1.6 The number of tires, batteries used per year and the amount of lubricants purchased vs. the amount sent back or recycled per year is recorded and year to year comparisons are made					
1.7 All unused or worn out items such as appliances, tractors, ATVs, electrical equipment, are taken to the proper recycling centers for disposal					
1.8 The total amount of hazardous materials, other than pesticides and fertilizers, present on the farm is known and their use is tracked on an annual basis (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.9 Employees are trained on the proper handling and disposal of hazardous materials (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.10 Employees are trained on legal requirements related to cleaning of					

farm equipment with water or steam cleaners and the resulting runoff					
1.11 Hazardous materials no longer used, as well as their containers, are disposed of according to legal requirements					
1.12 The farm participates in the pesticide container recycling program[25]					
1.13 Dumpsters and/or recycling containers are on cement pads to contain spills					
1.14 Dumpsters and/or recycling containers are covered to keep out rain					
1.15 Dumpsters and/or recycling containers are periodically inspected for leaks, spills, and litter. Problems noticed are corrected					
1.16 Bi-lingual signs are posted near the dumpster and/or recycling containers indicating what can or cannot be put in the container					

[25] Use the following link to find out how to participate in an Ag Container recycling program: http://www.acrecycle.org/contact_us.html

Water Management and Water Quality

California is the leading agriculture state in the US by a significant amount. This is due in large part to the high value of the many specialty crops grown in the state. It is also due to the excellent growing conditions such as fertile soils, a Mediterranean climate and the availability of affordable, high quality surface and ground water for irrigation. California is also the most populace state in the US and therefore affordable, high quality water is needed to support this population. It is clear that because of the demands for high quality, affordable water, this critical resource needs to be used efficiently and effectively by specialty crop producers. The following template will help document practices producers are using to achieve optimum water quality and use efficiency, as well as bring to their attention areas where improvements can possibly be made.

Irrigation Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pre-plant Planning					
1.1 Pre-plant analyses of the site was done to identify factors that affect quantity of irrigation water delivery and percolation rate such as existence of soil compaction, a root restricting layer, soil type, soil texture, soil chemistry (pH, salinity, etc.) and soil organic matter					
1.2 Ripping, plowing, chiseling, or other practices were implemented if pre-plant soil tests indicated water percolation and/or drainage problems					
1.3 Soil amendments were applied to correct soil chemical or physical issues if sampling identified factors that would affect water percolation					
1.4 Water source was sampled and evaluated for water quality					
1.5 The irrigation system was designed to deliver the quantity of water required for the crop and accommodate for variation in topography as well as in soil texture that affects water percolation and water holding capacity					
Irrigation Scheduling & Rates					
2.1 I measure and record the total amount of water used in each field every season and calculate water use per unit of crop production.					
2.2 I have a written water management plan for my field(s) that includes goals for the growing season.It takes into consideration annual rainfall, crop variety, crop maturity, water-related pest management issues, soil type, soil preparation, slope, water quality, irrigation efficiency, irrigation uniformity, energy efficiency					

2.3 Irrigation is initiated at the start of the season based on visual cues from the crop					
2.4 Irrigation is initiated at the start of the season based on measured soil moisture depletion					
2.5 Irrigation is initiated at the start of the season based on directly measuring plant moisture stress (e.g. with pressure bomb)					
2.6 Irrigation scheduling is influenced by peak energy pricing					
2.7 Water percolation rate and infiltration depth is monitored during the irrigation season					
2.8 Soil moisture depletion is estimated by visual inspection of the crop (e.g. growth or development) that indicates plant water stress					
2.9 Soil moisture depletion is tracked through soil coring					
2.10 Soil moisture depletion is tracked using soil-installed moisture monitoring devices					
2.11 Soil moisture depletion is tracked by directly measuring plant moisture stress (e.g. with a pressure bomb)					
2.12 Amount of irrigation and timing are dictated by the amount and timing of water available through my Water District					
2.13 Amount of irrigation and timing are based on visual cues of the crop					
2.14 Amount of irrigation and timing are based on irrigation history from past growing seasons					
2.15 Amount of irrigation and timing are based on historical crop evapotranspiration (ET)					
2.16 Water demand of the crop is estimated by determining ETo[26] through use of data from the nearest CIMIS weather station. This information is used in irrigation rate and scheduling					
2.17 Water demand from the crop is estimated by converting ETo to Etc using the appropriate crop coefficient factor (Kc), which takes into account crop canopy.This information is used in irritation rate and scheduling					
2.18 When appropriate, less than full water demand is applied to the crop (deficit irrigation)					
Irrigation Performance and System Maintenance – Pumps & Filters					
3.1 Pumping plant efficiency has been measured within at least the last 3 years (for areas where water table fluctuates considerably, pumping plant efficiency should be checked at least once every 2 years)					
3.2 Pumping plant efficiency has been measured within at least the last 5 years					
3.3 Energy use for irrigation is tracked on an annual basis and related to unit of production					
3.4 Electrical irrigation pumps are on time of use metering					

[26] ETo is the reference evapotranspiration and is calculated using measurements of climatic variable,s including solar radiation, humidity, temperature and wind speed, and is expressed in inches or millimeters of water. It is based on water use for a short mowed, full coverage grass crop.

3.5 If pumping efficiency is significantly reduced, I have improved it					
3.6 Diesel irrigation pumps are Tier 2 or higher					
3.7 A flow meter is installed on wells and/or pumps and I monitor and record the flows					
3.8 Pressure check points are installed on key lines from pumps					
3.9 Filter status (and flushing system) is manually checked at least twice a season and corrected if necessary					
3.10 Pressure gauges are installed for measuring pressure drops through filters					
Irrigation Performance & System Maintenance – Drip & Micro-sprinklers					
4.1 Distribution uniformity of the irrigation system is tested at least every 2 years					
4.2 The system has pressure compensating emitters to help maintain system distribution uniformity					
4.3 The irrigation system is monitored for leaks, breaks, and clogging every irrigation					
4.4 The irrigation system is monitored for leaks, breaks, and clogging at least once a season					
4.5 Fertigation is used to apply most of the fertilizers for the field					
4.6 An interlock system is installed so the injection pump shuts down if the irrigation pump shuts down. This prevents water source contamination					
4.7 Irrigation lines are flushed at the start of the season and then again at mid season, or more often as needed					
Irrigation Performance & System Maintenance – Sprinklers					
5.1 The irrigation system is monitored for leaks, breaks, and clogging every irrigation					
5.2 The irrigation system is monitored for leaks, breaks, and clogging at least once a season					
5.3 Sprinkler head rotation and nozzle clogging have been checked within the last 12 months and repaired if necessary					
5.4 Sprinkler head rotation and nozzle clogging are checked at least every other irrigation and repaired if necessary					
5.5 Sprinkler heads have been checked for wear in the past 5 years and replaced with the correct nozzle size if necessary to maintain distribution uniformity					
5.6 Fertigation is used to apply most of the fertilizers for the field					
5.7 An interlock system is installed so the injection pump shuts down if the irrigation pump shuts down. This will prevent water source contamination					
Irrigation Performance & System Maintenance – Flood & Furrow					
6.1 The field was laser leveled before planting the crop					

6.2 Levee locations in the field are based on observed infiltration rates (i.e. each check is appropriately sized for maximum water application uniformity)					
6.3 Irrigation produces no tail-water					
6.4 Irrigation produces tail-water and a tail-water recovery system is in place					
6.5 Flow meters are installed and flow volumes recorded on lines from pumps or in supply pipelines or ditches (e.g. Weir notch or Parshall flume) or a record of flow volumes is provided by the Water District					
Water quality – Source and resource					
7.1 Irrigation water is tested at least every 3 years for quality, including pH, total salt, nitrates, and biological problems. The quality of water in distribution reservoirs is tested if they are present on the farm.					
7.2 If a water quality problem exists, it is addressed					
7.3 I have accessed resource maps to determine if my field(s) are in Ground Water Protection Areas (GWPA)[27]					
7.4 If a field is in a GWPA, I have accessed and read the legal requirements for handling restricted use pesticides in GWPA areas and they are on file in the office					
7.5 I have identified and mapped areas on the farm that are potential sites for pesticides and fertilizers to enter the ground water					
7.6 The wellhead is situated so no surface water can reach it or a berm has been placed around the wellhead that prevents surface water from reaching it					
7.7 Return water wells, older wells and abandoned wells are sealed to prevent ground water contamination					
7.8 Irrigation practices create no off-site movement of chemical residues and sediments					
7.9 If storm water run-off occurs, one or more of the following mitigation practices are implemented: filter fabric fencing; filter strip; straw bale check dam; straw bale water bars; sediment basin; or other containment system					
7.10 Cover crops/vegetation is maintained on drain ditches and non-paved minor roadways to minimize rainfall run-off from field					
7.11 Soil percolation problems in the field have been addressed to minimize off-site movement of irrigation or storm water					

[27] http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpamaps.htm

Self-Assessment for Pistachio Production

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[4] Sustainable Conservation, 201 Needham St, Modesto CA 95354

Project History

Over the last 10 years the field of sustainable agriculture has become more and more important in the eyes of food retailers, buyers and consumers. As is often the case when new concerns arise in relation to food and food production, the spot light shines on the grower. Sustainable agriculture is challenging to define, and once defined it can be challenging for a grower to figure out how to implement it on the farm in an economically viable way. To meet these challenges a group of specialty crop trade associations, NGO's, and other specialty crop stakeholders met to discuss the topic of sustainable agriculture. One outcome of these discussions was an application to the California Department of Food and Agriculture Specialty Crop Block grant program for funds to hire sustainable agriculture professionals to help develop a plan to meet the challenges presented by sustainable agriculture. The Great Valley Center coordinated the grant application and engaged SureHarvest to provide the technical expertise. SureHarvest is a company with extensive experience in sustainable agriculture strategic planning, program design, and program implementation. The grant application was successful and began in September of 2009. The Great Valley Center directed the project and contracted with SureHarvest for project design, facilitation and implementation.

The grant had two primary goals. The first was to develop, through a stakeholder process, a sustainable agriculture strategic plan that each of the participating groups could use internally to help lay the foundation for their own sustainable agriculture program specific to their specialty crop. The second was to develop a tool, or tools, that could be used by their member growers to put the strategic plan into action on the farm.

The following paragraphs contain the sustainable agriculture strategic plan developed by the project leadership team, the members of which are listed in Table 1.

Sustainability Strategic Plan for the Multi-Commodity Project

The sustainability strategic plan for the Multi-Commodity Project is based on SureHarvest's 5 P's of sustainability framework. The 5 P's are: Principles, Processes, Practices, Performance Metrics, and Progress. They are defined as follows:

1. Principles – This is the sustainable vision for the project. It consists of the goals that the participants want to achieve from the design and implementation of the project.
2. Processes – These are the resource areas on the farm that need to be addressed in order to meet the principles or goals of the project. For example, this could be water, energy, and human resources management.
3. Practices – These are the practices that are implemented on the farm that impact the processes or resource areas. They are the on-the-ground actions that are carried out to assure that the principles or goals of the sustainable program are met.
4. Performance Metrics – These are the metrics used to measure the outcomes resulting from the practices implemented on the farm. There are many - examples include crop quality, water use, energy use, and worker satisfaction. Performance Metrics are used to measure the level of success in meeting the principles or goals of the project.

5. Progress – The process used to improve performance over time and communicate the results internally and externally. In other words, tracking the degree of progress one is making towards achieving the goals of the project. Measuring progress will require some kind of system for assessing the farm's performance over time, creating action plans to improve particular areas of performance, and reassessment over time to track progress.

Table 1. Multi-Commodity Project Leadership Team

Organization	Representative
Almond Board of California	Gabriele Ludwig*, Robert Curtis*
Bolthouse Farms	Troy Elliott*, Justin Groves*
California Grape & Tree Fruit League	Chris Valadez*, Barry Bedwell
California Specialty Crop Council	Lori Berger*
California Garlic & Onion Research Advisory Board	Robert Ehn
California Olive Council	Patty Darragh
California Pear Advisory Board	Bob McClain
California Pepper Commission	Glen Fischer*
California Pistachio Board	Robert Klein*
California Raisin Marketing Board	Gary Schultz
California Tomato Farmers	Ed Beckman*
California Tree Fruit Agreement	Gary VanSickle*, Lauren Friedman
California Walnut Board	David Ramos
Del Monte Foods	Pat McCaa
Sun-Maid Growers	Rick Stark*

*Leadership Team Member

Multi-Commodity Project Principles (1st P):

The principles for the Multi-Commodity Project were established by the Project Leadership Team. They are:

1. Create a resource area/practice template that:
   a. Will focus on increasing the economic performance for the participant.
   b. Is scalable and can be used by participating groups to accomplish the goals of their own sustainability programs.
   c. Provides the participant the ability to gauge the state of sustainability of the industry and their farm.
   d. Encourages continual improvement on the farm.
   e. As a whole encourages ecological harmony.
   f. Better defines the 3 E's of sustainability (economic viability, environmental soundness and social equity/responsibility) in a way we can all agree upon.
   g. Is open to and usable by any individual or group in the future that was not involved in the original effort.
   h. Benefit the participants and not result in unintended negative consequences.

2. The program should provide the information/data needed for groups to tell their sustainability story better to all their audiences, e.g. buyers, regulators, consumers, NGO's.
3. The outcomes from the project cause no harm to producers.

The Leadership Team of the Multi-Commodity Project decided the best tool for implementing their sustainability strategic plan was a self-assessment of practices template that stakeholders from specific specialty crops could then fine tune for their own use. The team chose to use the model developed by the California Sustainable Almond Program (CASP), which is a California Almond Board program developed in partnership with SureHarvest. The Leadership Team formed a stakeholder committee to draft the self-assessment template that covered the practice areas listed in the Multi-Commodity Project Strategic Plan. The Stakeholder Committee members are listed in Table 2.

Individual Contact	Title	Expertise
Billy Heller	Grower, Pacific Triple E Farms	Crop management
Bob Giampaoli	Grower, Live Oak Farms	Crop management
Cliff Sadoian	Grower	Crop management
Pat McCaa	Manager, Pest Management, Del Monte Foods	Crop management
Mechel S. Paggi (Mickey)	Director, Center for Agricultural Business, California State University, Fresno	Ag Business & economics
Glen Fischer	Ag Representative, Saticoy Foods Inc.	Crop management
John Trumble	Professor of Entomology, University of California Riverside	Pest management
Jeff Mitchell	Extension Specialist, University of California, Davis	Soils & plant nutrition
Pete Goodell	UC IPM Area Advisor, University of California, Davis	Pest management
Terry Prichard	Extension Specialist, University of California, Davis	Irrigation & crop water relations
Bill Peacock	Representing raisin growers via the Raisin Marketing Board and Tree Fruit Growers	Crop management
Troy Elliott	Director of Agronomy, Bolthouse Farms	Crop management

Table 2. Multi-Commodity Project Stakeholder Committee

The second phase of the Multi-Commodity Project began with SureHarvest obtaining a CDFA Specialty Crop Block Grant to finish the self-assessment template with the Multi-Commodity Leadership Team and Stakeholder Committees and then fine-tune the template into workbooks for individual specialty crops working with willing growers and stakeholders from each specialty crop community. The self-assessment workbook for pistachios which is presented on the following pages was developed using the Multi-Commodity self-assessment template through a series of reviews and edits by growers, other stakeholders and SureHarvest staff. Bob Klein and the Pistachio Marketing Board and Richard Matoain and the American Pistachio Growers were particularly helpful during the review process. The final version was produced by SureHarvest and submitted to CDFA along with their final report in June of 2013.

Air Quality Management

Pressure is being brought to bear on urban and rural industries, including agriculture, to reduce air pollutants in the Great Central Valley of California. This section of the self-assessment will help the grower identify practices that influence air quality, highlight where the grower is doing well, and determine areas that need improvement.

Air Quality Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In Field and Adjacent Land					
1.1 To minimize airborne dust and PM10[5] particles, a reduced tillage program is in place					
1.2 To minimize airborne dust and PM10 particles, a no-till program is in place					
1.3 If tillage is done, moisture content of the soil is taken into consideration to minimize dust					
1.4 To minimize airborne dust and PM10 particles, a cover crop is maintained at least every other row					
1.5 An every row permanent cover crop is maintained in the orchard					
1.6 Vegetation is maintained on non-cropped areas such as headlands, roadsides, and field edges to reduce wind erosion causing airborne dust					
1.7 Prunings are chipped and/or incorporated into the soil or composted rather than burned					
Roads					
2.1 Vehicle speed is restricted on dirt roads around fields to minimize airborne dust					
2.2 Dirt roads are treated with an anti-dust agent that meets the 50% PM10 control for a Fugitive PM10 Management Plan[6] or are graveled, watered, chipped, mulched (crop residues), sanded or seeded					
2.3 Heavily used roads are paved (e.g. main thoroughfares on farm)					
Engines and Fuel Consumption					
3.1 Engines are maintained on a regular schedule to ensure they are					

[5] PM 10 are particles 10 microns in diameter or smaller and pose a health risk because they pass through the throat and nose and penetrate the lungs.
[6] For details see http://www.airquality.nrcs.usda.gov/Documents/files/Dust_Control_Products.htm

running at optimum performance and efficiency so emissions are minimized					
3.2 At least some vehicles are equipped with engines able to use alternative fuels with lower emissions					
3.3 Some off-road farm vehicles are powered by engines that do not burn combustible fuel (e.g. battery-powered golf carts)					
3.4 Vehicle miles are tracked on an annual basis					
3.5 Stationary diesel engines have been replaced (or retrofitted) to Tier 3 or better, or have been replaced (or retrofitted) with technology relying on cleaner burning fuel or replaced with electric pumps					
3.6 Selection of vehicle power plants and stationary engines is in part determined by lower emissions ratings					
3.7 Some of the farm's energy requirements are obtained through renewable sources such as wind or solar					
Pesticide Management and Air Quality					
4.1 When choosing a pesticide to apply, its VOC 'footprint' is considered[7]					
4.2 Practices are implemented that reduce pesticide drift such as use of air induction nozzles, turning sprayers off at turn-arounds , not spraying when a temperature inversion exists in the field, and when wind exceeds 10 mph, or the velocity specified on the label					
Greenhouse Gas Emissions					
5.1 The application of orchard inputs that produce greenhouse gases, such as fertilizers, pesticides and diesel fuel, (e.g. CO_2, NOx) is optimized					

What are VOC's?

VOC stands for volatile organic compound. These are carbon based compounds contained in products used on the farm (such as certain pesticides), that volatilize (evaporate) when exposed to the air. Ground-based ozone is produced by chemical reactions involving VOC's, nitrogen oxides (NOx) and sunlight. While not direct air pollutants themselves, VOC's are important ozone precursors, and considered key targets for reduction in the Central Valley of California in regions where air quality is an issue. The California Department of Pesticide regulation does not know the reactivity of every VOC. Ideally, reactivity should be used to precisely determine VOC emissions. That said, appropriate data and analytical methods do exist at this time to make accurate estimates. The Department does hope to use reactivity at some point in the future. It calculates VOC emissions based on the best available science (Dr. Matt Fossen, pers. comm., Environmental Scientist, Calif. Dept. Pesticide Regulation). Air Quality and greenhouse gas emissions are such important topics in the Central Valley of California it is important to consider the various sources of potential air quality problems.

[7] A VOC calculator is found at: http://apps.cdpr.ca.gov/voc-calculator/

Energy Management

Energy is essential for crop production and it comes in several forms; as sunlight to power photosynthesis, as fuel to power internal combustion motorized vehicles and pumps, and as electricity to power shop and office lights and electronic equipment. Tracking energy is very important because it is getting more and more expensive all the time, increasing the cost of production. Burning of fuel produces GHG that affect air quality and contribute to climate change. So minimizing energy consumption saves money and reduces GHG production. Completing this section should help improve your understanding of energy use in your operation and encourage you to consider some forms of energy conservation.

Energy Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 An energy management plan is being implemented on the farm that includes yearly goals for overall energy use as well as energy used per unit of crop production.[8]					
1.2 The total amount (gallons) of fuel used annually on the farm in all operations is recorded and year to year comparisons are made. Each fuel type is recorded.					
1.3 The total amount of fuel used annually per acre and per unit of crop production is determined and year-to-year comparisons are made[9]					
1.4 The total amount of fuel used annually is calculated for each field and year-to-year comparisons are made. Each fuel type is recorded.					
1.5 Annual fuel consumption and/or electrical use for irrigation pumps are recorded and comparisons made on 4 year running averages.					
1.6 Electrical use for office(s), shop(s), and outdoor security lighting is tracked using energy bills and comparisons are made on 4 year running averages					
1.7 Fuel and electricity used are converted to a common metric such as British Thermal Units (BTU's) so they can be combined to calculate the total amount of energy used annually for crop production and comparisons are made[10] on 4 year running averages.					

[8] Ideally one would convert all energy consumption to BTU's (British Thermal Units) but initial energy management plans could start with using gallons of gasoline and diesel and kilowatt hours for electricity.
[9] This can be a simple calculation of taking the total gallons of fuel used for the year divided by the total amount of crops produced for the year.
[10] Energy conversion calculators for kilowatt hours to BTU's and gas or diesel to BTU's are readily and freely available on the Internet. For example Google 'convert kilowatt hours to BTU's and a link will be provided to a calculator.

1.8 The amount of energy used annually per acre and per unit of crop production is calculated and comparisons are made on 4 year running averages.					
1.9 The amount of energy used annually in each field is calculated and comparisons are made on 4 year running averages.					
1.10 A process is in place to ensure that the most appropriate piece of equipment is used for a given job (e.g. the most appropriate horse power engine for the job).					
1.11 One or more solar energy systems are installed on the property to generate electricity.					
1.12 One or more wind generators are installed on the property to generate electricity.					
1.13 Engines (stationary and mobile) and motors are maintained on a regular schedule to ensure they are running at an optimum fuel efficiency or optimum efficiency.					
1.14 Pumping plant efficiency (energy per acre foot pumped) is checked every 1 to 3 years (based on use) and adjustments are made if necessary (FSU website recommends every 1-3 years based on use).					
1.15 At least some light switches are fitted with motion detectors or photo cells to reduce time of use.					
1.16 At least some office and shop lights have been fitted with low energy consumption compact florescent bulbs or LED lights.					

Indirect Energy Use/Consumption:

Energy is directly expended when driving a vehicle, operating a pump, photocopying, or turning on and using a light bulb. Energy is also expended to manufacture inputs that are used on the farm, such as fertilizers, compost and pesticides. This type of energy consumption is called imbedded energy. If you want to figure out the total amount of energy consumed to produce a crop, then calculations should also be made to determine the amount of embedded energy that was consumed to produce the fertilizers, compost, and pesticides that were used to produce the crop.

Financial Management

The economic E of sustainable farming is literally where the buck stops. If a farm is not profitable, it is not sustainable. People farm not because they want to be accountants. They farm because they want to grow things. However, while financial management may be a challenging part of farming, doing it well is one of the keys to a successful and sustainable farm. This chapter will help the grower recognize strengths in financial management as well as point out areas where improvements are needed.

Financial Management **(The most appropriate person to fill out this section/chapter is the CEO/owner of the farm)**	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Planning and Risk Management					
1.1 A processing, harvesting and production financial plan has been developed for the farm and seasonal outcomes are compared to these plans					
1.2 A succession[11] plan is in place for the farm					
1.3 I have a written will and estate plan for the farm[12]					
1.4 A business continuation plan has been developed for the farm that addresses disasters, such as extreme weather events or the unexpected death of one or more key personnel					
1.5 A risk management plan has been developed for the farm that addresses factors such as absence of labor, blackouts, or lack of ability to deliver the crop to the processor					
1.6 Key personnel in the company have health insurance					
1.7 Key personnel in the company have disability insurance					
1.8 Key personnel have life or accidental death insurance					
Accounting and Financial Analyses					
2.1 A financial accounting system is used to track and report farm finances and is used to make farm management decisions					
2.2 I understand how to interpret both cash and accrual financial statements, including a balance sheet, income statement, cash flow, and financial ratios					
2.3 A financial advisor is consulted on an annual basis in relation					

[11] A succession plan is one where the change in leadership in the company has been determined, whether it is expected such as the CEO voluntarily stepping down/retiring, or unexpected such as due to illness or accident.
[12] An estate plan is a plan for the financial assets to pass from one generation to the next. It does not deal with the human and intellectual capital and passing that transition to the next generation. That is succession planning.

2.4 Financial profitability analyses for investments are done if investments are made					
2.5 The revenue and returns are tracked for each field/management unit in financial management reports					
2.6 Costs and returns are tracked for all important farming practices					
2.7 Costs and returns are tracked for implementing new sustainability practices and compared to costs and returns of practices they replaced					
2.8 Sensitivity analysis, i.e. change in crop prices over time, is used in production management decisions					
Purchasing and Borrowing					
3.1 More than one quote is obtained for major input purchases such as pesticides and fertilizers					
3.2 Interest rates and services from more than one lending institution are compared before borrowing a significant amount of money					

Food Safety Planning

How do we ensure that fresh food is safe? This is a question that is being debated by everyone all along the supply chain. Compliance with food safety production requirements is becoming a necessary requirement for many specialty crops. This section lists practices that are related to food safety planning.

Food Safety Planning	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Food Safety Management Planning					
1.1 A written food safety policy is in place for the farm that includes a commitment to food safety, how it is implemented, and how it is communicated to the employees					
1.2 A written food safety plan is on file and implemented on the farm					
1.3 If a food safety plan is in place, the plan meets Global Food Safety Initiative (GFSI) guidelines					
1.4The food safety plan is reviewed and updated at least annually					
1.5 Records are kept to demonstrate the food safety plan is being followed					
1.5 A person has been designated as being responsible for food safety functions on the farm					
1.6 All employees are trained in food safety procedures and practices on the farm					
1.7 My company participates in a third- party food safety certification/verification program (e.g. Agriculture Marketing Service GAP Certified, Scientific Certification Systems, PrimusGFS, GLOBALG.A.P.)					
1.8 If there is participation in a 3rd party food safety program, the program is Global Food Safety Initiative (GFSI) compliant or approved					

Soil Management

Soil is the most complex ecosystem on earth. Gaining a greater understanding of the soil resource in production fields is critical for making informed soil management decisions. Knowing the soil resource gives the grower greater control over yield and crop quality and is especially important in determining the long-term sustainability of the farm.

Soil provides the crop with three vital things: water, nutrients and air. These three things are best provided by a soil with good depth and structure, i.e. a soil in which the particles are bound together into small clumps (aggregates) of varying size. Soil aggregation is a measure of soil structure. Soil organic matter is important in maintaining soil structure by gluing soil minerals together into aggregates. Spaces between large aggregates (measured as millimeters) permit rapid drainage and easy root growth, and spaces between small aggregates (measured as less 1 millimeter down to 0.001 millimeter) trap water for use between irrigation and rain events. One of the more important aspects controlling aggregate stability is the amount of microbial activity and soil organic matter. Stable aggregates occur in varying sizes and are created by the cementing action of microbes and their byproduct and soil organic matter. The assemblage of soil aggregates creates habitat to promote faunal and microbial diversity, an important index of soil quality. Due to the warm to hot California climate, soil organic matter is low in many soils due to rapid breakdown of soil organic matter.

The following self-assessment template will help document the practices producers are using to manage their soil sustainably as well as suggest areas where improvements might be possible.

Soil Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Knowledge of soil properties					
1.1 The soil types in the field has/have been identified using soil samples taken pre-planting (for permanent crops soil pits were dug to establish soil series)					
1.2 Soil properties for each soil type in the field are recorded, including soil moisture holding capacity, texture, and rooting depth					
1.3 A soil sample has been taken in the field within the last 4 years and analyzed for macro and micro nutrients, as well as soil chemistry (e.g. pH, CEC, salts)					
1.4 A soil sample has been taken in the field within the last 2 years and analyzed for macro and micro nutrients, as well as soil chemistry (e.g. pH, CEC, salts)					
1.5 Soil pH is determined and amended if necessary					
Soil properties management					

2.1 If water infiltration is poor (water puddles and runs off when soil is dry underneath) the soil is amended either chemically or physically					
2.2 Cover crops are planted for soil management					
2.3 Resident vegetation is allowed to grow for soil management					
2.4 If soil organic matter is low for the soil series in my field, there is an ongoing program to build soil organic matter, either through additions of compost and/or growing cover crops					
2.5 Equipment is chosen or is modified to minimize soil compaction (e.g. lightest equipment possible, track-layers, wider or bigger diameter tires, tire pressures as low as possible)					
2.6 The soil is never tilled unless a problem develops that requires one pass to alleviate the problem (e.g. soil is too uneven for safe operation of equipment; this does not include aerating the soil with equipment like an Aerway)					
2.7 Tillage is done as necessary to correct orchard floor problems due to things like gopher or ground squirrel activity					
2.8 Tillage is done on a regular schedule					
2.9.1 In order to avoid soil compaction, heavy equipment is never driven on saturated soil					
Soil erosion					
3.1 If soil erosion is an issue, vegetation is maintained along farm roads, on field edges, and along irrigation canals not controlled by the irrigation district					
3.2 The infiltration/run-off rates of the field's soil is known and the rate of irrigation water are applied and adjusted accordingly					
3.3 Culverts are properly sized to accommodate high flows, and inlets and outlets have been hardened to prevent scour or energy dissipaters have been installed					
3.4 An orchard floor management plan is implemented to (1) protect the soil from water droplet impact, (2) enhance aggregate stability, (3) improve water infiltration, and (4) interrupt runoff pathways.[13]					
Crop nutrition management					
4.1 A crop nutrient management plan has been written for the orchard that uses a 'budgeting approach'[14] in determining the nutrient needs of the crop and takes into consideration factors like crop tissue analyses, soil type, time of year, soil moisture, crop load (e.g. alternate bearing), etc. (insert an educational box discussing the 4 R's of nutrient management; see http://www.ipni.net/4r)					

[13] O'Geen, Anthony. Orchard Floor Management Practices to Reduce Erosion & Protect Water Quality, University of California Division of Agriculture & Natural Resources (2006), http://fruitsandnuts.ucdavis.edu/files/103067.pdf.
[14] A budgeting approach means that the amount of nutrients leaving the field in the crop is estimated and the amount of nutrients added back to the field is based on this estimate. A one -to-one replacement is not implied or required since factors such as soil type affect nutrient availability to the crop and these factors must also be taken into account.

4.2 Lab results from the soil samples were used in developing the crop nutrient management plan					
4.3 Plant tissue are taken and analyzed at least once a season and used to help assess crop nutrient needs and assess the impact of the nutrition management program					
4.4 The year-to-year amounts of nitrogen, phosphorus, and potassium applied per acre are recorded and the amounts of N, P, & K applied per unit crop production are calculated					
4.5 Nutrients are applied to the root zone at the time of greatest need					
4.6 Due to the "alternate year" nature of pistachio yields, less fertilizer is applied during "off" years.					
4.7 Fertilizers are applied using Fertigation					
4.8 The total amount of nitrogen needed for the season is applied in a split application(s)					
4.9 Fertilizers are applied using a 'spoon feeding' approach where only the amount of nutrients required by the crop at the time are applied and multiple applications are made throughout the growing season based on crop growth stage and nutrient demand					
4.10 Micro nutrients are applied based on past crop history					
4.11 Micro nutrients are applied based on soil sample test results					
4.12 Micro nutrients are applied based on crop tissue sample test results					
4.13 Long-term records for the orchard are kept of the application program, including applications of fertilizer and soil amendments, results of leaf sampling, and yield.[15]					
4.14 Nutrient management is done using the concept of the 4Rs, i.e. applying the **r**ight rate, at the **r**ight time, in the **r**ight place, and using the **r**ight source.[16]					

The 4 R's of Nutrition and Nutrient Management

The 4 R's of nutrient management is an approach to fertilization developed and promoted by the International Plant Nutrition Institute (IPNI). Whenever nutrients are added to a field or orchard, it should be done at the right time, in the right place, using the right rate and the right source of nutrients. The right time is determined when uptake from the soil occurs. The right place is achieved by ensuring delivery of nutrients to the active roots and managing variability across the orchard. The right rate is applied by matching demand with supply. The right source is ensured by maximizing uptake and minimizing loss potential.

[15] Beede, Robert, Nutrients & Fertilization, Fruit & Nut Research & Information Center, http://fruitsandnuts.ucdavis.edu/pistachiopages/pistachio_nutrients_fertilization/
[16] Brown, Patrick & Siddiqui, Muhammad, *Managing Pistachio Nutrition*, California Pistachios http://fruitsandnuts.ucdavis.edu/files/135347.pdf

Ecosystem Management

An ecosystem is the complex community of living organisms and their physical environment functioning as an ecological unit. Components of an ecosystem are inseparable and interrelated. An ecosystem management approach to growing specialty crops acknowledges that people are a part of and have a significant impact on ecosystem structures and processes, and that people depend on and must assume responsibility for the ecological, economic, and social systems where they live. Ecosystem management is currently being encouraged and implemented by communities, government agencies, businesses, academics and various conservation organizations throughout the world[17].

Ecosystem Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Habitat maintenance and enhancement					
1.1 Hedgerows of trees and/or shrubs are maintained on at least some field edges					
1.2 Vegetation such as grasses, trees or shrubs are maintained along roadsides, ditch-banks and headlands					
1.3 Trees are maintained to provide habitat for wildlife					
1.4 Nesting boxes for owls have been placed around the farm and they are cleaned annually					
1.5 Perches for raptors have been placed around the farm					
1.6 If water courses exist on the farm property, setbacks are in place to minimize disturbance					
1.7 If water courses exist on the farm property, resident vegetation is maintained on the banks					
Whole farm issues					
2.1 I am an active member in the local watershed coalition					
2.2 Invasive pests (e.g. puncture vine, arundo) are monitored for and when found, controlled					
2.3 An environmental survey of the farm has been done noting the presence of sensitive areas, such as vernal pools, swales, oak trees, habitat for endangered species, and other environmental features which affect farming and actual farmable acres					
2.4 Some or all of the natural areas of my property are protected by a conservation easement (see education box below)					

[17] Reeves, K. 2008. Chapter 1. Ecosystem Management *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 15- 63.

2.5 Some or all of my property are protected by an agricultural easement program					
2.6 Unfarmed areas are maintained to increase biodiversity on the farm including wildlife, pollinators and/or arthropod natural enemies					

Education box: What is an ecosystem service?

The biological communities in an agricultural ecosystem provide benefits over and above the commercial crops they produce. These benefits are known as ecosystem services. They include removing carbon dioxide from the atmosphere, reducing greenhouse gases, the recycling of nutrients, regulation of microclimate and local hydrological processes. In some cases they result in the suppression of pest plants and animals through the production of pest natural enemies, and detoxification of noxious chemicals that enter the environment.

Education Box: What are Conservation and Agricultural Easements?

Conservation easements for protection of natural resources are legal agreements that allow landowners to donate or sell some "rights" on portions of their land to a public agency, land trust, or conservation organization. In exchange, the owner agrees to restrict development and farming in natural habitat, and assures the easement land remains protected in perpetuity. A 1996 study conducted by the National Wetlands Conservation Alliance indicated that the leading reasons landowners restored wetlands were to provide habitat for wildlife, to leave something to future generations, and to preserve natural beauty. Only 10% of landowners surveyed in the study restored wetlands solely for financial profit. This would also apply to other habitats besides wetlands. A conservation easement can provide you with financial benefits for the protection, enhancement, and restoration efforts for the natural environments on your property. The belief that natural resources such as wildlife, especially sensitive species, will reduce your land value is not true. Many easement programs include some sort of cash payment for a portion of the costs associated with habitat restoration and enhancement.

Agricultural conservation easements are for the explicit purpose of keeping farmland in production. They are similar to natural resource conservation easements, but, specifically protect farmland and maintain the practice of farming. In 1996, the state established the California Farmland Conservancy Program to protect farmland by funding agricultural easements. Based on a study conducted by UC Cooperative Extension and published in 2002, there were 34 local conservation organizations, land trusts, and open space districts that protect farmland through agricultural easements (see – *Agricultural Easements: New Tool for Farmland Protection California Agriculture*, January-February 2002, Volume 56:No. 1). Local opportunities may exist for one or both kinds of conservation easements on your property.

Pest Management

Integrated pest management (IPM) is a fundamental part of any sustainable farming program. It is cost-effective, flexible, and resilient. IPM was developed to respond to some significant pest management challenges that developed in the 1950's and 1960's. Events such as the development of pesticide resistance by many pests, secondary pest outbreaks, and environmental contamination due to the use of certain problematic pesticides, led a forward-looking group of entomologists at the University of California to conclude that agriculture was heading toward a pest management crisis. They realized the fact that pest problems are complex and connected to ecosystem processes was being overlooked. They concluded that the solutions to complex ecological problems must be broad-based and take the farm ecosystem into account. These researchers developed the IPM concept to meet the pest management crisis. Since its inception in 1959, IPM has evolved into the best way to manage pest problems on the farm.

University of California Statewide IPM Program crafted the following as the definition of IPM[18]:
Integrated Pest Management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.

Farming is carried out within the ecosystem and is a long-term endeavor so the use of management practices that are ecosystem-based and long-term in nature is important. By using a combination of control techniques to manage a pest problem, we develop a broad-based management strategy that will still be successful even if one particular technique does not work. Based on our experience with chemical controls, we know that pest control decisions must take into account not only economic risks, but effects on the environment and people's health well[19].

Pest Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pest Management Framework for Farm					
1.1 An integrated pest management framework/plan for the farm has been developed that takes into account the landscape within which I farm, an understanding of the cropping system and how it affects the					

[18] http://www.ipm.ucdavis.edu/IPMPROJECT/about.html
[19] Ohmart, C. P. and C. P. Storm. 2008. Chapter 6. Pest Management. *In* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 187- 267.

population levels of key pests, includes monitoring protocols and economic thresholds for key pests, monitoring protocols and important pest natural enemies, and the key biological, cultural and chemical control options available for key pests					
1.2 Each year the pest management framework is reviewed with all those involved in pest management on the farm and adjustments are made according to the goals set forth in the plan and pest management results from the past year					
Risk Assessment					
2.1 Key pests for the farm have been identified in the following groups: diseases, insects, mites, weeds, mammals and birds; and targeted for management					
2.2 Monitoring protocols have been established and are followed for key pests					
2.3 I and/or my Pest Control Advisor (PCA) have established and use economic thresholds for key pests					
2.4 I and/or my PCA keep written spray records containing the information required by California Department of Pesticide Regulation as well as weather conditions and effectiveness					
2.5 Environmentally sensitive areas are known in and near the orchard, such as distance to ground water, surface water, wetlands, vernal pools, swales, houses, schools, public and private roads					
2.6 Environmentally sensitive areas in and near the orchard have been mapped, such as distance to ground water, surface water, wetlands, vernal pools, swales, houses, schools, public and private roads					
Monitoring					
3.1 The UC IPM year round pest management program for pistachios[20] is followed					
3.2 The UC IPM pest management guidelines for pistachios are used[21]					
3.4 I monitor pest populations in the orchard					
3.5 A PCA monitors pest populations in the orchard					
3.6 Monitoring is done for pest natural enemies and their numbers are considered when making pest management decisions					
3.7 Cultural factors, such as time to harvest, preexisting plant damage, plant moisture stress, plant health, and crop load, are considered in pest management decision-making					
3.8 Qualitative (descriptive) written pest monitoring records are kept and are used during the pest management decision making process					
3.9 Quantitative (numeric) written pest monitoring records are kept and are used during the pest management decision making process					
3.10 If pest management recommendations from a PCA are relied upon for pest management decisions, someone from farm management					

[20] http://www.ipm.ucdavis.edu/PMG/selectnewpest.pistachios.html
[21] http://www.ipm.ucdavis.edu/PDF/PMG/pmgpistachio.pdf

reviews with them the pest situation before making a decision to take a management action					
3.11 Crew supervisors and farm managers are encouraged to report any pest problem that is out of the ordinary (e.g. pests they have never seen before) and report it to the appropriate person					
3.12 Pictures of important invasive pests are posted in convenient places so employees can monitor for their presence					
Pesticide Management					
4.1 'Smart'[22] sprayers are used when applying pesticides in the orchard					
4.2 Pesticide drift is minimized by using technologies such as air induction nozzles, or some pesticides are applied using chemigation					
4.3 Pesticides with different modes of action are rotated to minimize development of resistance					
4.4 A written spray drift management plan has been drawn up for each orchard that includes a map of the field and location of sensitive areas and sprayer operators follow the plan					
4.5 Calibration and spray coverage tests are done at least once a season on sprayers and are based on manufacturers' recommendations as well as site characteristics such as crop canopy present					
4.6 Buffer zones have been established for each orchard based on pesticide label specifications as well as adjacent crops and other sensitive sites					
4.7 Sprays are timed such that there is minimal or no human activity in adjacent areas at the time of spraying					
4.8 Sprayer nozzles are shutoff at row ends near environmentally sensitive areas					
4.9 There is a barrier around the wellhead that prevents surface water running to the wellhead					
4.10 Pesticide mixing and loading area is more than 100 feet from the wellhead unless it is protected by a berm or other physical characteristics that prevent surface water running to the wellhead					
4.11 A separate water supply tank is used for pesticide mixing or chemicals are added to the tank at least 100 feet away from the well.					
4.12 Either a double-check valve, reduced pressure principle backflow prevention device or an air gap is in place and maintained between the well pump and sprayer tank[23]					
4.13 Pesticide mixing and loading is done using a closed system or with water soluble pesticide packets when available for the pesticide being applied					
4.14 Spray mixing, loading and calibration is planned so that the tank is empty at the end of the spray job					

[22] A smart sprayer is one equipped with sensors that detect presence or absence of target and shuts off when target is not present.
[23] This is a legal requirement

4.15 The following safe pesticide storage practices are used: dry pesticides stored above liquids, pesticides are stored more than 300 feet from nearest well, storage area has impermeable floor and sump to contain leaks, and only undamaged containers are stored					
4.16 An emergency response plan has been established for pesticide and fertilizer spills and exposure posted in the appropriate places					
4.17 Workers are trained to follow the emergency response plan for pesticide spills or exposure					
4.18 A pesticide risk model such as PRiME[24], WIN PST or UC IPM's Water Tox[25] is used when considering which pesticides to apply					
4.19 The VOC 'footprint' of a pesticide is considered when deciding which pesticides to apply[26]					
4.20 Practices are implemented which reduce the amount of *Aspergillus flavus* inoculum in the orchard.[27, 28]					
Prevention and Cultural Practices					
5.1 Resistance rootstocks are used to manage key root diseases					
5.2 All weeds and grasses are removed from the orchard and around the base of each tree to reduce damage from plant bugs					
5.3 To reduce the incidence of navel orangeworm during the growing season and minimize the need for pesticide use during the growing season, any mummy nuts are removed from the trees and destroyed.[29]					
5.4 Harvest is timed to reduce the incidence of navel orangeworm					
5.5 Ground mummies of navel orangeworms are destroyed by disking or mowing after removing as many nuts as possible from the berm by blowing or raking					
Biological control					
6.1 Conservation of pest natural enemies is considered when choosing a pesticide to use in the orchard					
6.2 Sprays are timed to minimize their impact on pest natural enemies					
Effects of Pest Management on Non-Target Sites & Organisms					
7.1 Effects of a pesticide on non-target organisms existing on the farm, such as birds and small mammals, are considered when selecting pesticides to apply					

[24] PRiME is the Pesticide Risk Mitigation Engine and can be accessed at http://ipmprime.org/cigipm/

[25] The model output is accessible at http://www.ipm.ucdavis.edu by viewing the webpage for the pest in question and clicking on the link labeled 'Water Quality Compare Treatments')

[26] http://apps.cdpr.ca.gov/voc-calculator/

[27] Aflatoxin is a potent carcinogen produced by the fungi *Aspergillus flavus* and associated with liver cancer in humans. Aflatoxin is also an acute toxin for animals that are fed a diet contaminated with aflatoxin. The practices above will reduce the risk of aflatoxin contamination.

[28] California Pistachio Research Board, *Good Agricultural Practices Manual, Guidelines for California Pistachio Growers* (2009), http://ucfoodsafety.ucdavis.edu/files/26477.pdf.

[29] Beede, Robert, Nutrients & Fertilization, Fruit & Nut Research & Information Center, http://fruitsandnuts.ucdavis.edu/pistachiopages/pistachio_nutrients_fertilization/

Social Responsibility

Human Resources Management	Not Familiar	Familiar, not tried	Have tried it	Currently Use	Not applicable
Staffing and Recruiting Strategy					
1.1 A long term (2-5 years) staffing and recruiting strategy is in place					
1.2 A variety of recruiting methods is used depending on job opening, e.g. word of mouth, newspaper, web recruiting, job fair, temporary or contract services					
1.3 A standard interviewing process is used in recruitment which includes a specific set of review questions					
1.4 A job description exists for each type of job and it is given to the employee and their supervisor					
1.5 Job descriptions are reviewed and updated at least once every two years					
Employee Orientation, Safety Training, and Career Development					
2.1 An orientation program is provided for new non-seasonal employees					
2.2 Safety training is done when employee begins a new job assignment, or any new process, procedure or use of a substance or equipment that creates a new hazard is introduced					
2.3 If labor is contracted, the contractor is licensed, insured, and bonded and they adhere to Cal OSHA standards					
2.4 If labor is contracted, a check is made to ensure contract labor company adheres to all relevant Cal OSHA safety regulations					
2.5 Safety statistics such as time lost due to accidents are tracked and retained for at least 2 years					
2.6 Employees are instructed as necessary to attend training seminars or other educational programs at least once a year that enhance their skills in the workplace					
2.7 Employees are encouraged to attend training seminars or other educational programs at least once a year that enhance their skills in the workplace (e.g. SpraySafe)					
2.8 The company pays for training when required and/or provides tuition reimbursement for work-related college classes					
2.9 A meeting of top management is held annually to discuss company goals and exchange ideas					
Staying Informed					
3.1 Trade journals/appropriate trade literature (including literature on worker issues, safety issues, Farm Bureau, trade association					

literature, etc.) are made available for the farm management team (FMT) to read					
3.2 The FMT has current membership in local grower association(s)					
3.3 The FMT regularly attend regional and/or statewide industry meetings (e.g. irrigation district, Farm Bureau, Water Coalition, etc.), trade shows (e.g. World Ag Expo), and seminars (e.g. UC, CDFA, CSU seminars, research meetings from Commodity Boards)					
3.4 The FMT takes a leadership role in local, regional or state industry associations (e.g. Western Growers, California Grape & Tree Fruit League, Grower-Shipper Association)					
3.5 The company is involved in regional land use planning					
Performance, discipline, grievance process, and employee recognition					
4.1 A job performance process is in place and is linked to pay and promotions					
4.2 A process is in place for employees to comment on job satisfaction					
4.3 The company has a grievance process in place					
4.4 Filed grievances are processed in a timely manner					
4.5 A process is in place by which employees are recognized for good job performance and/or years of service					

Community Support	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 The company is involved in initiatives, through time commitment and/or donations, that enhance the community such as the Chamber of Commerce, schools/education programs, churches, public health, affordable housing					
1.2 The company is involved in regional water issues such as the regional water quality coalition, irrigation districts, ground water use planning, and/or the irrigated lands waiver program planning					

Waste Management

Sustainable agriculture provides a strategy for managing all aspects of the farming enterprise, including the management of the crop, soil, water, pests and human resources. It also relates to the farm's infrastructure as well, such as offices and shop. While the most interesting part of sustainable farming addresses what happens in the field, it is important not to forget important issues like waste management. In a lot of situations, waste management is one of the most straightforward processes to address on the farm.

Waste Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In field, shop and office					
1.1 A waste management plan for the farm has been written that includes waste reduction goals, recycling goals, hazardous material use reduction goals					
1.2 The farm has an established recycling program					
1.3 The value of recycling is part of the orientation and training of employees					
1.4 All unused or worn out items such as appliances, tractors, ATVs, electrical equipment, are taken to the proper recycling centers for disposal					
1.5 Employees are trained on the proper handling and disposal of hazardous materials (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.6 Employees are trained on legal requirements related to cleaning of farm equipment with water or steam cleaners and the resulting runoff					
1.7 Hazardous materials no longer used, as well as their containers, are disposed of according to legal requirements					
1.8 The farm participates in the pesticide container recycling program[30]					
1.9 Dumpsters and/or recycling containers are periodically inspected for leaks, spills, and litter. Problems noticed are corrected					
1.10 Bi-lingual signs are posted near the dumpster and/or recycling containers indicating what can or cannot be put in the container					

[30] Use the following link to find out how to participate in an Ag Container recycling program: http://www.acrecycle.org/contact_us.html

Water Management and Water Quality

California is the leading agriculture state in the US by a significant amount. This is due in large part to the high value of the many specialty crops grown in the state. It is also due to the excellent growing conditions such as fertile soils, a Mediterranean climate and the availability of affordable high quality surface and ground water for irrigation. California is also the most populace state in the US, and therefore affordable high quality water is needed to support this population. It is clear that because of the demands for high quality, affordable water, this critical resource needs to be used efficiently and effectively by specialty crop producers. The following template will help document practices producers are using to achieve optimum water quality and use efficiency as well as bring to their attention areas where improvements can possibly be made.

Irrigation Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pre-plant Planning					
1.1 Pre-plant analyses of the site was done to identify factors that affect quantity of irrigation water delivery and percolation rate such as existence of soil compaction, a root restricting layer, soil type, soil texture, soil chemistry (pH, salinity, etc.) and soil organic matter					
1.2 Ripping, plowing, chiseling, or other practices were implemented if pre-plant soil tests indicated water percolation and/or drainage problems					
1.3 Soil amendments were applied to correct soil chemical or physical issues if sampling identified factors that would affect water percolation					
1.4 The Water source was sampled and evaluated for water quality					
1.5 The irrigation system was designed to deliver the quantity of water required for the crop and accommodate for variation in topography as well as in soil texture that affects water percolation and water holding capacity					
1.6 In order to allow for frequent application and reduce water waste, micro-sprinklers or drip irrigation is used.[i]					
1.7 On newly planted trees, emitters are placed to conserve water while providing adequate water to the newly planted tree					
Irrigation Scheduling & Rates					
2.1 The total amount of water applied to each orchard is measured and recorded every season and the amount of water applied per ton of pistachios is calculated					
2.2 A water management plan for the orchard has been written that includes goals for the growing season and takes into consideration					

annual rainfall, crop variety, crop maturity, water-related pest management issues, soil type, soil preparation, slope, water quality, irrigation efficiency, irrigation uniformity, energy efficiency					
2.3 Irrigation is initiated at the start of the season based on measured soil moisture depletion					
2.4 Irrigation is initiated at the start of the season based on directly measuring plant moisture stress (e.g. with pressure bomb)					
2.5 Irrigation scheduling is influenced by peak energy pricing					
2.6 Water percolation rate and infiltration depth is monitored during the irrigation season					
2.7 Soil moisture depletion is estimated by visual inspection of the trees (e.g. growth or development) that indicates plant water stress					
2.8 Soil moisture depletion is tracked through soil coring					
2.9 Soil moisture depletion is tracked using soil-installed moisture monitoring devices					
2.10 Soil moisture depletion is tracked by directly measuring plant moisture stress (e.g. with a pressure bomb)					
2.11 Amount of irrigation and timing are dictated by the amount and timing of water available through the Irrigation District					
2.12 Amount of irrigation and timing are based on visual cues of the trees					
2.13 Amount of irrigation and timing are based on irrigation history from past growing seasons					
2.14 Amount of irrigation and timing are based on historical crop evapotranspiration (ET)					
2.15 Water demand of the crop is estimated by determining ETo[31] through using data from the nearest CIMIS weather station and used in irrigation rate and scheduling					
2.16 Water demand from the crop is estimated by converting ETo to Etc and using the appropriate crop coefficient factor (Kc) which takes into account crop canopy and used in irrigation rate and scheduling					
2.17 When appropriate less than full water demand is applied to the orchard (deficit irrigation)					
General Irrigation Performance and System Maintenance					
3.1 Pumping plant efficiency has been measured within at least the last 3 years (for areas where water table fluctuates considerably pumping plant efficiency should be checked at least once every 2 years)					
3.2 Pumping plant efficiency has been measured within at least the last 5 years					
3.3 Energy use for irrigation is tracked on an annual basis and related to unit of production					

[31] ETo is the reference evapotranspiration and is calculated using measurements of climatic variables including solar radiation, humidity, temperature and wind speed and is expressed in inches or millimeters of water. It is based on water use for a short mowed full coverage grass crop.

3.4 Electrical irrigation pumps are on time of use metering					
3.5 If pumping efficiency is significantly reduced, I have improved it					
3.6 Diesel irrigation pumps are Tier 2 or higher					
3.7 A flow meter is installed on wells and/or pumps and I monitor and record the flows					
3.8 Pressure check points are installed on key lines from pumps					
3.9 Filters status (and flushing system) is manually checked regularly and corrected if necessary					
3.10 Pressure gauges are installed for measuring pressure drops through filters					
3.11 The irrigation system is monitored for leaks, breaks, and clogging every irrigation					
3.12 Irrigation lines are flushed at the start of the season and then again at mid-season, or more often as needed					
3.13 Fertigation is used to apply most of the fertilizers for the field					
3.14 An interlock system is installed so injection pump shuts down if irrigation pump shuts down to prevent water source contamination					
4.0 Irrigation Performance & System Maintenance – if Drip & Micro-sprinklers, if not go to 5.0					
4.1 Distribution uniformity of the irrigation system is tested regularly					
4.2 The system has pressure compensating emitters to help maintain system distribution uniformity					
5.0 Irrigation Performance & System Maintenance – if Sprinklers, if not go to 6.0					
5.1 Sprinkler head rotation and nozzle clogging have been checked within the last 12 months and repaired if necessary					
5.2 Sprinkler head rotation and nozzle clogging are checked at least every other irrigation and repaired if necessary					
5.3 Sprinkler heads have been checked for wear in the past 5 years and replaced with the correct nozzle size if necessary to maintain distribution uniformity					
6.0 Irrigation Performance & System Maintenance – if Flood & Furrow					
6.1 The field was laser leveled before planting the crop					
6.2 Levee locations in the field are based on observed infiltration rates (i.e. each check is appropriately sized for maximum water application uniformity)					
6.3 Irrigation produces no tail-water					
6.4 Irrigation produces tail-water and a tail-water recovery system is in place					
6.5 Flow meters are installed and flow volumes recorded on lines from pumps or in supply pipelines or ditches (e.g. Weir notch or Parshall flume) or a record of flow volumes is provided by the water district					

Water quality – Source and resource					
7.1 Irrigation water is tested at least every 3 years for quality, including pH, total salt, nitrates, and biological problems. The quality of water in distribution reservoirs is tested if they are present on the farm.					
7.2 If a water quality problem exists it is addressed					
7.3 Resource maps have been examined to determine if the orchard is in a Ground Water Protection Area (GWPA)[32]					
7.4 If a field is in a GWPA, legal requirements for handling restricted use pesticides in GWPA areas have been assessed and are on file in the office					
7.5 Areas on the farm that are potential sites for pesticides and fertilizers to enter the ground water have been identified and mapped					
7.6 The wellhead is situated so no surface water can reach it or a barrier has been placed around the wellhead that prevents surface water from reaching it					
7.7 Return water wells, older wells and abandoned wells are sealed to prevent ground water contamination					
7.8 Irrigation practices create no off-site movement of chemical residues and sediments					
7.9 If storm water run-off occurs one or more of the following mitigation practices are implemented: filter fabric fencing; filter strip; straw bale check dam; straw bale water bars; sediment basin; or other containment system					

[32] http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpamaps.htm

Self-Assessment for Processing Tomato Production

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June 2013

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Funded by a California Department of Food and Agriculture
Specialty Crop Block Grant to SureHarvest

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Project History

Over the last 10 years the field of sustainable agriculture has become more and more important in the eyes of food retailers, buyers and consumers. As is often the case when new concerns arise in relation to food and food production, the spot light shines on the grower. Sustainable agriculture is challenging to define, and once defined it can be challenging for a grower to figure out how to implement it on the farm in an economically viable way. To meet these challenges a group of specialty crop trade associations, NGO's, and other specialty crop stakeholders met to discuss the topic of sustainable agriculture. One outcome of these discussions was an application to the California Department of Food and Agriculture Specialty Crop Block grant program for funds to hire sustainable agriculture professionals to help develop a plan to meet the challenges presented by sustainable agriculture. The Great Valley Center coordinated the grant application and engaged SureHarvest to provide the technical expertise. SureHarvest is a company with extensive experience in sustainable agriculture strategic planning, program design, and program implementation. The grant application was successful and began in September of 2009. The Great Valley Center directed the project and contracted with SureHarvest for project design, facilitation and implementation.

The grant had two primary goals. The first was to develop, through a stakeholder process, a sustainable agriculture strategic plan that each of the participating groups could use internally to help lay the foundation for their own sustainable agriculture program specific to their specialty crop. The second was to develop a tool, or tools, that could be used by their member growers to put the strategic plan into action on the farm.

The following paragraphs contain the sustainable agriculture strategic plan developed by the project leadership team, the members of which are listed in Table 1.

Sustainability Strategic Plan for the Multi-Commodity Project

The sustainability strategic plan for the Multi-Commodity Project is based on SureHarvest's 5 P's of sustainability framework. The 5 P's are: Principles, Processes, Practices, Performance Metrics, and Progress. They are defined as follows:

1. Principles – This is the sustainable vision for the project. It consists of the goals that the participants want to achieve from the design and implementation of the project.
2. Processes – These are the resource areas on the farm that need to be addressed in order to meet the principles or goals of the project. For example, this could be water, energy, and human resources management.
3. Practices – These are the practices that are implemented on the farm that impact the processes or resource areas. They are the on-the-ground actions that are carried out to assure that the principles or goals of the sustainable program are met.
4. Performance Metrics – These are the metrics used to measure the outcomes resulting from the practices implemented on the farm. There are many - examples include crop quality, water use, energy use, and worker satisfaction. Performance Metrics are used to measure the level of success in meeting the principles or goals of the project.

5. Progress – The process used to improve performance over time and communicate the results internally and externally. In other words, tracking the degree of progress one is making towards achieving the goals of the project. Measuring progress will require some kind of system for assessing the farm's performance over time, creating action plans to improve particular areas of performance, and reassessment over time to track progress.

Table 1. Multi-Commodity Project Leadership Team

Organization	**Representative**
Almond Board of California	Gabriele Ludwig*, Robert Curtis*
Bolthouse Farms	Troy Elliott*, Justin Groves*
California Grape & Tree Fruit League	Chris Valadez*, Barry Bedwell
California Specialty Crop Council	Lori Berger*
California Garlic & Onion Research Advisory Board	Robert Ehn
California Olive Council	Patty Darragh
California Pear Advisory Board	Bob McClain
California Pepper Commission	Glen Fischer*
California Pistachio Board	Robert Klein*
California Raisin Marketing Board	Gary Schultz
California Tomato Farmers	Ed Beckman*
California Tree Fruit Agreement	Gary VanSickle*, Lauren Friedman
California Walnut Board	David Ramos
Del Monte Foods	Pat McCaa
Sun-Maid Growers	Rick Stark*

*Leadership Team Member

Multi-Commodity Project Principles (1st P):

The principles for the Multi-Commodity Project were established by the Project Leadership Team. They are:

1. Create a resource area/practice template that:
    a. Will focus on increasing the economic performance for the participant.
    b. Is scalable and can be used by participating groups to accomplish the goals of their own sustainability programs.
    c. Provides the participant the ability to gauge the state of sustainability of the industry and their farm.
    d. Encourages continual improvement on the farm.
    e. As a whole encourages ecological harmony.
    f. Better defines the 3 E's of sustainability (economic viability, environmental soundness and social equity/responsibility) in a way we can all agree upon.
    g. Is open to and usable by any individual or group in the future that was not involved in the original effort.
    h. Benefit the participants and not result in unintended negative consequences.

2. The program should provide the information/data needed for groups to tell their sustainability story better to all their audiences, e.g. buyers, regulators, consumers, NGO's.
3. The outcomes from the project cause no harm to producers.

The Leadership Team of the Multi-Commodity Project decided the best tool for implementing their sustainability strategic plan was a self-assessment of practices template that stakeholders from specific specialty crops could then fine tune for their own use. The team chose to use the model developed by the California Sustainable Almond Program (CASP), which is a California Almond Board program developed in partnership with SureHarvest. The Leadership Team formed a stakeholder committee to draft the self-assessment template that covered the practice areas listed in the Multi-Commodity Project Strategic Plan. The Stakeholder Committee members are listed in Table 2.

Individual Contact	Title	Expertise
Billy Heller	Grower, Pacific Triple E Farms	Crop management
Bob Giampaoli	Grower, Live Oak Farms	Crop management
Cliff Sadoian	Grower	Crop management
Pat McCaa	Manager, Pest Management, Del Monte Foods	Crop management
Mechel S. Paggi (Mickey)	Director, Center for Agricultural Business, California State University, Fresno	Ag Business & economics
Glen Fischer	Ag Representative, Saticoy Foods Inc.	Crop management
John Trumble	Professor of Entomology, University of California Riverside	Pest management
Jeff Mitchell	Extension Specialist, University of California, Davis	Soils & plant nutrition
Pete Goodell	UC IPM Area Advisor, University of California, Davis	Pest management
Terry Prichard	Extension Specialist, University of California, Davis	Irrigation & crop water relations
Bill Peacock	Representing raisin growers via the Raisin Marketing Board and Tree Fruit Growers	Crop management
Troy Elliott	Director of Agronomy, Bolthouse Farms	Crop management

Table 2. Multi-Commodity Project Stakeholder Committee

The second phase of the Multi-Commodity Project began with SureHarvest obtaining a CDFA Specialty Crop Block Grant to finish the self-assessment template with the Multi-Commodity Leadership Team and Stakeholder Committees and then fine-tune the template into workbooks for individual specialty crops working with willing growers and stakeholders from each specialty crop community. The self-assessment workbook for processing tomatoes which is presented on the following pages was developed using the Multi-Commodity self-assessment template through a series of reviews and edits by growers, other stakeholders and SureHarvest staff. Gene Miyao, University of California Cooperative Extension, and Dr Dan Sonke, Campbell's Soup were particularly helpful during the review process. The final version was produced by SureHarvest and submitted to CDFA along with their final report in June of 2013.

Air Quality Management

Pressure is being brought to bear on urban and rural industries, including agriculture, to reduce air pollutants in the Great Central Valley of California. This section of the self-assessment will help the grower identify practices that influence air quality, highlight where the grower is doing well, and determine areas that need improvement.

Air Quality Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In Field and Adjacent Land					
1.1 To minimize airborne dust and PM10[5] particles a reduced tillage program is in place including the use of permanent beds					
1.2 If tillage is done, moisture content of the soil is taken into consideration to minimize dust					
1.3 Vegetation is maintained on non-cropped areas such as headlands, roadsides, and field edges to reduce wind erosion causing airborne dust					
Roads					
2.1 Vehicle speed is restricted on dirt roads around fields to minimize airborne dust					
2.2 Dirt roads are treated with an anti-dust agent designed to meet the 50% PM10 control for a Fugitive PM10 Management Plan[6]					
2.3 Dirt roads are graveled, watered, chipped, mulched (crop residues), sanded or seeded					
2.4 Heavily used roads are paved (e.g. main thoroughfares on farm)					
Engines and Fuel Consumption					
3.1 Engines are maintained on a regular schedule to ensure they are running at optimum performance and efficiency so that emissions are minimized					
3.2 At least some vehicles are equipped with engines able to use alternative fuels with lower emissions (e.g., compressed natural gas, flex fuel, biodiesel, propane)					
3.3 Some farm vehicles are battery powered (e.g. golf carts)					
3.4 Vehicle miles are tracked (e.g. on an annual basis)					

[5] PM 10 are particles 10 microns in diameter or smaller and pose a health risk because they pass through the throat and nose and penetrate the lungs.
[6] For details see http://www.airquality.nrcs.usda.gov/Documents/files/Dust_Control_Products.htm

3.5 Stationary diesel engines have been replaced (or retrofitted) to Tier 3 (US EPA rating) or better					
3.6 Stationary diesel engines have been replaced (or retrofitted) with technology relying on cleaner burning fuel (e.g. propane, natural gas, biodiesel) or replaced with electric pumps					
3.7 Selection of vehicle power plants and stationary engines is at least in part determined by lower emissions ratings					
3.8 Some of the farm's energy requirements are obtained through renewable sources such as wind or solar					
Pesticide Management and Air Quality					
4.1 When choosing a pesticide to apply, its VOC 'footprint' is considered[7]					
4.2 One or more of the following practices are implemented that reduce pesticide drift such as: use of air induction nozzles, turning sprayers off at turn-arounds, not spraying when a temperature inversion exists in the field or when wind exceeds 10 mph (or the velocity specified on the label)					
Greenhouse Gas Emissions					
5.1 I am aware of the role of CO_2, N_2O, and methane as greenhouse gases and where they are produced in my farming operations					
5.2 CO_2 and N_2O production are calculated and tracked					

What are VOC's?

VOC stands for volatile organic compound. These are carbon based compounds contained in products used on the farm, such certain pesticides, that volatilize (evaporate) when exposed to the air. Ground-based ozone is produced by chemical reactions involving VOC's, nitrogen oxides (NOx) and sunlight. Ozone is unhealthy for people, animals, and plants and also is a major component of smog. While not direct air pollutants themselves, VOC's are important ozone precursors, and are considered key targets for reduction in regions where air quality is an issue. The California Department of Pesticide Regulation does not know the reactivity of every VOC and ideally reactivity should be used to precisely determine VOC emissions. That said, appropriate data and analytical methods do exist at this time to make accurate estimates. The Department does hope to use reactivity at some point in the future. It calculates VOC emissions based on the best available science (Dr Matt Fossen, pers. comm., Environmental Scientist, Calif. Dept. Pesticide Regulation).

[7] A VOC calculator is found at: http://apps.cdpr.ca.gov/voc-calculator/

Energy Management

Energy is essential for crop production and it comes in several forms; as sunlight to power photosynthesis, as fuel to power our internal combustion motorized vehicles and pumps, and as electricity to power our shop, lights, and electronic equipment. Tracking energy is very important as it is getting more expensive all the time, increasing our cost of production. Burning of fuel produces GHG's affecting air quality and contributing to climate change. Minimizing energy consumption saves money and reduces GHG production. Completing this section should help improve your understanding of energy use in your operation and encourage you to consider some forms of energy conservation.

Energy Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 The total amount (gallons, therms, etc.) of fuel used annually on the farm in all operations is recorded and year to year comparisons are made. Each fuel type is recorded					
1.2 The total amount of fuel used annually per acre and per unit of crop production is determined and year-to-year comparisons are made[8]					
1.3 The total amount of fuel used annually is calculated for each field and year-to-year comparisons are made. Each fuel type is recorded					
1.4 Annual fuel consumption and/or electrical use for irrigation pumps are recorded and comparisons made from year-to-year.					
1.5 Electrical use for office(s), shop(s), and outdoor security lighting is tracked using energy bills and year-to-year comparisons are made					
1.6 Fuel and electricity used are converted to a common metric such as British Thermal Units (BTU's) so they can be combined to calculate the total amount of energy used annually for crop production and year to year comparisons are made[9]					
1.7 The amount of energy used annually per acre and per unit of crop production is calculated and year to year comparisons are made					
1.8 The amount of energy used annually in each field is calculated and year-to-year comparisons are made					

[8] This can be a simple calculation of dividing the total gallons of fuel used for the year divided by the total amount of crops produced for the year

[9] Energy conversion calculators for kilowatt hours to BTU's and gas or diesel to BTU's are readily and freely available on the Internet. For example using Google type 'convert gas to BTU's and you will be directed to a website where a calculator is available to make your conversion. Simply type in the number of gallons of gas and the calculator will produce the number of BTU's it represents.

1.9 An energy management plan is being implemented on the farm that includes yearly goals for overall energy use as well as energy used per unit of crop production.[10]					
1.10 A process is in place to ensure that the most appropriate piece of equipment is used for a given job (e.g. the most appropriate horse power engine for the job)					
1.11 One or more solar energy systems are installed on the property to generate electricity					
1.12 One or more wind generators are installed on the property to generate electricity					
1.13 Engines (stationary and mobile) and motors are maintained on a regular schedule to ensure they are running at an optimum fuel efficiency or optimum efficiency.					
1.14 Pumping plant efficiency (energy per acre foot pumped) is checked every 1 to 3 years (based on use) and adjustments made if necessary (FSU website recommends every 1-3 years based on use)					
1.14 At least some light switches are fitted with motion detectors or photo cells to reduce time of use					
1.15 At least some office and shop lights have been fitted with low energy consumption compact florescent bulbs or LED lights.					

Indirect Energy Use/Consumption:

Energy is directly expended when driving a vehicle, operating a pump, photocopying, or turning on and using a light bulb. Energy is also expended to manufacture inputs that are used on the farm, such as fertilizers, compost and pesticides. This type of energy consumption is called embedded energy. If you want to figure out the total amount of energy consumed to produce a crop then calculations should also be made to determine the amount of embedded energy that was consumed to produce the fertilizers, compost, and pesticides that were used to produce the crop.

[10] Ideally one would convert all energy consumption to BTU's (British Thermal Units) or joules but initial energy management plans could start with using gallons of gasoline and diesel and kilowatt hours for electricity.

Financial Management

The economic E of sustainable farming is literally where the buck stops. If a farm is not profitable, it is not sustainable. People farm not because they want to be accountants. They farm because they want to grow things. However, while financial management may be a challenging part of farming, doing it well is one of the keys to a successful and sustainable farm. This chapter will help the grower recognize strengths in financial management as well as point out areas where improvements are needed.

Financial Management **(The most appropriate person to fill out this section/chapter is the CEO/owner of the farm)**	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Planning and Risk Management					
1.1 A marketing and production plan has been developed for my farm and seasonal outcomes are compared to these plans					
1.2 A succession[11] plan is in place for the farm					
1.3 I have a written will and estate plan for the farm[12]					
1.4 A business continuation plan (disaster[13] management plan) has been developed for the farm					
1.4 A risk management plan has been developed for the farm					
1.5 Key personnel in the company have health insurance					
1.6 Key personnel in the company have disability insurance					
1.7 Key personnel have life or accidental death insurance					
Accounting and Financial Analyses					
2.1 A financial accounting system is used to track and report farm finances and to make decisions about farming operation					
2.2 Interpretation of both cash and accrual financial statements is understood, including a balance sheet, income statement, cash flow, and financial ratios					
2.3 A financial advisor is consulted at least on an annual basis					
2.4 Financial profitability analyses for investments are done if/when investments are made					

[11] A succession plan is one where the change in leadership in the company has been determined, whether it is expected, such as the CEO voluntarily stepping down/retiring, or unexpected, such as due to illness or accident.
[12] An estate plan is a plan for the financial assets to pass from one generation to the next. It does not deal with the human and intellectual capital and passing that transition to the next generation. That is succession planning.
[13] Disaster in this case is not just weather but also unexpected death of one or more key company personnel.

2.5 The revenue and returns are tracked for each field/management unit in my financial management reports					
2.6 Costs and returns are tracked for all important farming practices					
2.7 Costs and returns are tracked for implementing new sustainability practices and compared to costs and returns of practices they replaced					
2.8 Sensitivity analysis, i.e. change in crop prices over time, is used to analyze financial risk over time					
Purchasing and Borrowing					
3.1 More than one quote is obtained for major input purchases such as pesticides and fertilizers					
3.2 Interest rates and services from more than one lending institution are compared before borrowing a significant amount of money					

Food Safety Management

Note: Concern has been expressed by some grower groups that if this section is filled out by a grower there may be an implication that it will qualify them for meeting the basics of a food safety plan. This is not the case. Filling this section out is not equivalent to having a food safety plan. Therefore some groups chose to delete the questions in the following section and replace it with a series of questions that focus only on food safety planning. These replacements questions appear on page 13 at the end of the following self-assessment questions so reader can consider them as alternatives.

Food Safety Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Food Safety Management Planning					
1.1 A written food safety policy is in place for the farm that includes a commitment to food safety, how it is implemented, and how it is communicated to the employees.					
1.2 A written food safety plan is in place that identifies all locations of the farm and products covered by the plan. The plan addresses potential physical, chemical, and biological hazards and hazard control procedures, including monitoring, verification and record keeping, for the following areas: water, soil amendments, field sanitation, production environment and worker practices					
1.3 The food safety plan is reviewed at least annually					
1.4 Record keeping is kept to demonstrate the food safety plan is being followed					
1.5 A person has been designated as being responsible for food safety functions on the farm					
1.6 All employees are trained in food safety procedures and practices on the farm					
Food Safety Risk Assessment of Field					
2.1 An assessment has been made of the production field focusing on the likelihood of intrusions by animals that pose significant food safety risks (e.g. deer, pigs, livestock) and, if necessary, actions are taken to reduce the likelihood of intrusion					
2.2 An evaluation has been made on land and waterways adjacent to the field for possible sources of human pathogens of concern (e.g. manure storage, CAFO's, grazing/open range areas, surface water, sanitary facilities and composting operations)					
2.3 An assessment of historical land use has been made to determine any					

potential issues from these uses that might impact food safety (e.g. hazardous waste sites, landfills, etc.)					
2.4 My company participates in a third party food safety certification program (e.g. Agriculture Marketing Service GAP Certified, Scientific Certification Systems, Primus. Global GAP)					
Water					
3.1 A water system description for the field/ranch has been created that indicates, either with drawings or maps, the location of permanent fixtures, such as pumps, wells, underground lines, gates & valves reservoirs, and returns					
3.2 Irrigation water and water used in harvest operations is tested for microbial quality, and if microbial levels are above specific action levels, corrective actions are taken					
3.4 Records of all water tests are retained, along with Certificates of Analysis, for at least 2 years					
3.5 Irrigation pipe and drip tape are stored in a manner that reduces the potential for pest infestation					
3.6 Water applied to edible portions of the crop, either as overhead irrigation or pesticide applications, is tested for microbial quality					
Organic Soil Amendments					
4.1 Raw manure or a soil amendment that contains un-composted or incompletely composted or non-thermally treated animal manure is not applied to field					
4.2 If compost is applied, it is sourced from a supplier that provided their written Standard Operating Procedures that prevents cross-contamination of finished compost with raw materials through equipment, runoff or wind.					
4.3 If organic soil amendments are used, microbial testing is performed by the supplier prior to application					
Sanitation					
5.1 Toilet facilities are readily available to all field employees and are located according to Cal OSHA regulations					
5.2 Toilet facilities are clean and maintained on a regular basis					
5.3 Field employees are trained on the importance of sanitation in the field					
5.4 Field sanitation units are accessible to all employees					
5.5 A response plan is in place in the event of a spill from toilet or sanitation facilities and employees are trained to implement it					
5.6 Workers are educated on sanitation issues such as not working on the job while sick or injured (e.g. infected cuts)					
Harvesting and Transportation					
6.1 A traceability system is in place and appropriate for my crop					

6.2 A mock recall has been done to check the effectiveness of the traceability system (mock recalls would usually be done in conjunction with a packer/shipper or processor)					
6.3 All harvesting containers and bulk hauling vehicles that come into direct contact with the harvest crop are cleaned and/or sanitized on a scheduled basis using a written record system					
6.4 Packaging materials used in field operations are properly stored and protected from contamination					
6.5 Harvesting equipment that comes into contact with the crop is kept in good repair					
6.6 Harvesting equipment is designed and operated so as to reduce potential contamination (such as leaking hydraulic oil or engine fluids)					

Alternative Food Safety Assessment:

How do we ensure that fresh food is safe? This is a question that is being debated by everyone all along the supply chain. Compliance with food safety production requirements is becoming a necessary requirement for many specialty crops. This section lists practices that are related to food safety planning.

Food Safety Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Food Safety Management Planning					
1.1 A written food safety policy is in place for the farm that includes a commitment to food safety, how it is implemented, and how it is communicated to the employees					
1.2 A written food safety plan is on file and implemented on the farm					
1.3 If so, the plan meets Global Food Safety Initiative (GFSI) guidelines					
1.4 The food safety plan is reviewed and updated at least annually					
1.5 Records are kept to demonstrate the food safety plan is being followed					
1.6 A person has been designated as being responsible for food safety functions on the farm					
1.7 All employees are trained in food safety procedures and practices on the farm					
1.8 My company participates in a third- party food safety					

	certification/verification program (e.g. Agriculture Marketing Service GAP Certified, Scientific Certification Systems, PrimusGFS, GLOBALG.A.P.)					
1.9	If so, the program is Global Food Safety Initiative (GFSI) compliant or approved					

Soil Management

Soil is the most complex ecosystem on earth. Gaining a greater understanding of the soil resource in your fields is critical for making informed soil management decisions. Knowing your soil resource gives you greater control over yield and crop quality and is especially important in determining the long-term sustainability of your farm.

Soil provides the crop with three vital things: water, nutrients and air. These three things are best provided by a soil with good depth and structure i.e. a soil in which the particles are bound together into small clumps (aggregates) of varying size. Soil aggregation is a measure of soil structure. Soil organic matter is important in maintaining soil structure by gluing soil minerals together into aggregates. Spaces between large aggregates (measured as millimeters) permit rapid drainage and easy root growth, and spaces between small aggregates (measured as less 1 millimeter down to 0.001 millimeter) trap water for use between irrigation and rain events. One of the more important aspects controlling aggregate stability is the amount of microbial activity and soil organic matter. Stable aggregates occur in varying sizes and are created by the cementing action of microbes and their byproduct and soil organic matter. The assemblage of soil aggregates creates habitat to promote faunal and microbial diversity, an important index of soil quality. In the warm to hot California climate, soil organic matter is low in many soils due to rapid breakdown of soil organic matter.

The following self-assessment will help document the practices producers are using to manage their soil sustainably as well as suggest areas where improvements might be possible.

Soil Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Knowledge of soil properties					
1.1 The soil types in the field has/have been identified using NRCS or state soil maps					
1.2 The soil types in the field has/have been identified using soil samples taken pre-planting					
1.3 Soil properties for each soil type in the field is recorded, including soil moisture holding capacity, texture, and rooting depth					
1.4 A soil sample has been taken in the field more than 2 years ago and analyzed for macro and micro nutrients					
1.5 A soil sample has been taken in the field within the last 2 years and analyzed for macro and micro nutrients as well as soil chemistry (e.g. pH, CEC, salts)					
1.6 If soil pH is less than 5.5, it is amended with lime and if it is above 8.0 it is amended with an acidifying agent					

Soil properties management					
2.1 If water infiltration is poor (water puddles and runs off when soil is dry underneath) the soil is amended either chemically (e.g. with gypsum or organic matter such as compost or manure) or physically (e.g. chiseling or shallow ripping)					
2.2 Soil is tested for organic matter content at least every 2 years					
2.3 If soil organic matter is low for the soil series in my field, I have an ongoing program to build soil organic matter such as rotating tomatoes with high residue crops, cover cropping, and/or adding organic amendments					
2.4 Equipment is chosen or is modified to minimize soil compaction (e.g. lightest equipment possible, track-layers, wider or bigger diameter tires, tire pressures as low as possible)					
2.5 Tillage is never done when soil is too wet					
2.6 Reduced tillage is practiced and permanent beds are used					
Crop nutrition management					
3.1 I have a written crop nutrient management plan that uses a 'budgeting approach'[14] in determining the nutrient needs of the crop and takes into consideration factors like crop tissue analyses, soil type, time of year, soil moisture, crop load, etc.					
3.2 The crop's nutrient management plan is based solely on the recommendations as given by my field consultant and/or from the soil testing lab					
3.3 Soil samples are taken to a depth of 12 inches annually at permanent monitoring sites based on soil type and analyzed by an accredited laboratory					
3.4 Soil samples are taken to a depth of 12 inches at least every two years and analyzed by an accredited laboratory					
3.5 Soil samples are taken and analyzed every 3 years or less often or never taken					
3.6 Plant tissue or plant sap samples are taken at key growth stages during the year and analyzed by an accredited laboratory to fine-tune nutrient applications for each field and soil type					
3.7 With the help of my field consultant I am able to interpret the lab results from the field soil samples and we use them in the crop nutrient management plan					
3.8 I am able to interpret the lab results from the soil samples and I use them in my crop nutrient management plan					
3.9 Plant tissue are taken and analyzed at least once a season and used to help assess crop nutrient needs					

[14] A budgeting approach means that the amount of nutrients leaving the field in the crop is estimated and the amount of nutrients added back to the field is based on this estimate. A one -to-one replacement is not implied or required since factors such as soil type affect nutrient availability to the crop and these factors must also be taken into account.

3.10 The year-to-year the amount of nitrogen applied per acre is recorded and the amount of N applied per unit crop production is calculated					
3.11 The year-to-year the amount of phosphorus applied per acre is recorded and the amount of P applied per unit crop production is calculated					
3.12 The year-to-year the amount of potassium applied per acre is recorded and the amount of K applied per unit crop production is calculated					
3.13 Fertilizers are applied using fertigation					
3.14 The total amount of nitrogen needed for the season is applied in one application					
3.15 The total amount of nitrogen needed for the season is applied in a split application(s)					
3.16 Fertilizers are applied using a 'spoon feeding' approach where only the amount of nutrients required by the crop at the time are applied and multiple applications are made throughout the growing season based on crop growth stage and nutrient demand					
3.17 Fertilizer application records are kept for each block that include date, fertilizer type and amount, and method of application					
3.18 Micro nutrients are applied on a regular basis without reference to crop needs or crop history					
3.19 Micro nutrients are applied based on past crop history					
3.20 Micro nutrients are applied based on soil sample test results					
3.21 Micro nutrients are applied based on crop tissue sample test results					
Soil erosion					
4.1 Vegetation is maintained along farm roads, on field edges, and along irrigation canals not controlled by the irrigation district					
4.2 I know the infiltration/run-off rates of the field's soil and the rate of irrigation water is applied and is adjusted accordingly					
4.3 No tillage is done on field borders or along irrigation canals					
4.4 Ditches have been grassed or hardened to prevent downcutting					
4.5 Culverts are properly sized to accommodate high flows, and inlets and outlets have been hardened to prevent scour, or energy dissipaters have been installed					
4.6 Cover crops are planted on beds between seasons to minimize erosion					

Ecosystem Management

An ecosystem is the complex community of living organisms and their physical environment functioning as an ecological unit. Components of an ecosystem are inseparable and interrelated. An ecosystem management approach to growing specialty crops acknowledges that people are a part of and have a significant impact on ecosystem structures and processes, and that people depend on and must assume responsibility for the ecological, economic, and social systems where they live. Ecosystem management is currently being encouraged and implemented by communities, government agencies, businesses, academics and various conservation organizations throughout the world[15].

Ecosystem Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Habitat maintenance and enhancement					
1.1 Hedgerows of trees and/or shrubs are maintained on at least some field edges					
1.2 Vegetation such as grasses, trees or shrubs are maintained along roadsides, ditch-banks and headlands					
1.3 Trees have been planted to provide habitat for wildlife					
1.4 Trees are maintained to provide habitat for wildlife					
1.5 Nesting boxes for owls or other birds have been placed around the farm and they are cleaned annually					
1.6 Perches for raptors have been placed around the farm					
1.7 If water courses exist on my property setbacks are in place to minimize disturbance					
1.8 If water courses exist on my property resident vegetation is maintained on the banks					
1.9 If water courses exist on my property banks are vegetated with a mix of grasses, trees and shrubs					
1.10 Habitat establishment projects use native plant species or non-natives with documented wildlife benefits					
Whole farm issues					
2.1 I am an active member in a local watershed coalition					
2.2 I participate in a watershed stewardship planning group if one exists in my region					
2.3 Invasive pests (e.g. puncture vine, arundo) are monitored and when found controlled					
2.4 An environmental survey of the farm such as an NRCS conservation survey has been done noting the presence of sensitive areas, such as					

[15] Reeves, K. 2008. Chapter 1. Ecosystem Management *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 15- 63.

oak trees, habitat for endangered species, and other environmental features which affect farming and actual farmable acres[16]					
2.5 the farm property is managed to protect and/or enhance habitat for threatened and endangered species					
2.6 Some or all of the natural areas of my property is protected by a conservation easement (see education box below)					
2.7 Some or all of my property are protected by an agricultural easement program					
2.8 The farm is managed to optimize ecosystem services such as wildlife, pollinators, and/or arthropod natural enemies and increased biodiversity (see box below for definition of an ecosystem service)					
2.9 Indicators of biodiversity on the farm are monitored and recorded, such as animal and plant populations , pollinators, or arthropod natural enemies					
2.10 Unfarmed areas are maintained to increase biodiversity on the farm including wildlife, pollinators and/or arthropod natural enemies					

What is an ecosystem service?

The biological communities in an agricultural ecosystem provide benefits over and above the commercial crops they produce. These benefits are known as ecosystem services. They include removing carbon dioxide from the atmosphere, producing oxygen, reducing greenhouse gases, the recycling of nutrients, regulation of microclimate and local hydrological processes, in some cases they result in the suppression of pest plants and animals through the production of pest natural enemies, and detoxification of noxious chemicals that enter the environment.

Conservation and Agricultural Easements

Conservation easements for protection of natural resources are legal agreements that allow landowners to donate or sell some "rights" on portions of their land to a public agency, land trust, or conservation organization, often reducing the tax burden on the property. In exchange, the owner agrees to restrict development and farming in natural habitat, and assures the easement land remains protected in perpetuity. A 1996 study conducted by the National Wetlands Conservation Alliance indicated that the leading reasons landowners restored wetlands were to provide habitat for wildlife; to leave something to future generations; and to preserve natural beauty. Only 10% of landowners surveyed in the study restored wetlands solely for financial profit. This would also apply to other habitats besides wetlands. A conservation easement can provide you with financial benefits for the protection, enhancement, and restoration efforts for the natural environments on your property. The belief that natural resources such as wildlife, especially sensitive species, will reduce your land value is seldom true. Many easement programs include some sort of cash payment for a portion of the costs associated with habitat restoration and enhancement.

[16] NRCS has a lot of resources available for helping with environmental planning on the farm. Contact your local NRCS office for help http://www.nrcs.usda.gov.

Agricultural conservation easements are for the explicit purpose of keeping farmland in production. They are similar to natural resource conservation easements, but, specifically protect farmland and maintain the practice of farming. In 1996, the state established the California Farmland Conservancy Program to protect farmland by buying easements. Based on a study conducted by UC Cooperative Extension and published in 2002, there were 34 local conservation organizations, land trusts, and open space districts that protect farmland through conservation easements (see – *Agricultural Easements: New Tool for Farmland Protection California Agriculture*, January-February 2002, Volume 56:No. 1). Local opportunities may exist for one or both kinds of conservation easements on your property.

Pest Management

Integrated pest management (IPM) is a fundamental part of any sustainable farming program. It is cost-effective, flexible, and resilient. IPM was developed to respond to some significant pest management challenges that developed in the 1950's and 1960's. Events such as the development pesticide resistance by many pests, secondary pest outbreaks, and environmental contamination due to the use of certain problematic pesticides led a group of entomologists at the University of California to conclude that agriculture was heading toward a pest management crisis. They recovered the idea that pest problems are complex and connected to ecosystem processes. They concluded that the solutions to complex ecological problems must be broad-based and take the farm ecosystem into account. These researchers developed the IPM concept to meet the pest management crisis. Since its inception in 1959, IPM has evolved into the most strategic approach to managing pest problems on the farm.

University of California Statewide IPM Program crafted the following as the definition of IPM[17]:
Integrated Pest Management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as resistant varieties, habitat manipulation, modification of cultural practices, and use of biological control. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.

Farming is carried out within the ecosystem and is a long-term endeavor so we want to use management practices that are ecosystem-based and long-term in nature. By using a combination of control techniques to manage a pest problem, we develop a broad-based management strategy that will still be successful even if one particular technique does not work. Also, based on our experience with chemical controls, we know that pest control decisions must take into account not only economic risks, but effects on the environment and people's health, as well[18].

Pest Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pest Management Framework for Farm					
1.1 I have an integrated pest management framework/plan for my farm that takes into account the landscape within which I farm, an					

[17] http://www.ipm.ucdavis.edu/IPMPROJECT/about.html
[18] Ohmart, C. P. and C. P. Storm. 2008. Chapter 6. Pest Management. *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 187- 267.

understanding of the cropping system and how it affects the population levels of key pests, includes monitoring protocols and economic thresholds for key pests, monitoring protocols and important pest natural enemies, and the key biological, cultural and chemical control options available for key pests					
1.2 Each year I review the pest management framework with all those involved in pest management on my farm and make adjustments according to my goals and pest management results from the past year					
Risk Assessment					
2.1 Key pests for my farm have been identified in the following groups: diseases, insects, mites, weeds, mammals and birds; and targeted for management					
2.2 Monitoring protocols have been established and are used to monitor key pests					
2.3 I and/or my Pest Control Advisor (PCA) have established and use economic thresholds for key pests					
2.4 I and/or my PCA keep written spray records containing the information required by California Department of Pesticide Regulation as well as weather conditions and effectiveness					
2.5 I am aware of the environmentally sensitive areas in and near my field such as distance to ground water, surface water, wetlands, houses, schools, public and private roads					
2.6 I have mapped the environmentally sensitive areas in and near my field such as distance to ground water, surface water, wetlands, houses, schools, public and private roads					
Monitoring					
3.1 I and/or my PCA follow the UC IPM year round program for processing tomato[19]					
3.2 I and/or my PCA use the UC IPM pest management guidelines for tomatoes[20]					
3.3 I and/or my PCA use the UC IPM pest management manual for tomatoes[21]					
3.4 Pest populations are monitored in the tomato fields at least weekly during the times of the season favorable to pests and diseases					
3.5 A licensed Pest Control Advisor monitors pest populations in the tomato fields					
3.6 I and/or my PCA monitor for pest natural enemies if they are important in controlling key pests and take their numbers in consideration when making pest management decisions					
3.7 Cultural factors, such as time to harvest, preexisting plant damage, plant moisture stress, plant health, and crop load, are considered in					

[19] **http://www.ipm.ucdavis.edu/PMG/selectnewpest.tomatoes.html**
[20] **http://www.ipm.ucdavis.edu/PMG/selectnewpest.tomatoes.html**
[21] **http://www.ipm.ucdavis.edu/IPMPROJECT/ADS/manual_tomato.html**

pest management decision-making if they have significant effects on the risk of damage due to key pests					
3.8 I or my PCA keeps qualitative (descriptive) written pest monitoring records and they get shared during the decision making process					
3.9 I and/or my PCA keeps quantitative (numeric) written pest monitoring records and they get shared during the decision making process					
3.10 If pest management recommendations from a PCA are relied upon, I and/or my farm manager review the pest situation with him/her before making a decision to take a management action					
3.11 Crew supervisors and farm managers are encouraged to report any pest problem that is out of the ordinary (e.g. pests they have never seen before) and report it to the appropriate person					
3.12 Pictures of important invasive pests are posted in convenient locations so employees can monitor for their presence					
Pesticide Management					
4.1 Pesticide drift is minimized by using technologies such as air induction nozzles, or some pesticides are applied using chemigation					
4.2 I rotate the use of pesticides according to 'mode of action' to minimize development of resistance					
4.3 I keep a written record of pesticide use by 'mode of action' as a part of my pesticide resistance strategy					
4.4 A written spray drift management plan has been drawn up for each field, including a map of the field and location of sensitive areas, and sprayer operators follow the plan					
4.5 Calibration and spray coverage tests are done at least once a season on my sprayer following manufacturers' recommendations adapted to site characteristics such as actual crop canopy					
4.6 Buffer zones have been established for each field based on pesticide label specifications as well as adjacent crops and other sensitive sites					
4.7 Sprays are timed such that there is minimal or no human activity in adjacent areas					
4.8 Dormant season pesticide applications are not made when wind speeds exceed 10mph[22]					
4.9 To avoid long distance pesticide drift, dormant sprays are not done in dead calm when a temperature inversion exists					
4.10 Sprayer nozzles are shutoff at row ends near environmentally sensitive areas					
4.11 There is a berm or other mechanism around the wellhead to prevent surface water running from the perimeter to the wellhead					
4.12 Pesticide mixing and loading area is more than 100 feet from the wellhead unless it is protected by a berm or other physical barrier that prevent surface water running from the perimeter to the wellhead					

[22] CDPR Rule for Dormant Season Insecticides Fact Sheet

4.13 A separate water supply tank is used for pesticide mixing or chemicals are added to the tank at least 100 feet away from the well.					
4.14 Either a double-check valve, reduced pressure principle backflow prevention device, or an air gap is in place and maintained between the well pump and sprayer tank[23]					
4.15 Pesticide mixing and loading is done using a closed system or with water soluble pesticide packets when available for the pesticide being applied					
4.16 Spray mixing, loading and calibration is planned so that the tank is empty at the end of the spray job					
4.18 I use the following safe pesticide storage practices: dry pesticides stored above liquids, pesticides are stored more than 300 feet from nearest well, storage area is locked and has impermeable floor and sump to contain leaks, and only undamaged containers are stored					
4.17 I have an emergency response plan for pesticide and fertilizer spills and exposure posted in the appropriate places					
4.18 Workers are trained to follow the emergency response plan for pesticide spills or exposure					
4.19 A pesticide risk model such as PRiME[24], WIN PST [25]or UC IPM's Water Tox[26] is used when considering which pesticides to apply					
4.20 The VOC (volatile organic compound) air quality footprint of a pesticide is considered when deciding which pesticides to apply[27]					
Prevention and Cultural Practices					
5.1 My crop rotation avoids back to back tomato to reduce soil borne disease pressure					
5.2 Weeds on field perimeters are managed to reduce the potential reservoirs for diseases such as tomato spotted wilt					
Biological control					
6.1 I monitor for pest natural enemies if they are important in controlling my key pests					
6.2 If a pest natural enemy is important for a key pest I implement practices that augment their populations like planting nectar sources and avoid using pesticides that may be harmful to natural enemies					
6.3 I release pest natural enemies that have been proven to be effect controls for a key pest					
6.4 Conservation of pest natural enemies is considered when choosing a pesticide to use in the field					
6.5 Conservation of natural enemies is considered when deciding on spray timing					

[23] This is a legal requirement
[24] PRiME is the Pesticide Risk Mitigation Engine and can be accessed at http://ipmprime.org/cigipm/
[25] WIN PST is a software tool available from your local USDA NRCS office – www.nrcs.usda.gov.
[26] The model output is accessible at http://www.ipm.ucdavis.edu by viewing the webpage for the pest in question and clicking on the link labeled 'Water Quality Compare Treatments)
[27] http://apps.cdpr.ca.gov/voc-calculator/

6.6 I establish areas adjacent to the field to augment natural enemies by growing plants that provide shelter, nectar, and pollen for them					
Effects of Pest Management on Non-Target Sites & Organisms					
7.1 Effects of a pesticide on pollinators are considered when selecting the material to apply					
7.2 I am a member of the local Irrigated Lands Water Quality Coalition[28] (which monitors pesticide concentration in surface and ground water)					
7.3 Effects of a pesticide on non-target organisms existing on my farm, such as birds and small mammals, are considered when selecting the material to apply					

[28] This is a legal requirement in California's Central Valley, unless you have a discharge permit direct with its own water quality requirements.

Social Responsibility

Increasingly, tomato processors are getting questions about the treatment of labor on farms. This is in part because of the attention fresh market tomatoes have received in books such as *Tomatoland: How Modern Industrial Agriculture Destroyed Our Most Alluring Fruit*, which documents abuses by labor contractors in Florida's fresh market tomato production. It is not enough to say that processing tomatoes are machine-harvested with less labor required. An understanding of good labor management practices is good for both the employer and the employee.

Human Resources Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Staffing and Recruiting Strategy					
1.1 A long term (2-5 years) staffing and recruiting strategy is in place					
1.2 A variety of recruiting methods is used depending on job opening, e.g. word of mouth, newspaper, web recruiting, job fair, temporary or contract services					
1.3 A standard interviewing process is used in recruitment which includes a specific set of review questions					
1.4 A job description exists for each type of job and it is given to the employee and their supervisor					
1.5 Job descriptions are reviewed and updated at least once every two years					
1.6 For non-seasonal employees, an exit interview is conducted with departing employees to give the company an opportunity to learn what went well and what could improve					
1.7 No underage workers are employed by the farming company or by any labor contractor engaged by the farming company					
Employee Orientation, Safety Training, and Career Development					
2.1 An orientation program is provided for new non-seasonal employees					
2.2 Safety training is done according to Cal OSHA regulations, i.e. when an employee begins a new job assignment, or any new process, procedure or use of a substance or equipment that creates a new hazard					
2.3 All new employees undergo safety training					
2.4 If labor is contracted, a check is made to ensure contract labor company adheres to all relevant Cal OSHA safety regulations					
2.5 Safety statistics such as time lost due to accidents are tracked and retained for at least 2 years					

2.6 Employees are instructed as necessary to attend training seminars or other educational programs at least once a year to enhance their skills in the workplace					
2.7 Employees are encouraged at least once a year to attend training seminars or other educational programs to enhance their skills in the workplace (e.g. SpraySafe)					
2.8 The farming company pays for training when required and/or provides tuition reimbursement for work-related college classes					
2.9 A formal career planning process is in place for non-seasonal employees					
2.10 Every non-seasonal employee is provided an employee handbook that includes at a minimum the company's work standards and policies and an overview of benefits					
2.11 The employee handbook is written in an appropriate language(s)					
2.12 An employee meeting is held at least once a year to discuss company goals and to exchange ideas					
2.13 A meeting of top management is held annually to discuss company goals and exchange ideas					
Staying Informed					
3.1 Trade journals/appropriate trade literature (including literature on worker issues, safety issues, Farm Bureau, trade association literature, etc.) are made available for the farm management team (FMT) to read					
3.2 The FMT has current membership in local grower association(s)					
3.3 The FMT regularly attend regional and/or statewide industry meetings (e.g. irrigation district, Farm Bureau, Water Coalition, etc), trade shows (e.g. World Ag Expo), and seminars (e.g. UC, CDFA, CSU seminars, research meetings from Commodity Boards)					
3.4 The FMT takes a leadership role in local, regional or state industry associations (e.g. Western Growers, California Grape & Tree Fruit League, Grower-Shipper Association)					
Performance, discipline, grievance process, and employee recognition					
4.1 A job performance process is in place and is linked to pay and promotions					
4.2 A form and process is in place for employees to comment on job satisfaction					
4.3 The farming company has a grievance process in place and it is documented in the employee handbook					
4.4 Filed grievances are recorded and processed in a timely manner					
4.5 A formal process is in place by which employees are recognized for good job performance and/or years of service					
4.6 A suggestion box is provided in a convenient location so that employees can provide ideas for improvements in company practices, working environment, and other areas.					

Health benefits, paid time off, and other benefits					
5.1 Basic health benefits are provided to non-seasonal employees					
5.2 Non-seasonal employees have paid holidays and vacation time					
5.3 Employees are provided sick leave and/or personal days					
5.4 Non-seasonal employees are provided a formal pension plan or a company 401k					

Community Support	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 My company is involved in regional land use planning					
1.2 My company is involved in initiatives, through time commitment and/or donations, that enhance the community such as the Chamber of Commerce, schools/education programs, churches, public health, affordable housing					
1.3 My company is involved in regional water issues such as the regional water quality coalition, irrigation districts, ground water use planning, and/or the irrigated lands waiver program planning					

Waste Management

Sustainable agriculture provides a strategy for managing all aspects of your farming enterprise, including the management of the crop, soil, water, pests and human resources. It also relates to your farm's infrastructure as well such as your offices and shop. While the most interesting part of sustainable farming addresses what happens in the field it is important not to forget important issues like waste management. In many situations, waste management is one of the most straightforward processes to address on the farm.

Waste Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In field, shop and office					
1.1 The farm has a written waste management plan that includes waste reduction goals, recycling goals, hazardous material use reduction goals					
1.3 The farm has an established recycling program for metal, cardboard, plastics, paper and glass					
1.4 The value of recycling is part of the orientation and training of employees					
1.5 The amount of metals, cardboard, plastics, paper and glass recycled annually vs. the amounts thrown away is determined and year to year comparisons are made					
1.6 The number of tires, batteries used per year and the amount of lubricants purchased vs. the amount sent back or recycled per year is recorded and year to year comparisons are made					
1.7 All unused or worn out items such as appliances, tractors, ATVs, electrical equipment, are taken to the proper recycling centers for disposal					
1.8 The total amount of hazardous materials, other than pesticides and fertilizers, present on the farm is known and their use is tracked on an annual basis (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.9 Employees are trained on the proper handling and disposal of hazardous materials (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.10 Employees are trained on legal requirements related to cleaning of farm equipment with water or steam cleaners and the resulting runoff					
1.11 Hazardous materials no longer used, as well as their containers, are disposed of according to legal requirements					

1.12 The farm participates in the pesticide container recycling program[29]					
1.13 Dumpsters and/or recycling containers are on cement pads to contain spills					
1.14 Dumpsters and/or recycling containers are covered to keep out rain					
1.15 Dumpsters and/or recycling containers are periodically inspected for leaks, spills, and litter. Problems found are corrected					
1.16 Bi-lingual signs are posted near the dumpster and/or recycling containers indicating what can or cannot be put in the container					

[29] Use the following link to find out how to participate in an Ag Container recycling program: http://www.acrecycle.org/contact_us.html

Water Management and Water Quality

California is the leading agriculture state in the US by a significant amount. This is due in large part to the high value of the many specialty crops grown in the state. It is also due to the excellent growing conditions such as fertile soils, a Mediterranean climate and the availability of affordable high quality surface and ground water for irrigation. California is also the most populated state in the US and therefore affordable high quality water is needed to support this population. Water is also needed to support the diverse fish and wildlife populations in the state. It is clear that because of the demands for high quality, affordable water, as well as adequate water for fish and wildlife, this critical resource needs to be used efficiently and effectively by specialty crop producers. The following template will help document practices producers are using to achieve optimum water quality and use efficiency as well as bring to their attention to areas where improvements can possibly be made.

Irrigation Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pre-plant Planning					
1.1 Pre-plant analyses of the site was done to identify factors that affect quantity of irrigation water delivery and percolation rate such as existence of soil compaction, a root restricting layer, soil type, soil texture, soil chemistry (pH, salinity, etc.) and soil organic matter					
1.2 Ripping, plowing, chiseling, or other practices were implemented if pre-plant soil tests indicated water percolation and/or drainage problems					
1.3 Soil amendments were applied to correct soil chemical or physical issues if sampling identified factors that would affect water percolation					
1.4 Water source was sampled and evaluated for water quality					
1.5 The irrigation system was designed to deliver the quantity of water required for the crop and accommodate for variation in topography as well as in soil texture that affects water percolation and water holding capacity					
Irrigation Scheduling & Rates					
2.1 I have a written water management plan for my field(s) that includes goals for the growing season and takes into consideration annual rainfall, crop variety, crop maturity, water-related pest management issues, soil type, soil preparation, slope, water quality, irrigation efficiency, irrigation uniformity, energy efficiency					
2.2 I measure and record the total amount of water used in each field every season and calculate water use per unit of crop production.					

2.3 Irrigation is initiated at the start of the season based on visual cues from the crop					
2.4 Irrigation is initiated at the start of the season based on measured soil moisture depletion					
2.5 Irrigation scheduling is influenced by peak energy pricing					
2.6 Water percolation rate and infiltration depth is monitored during the irrigation season and used in making decisions on rates of water applied					
2.7 Soil moisture depletion is estimated by visual inspection of the crop water stress status and is used in irrigation scheduling					
2.8 Soil moisture depletion is tracked through soil coring and used in irrigation scheduling					
2.9 Soil moisture depletion is tracked using soil-installed moisture monitoring devices and used in irrigation scheduling					
2.10 Amount of irrigation and timing are dictated by the amount and timing of water available through my water district					
2.11 Amount of irrigation and timing are based on historical crop evapotranspiration (ET)					
2.12 Water demand of the crop is estimated by determining ETo[30] through using data from the nearest CIMIS weather station and used in irrigation rate and scheduling					
2.13 Water demand from the crop is estimated by converting ETo to Etc[31] using the appropriate crop coefficient factor (Kc) and taking into account crop canopy. The calculated demand is used in irritation rate and scheduling					
Irrigation Performance and System Maintenance – Pumps & Filters					
3.1 Pumping plant efficiency has been measured within at least the last 3 years (for areas where water table fluctuates considerably pumping plant efficiency should be checked at least once every 2 years) and corrective actions taken if low					
3.2 Pumping plant efficiency has been measured within at least the last 5 years and corrective action taken if low					
3.3 Energy use for irrigation is tracked on an annual basis and related to unit of production					
3.4 Electrical irrigation pumps are on time of use metering					
3.6 Diesel irrigation pump engines are Tier 2 or higher					
3.7 A flow meter is installed on wells and/or pumps and I monitor and record the flows					
3.8 Pressure check points are installed on key lines from pumps					

[30] ETo is the reference evapotranspiration and is calculated using measurements of climatic variables including solar radiation, humidity, temperature and wind speed and is expressed in inches or millimeters of water. It is based on water use for a short mowed full coverage grass crop. See http://wwwcimis.water.ca.gov.
[31] Etc takes ETo and a calculation based on a crop specific coefficient (Kc) and the percent of canopy cover to estimate crop evapotranspiration for the time period (e.g. day or week). See http://wwwcimis.water.ca.gov.

3.9 Filters status (and flushing system) is manually checked at least twice a season and corrected if necessary					
3.10 Pressure gauges are installed for measuring pressure drops through filters					
Irrigation Performance & System Maintenance – Drip & sprinklers. If Flood or Furrow Irrigation skip to 5.0					
4.1 Distribution uniformity of the irrigation system is tested at least every 2 years					
4.2 The irrigation system is monitored for leaks, breaks, and clogging every irrigation					
4.3 The irrigation system is monitored for leaks, breaks, and clogging at least once a season					
4.4 Fertigation is used to apply most of the fertilizers for the field					
4.5 To prevent water source contamination, an interlock system is installed to shut down the injection pump if the irrigation pump shuts down					
4.6 Irrigation lines are flushed at the start of the season and then again at mid season and more often as needed					
5.0 Irrigation Performance & System Maintenance – Flood & Furrow. If not flood or furrow irrigated, skip to 6.0					
5.1 The field was laser leveled before planting the crop					
5.2 Levee locations in the field are based on observed infiltration rates (i.e. each check is appropriately sized for maximum water application uniformity)					
5.3 Irrigation produces no tail-water					
5.4 Irrigation produces tail-water and a tail-water recovery system is in place					
5.5 Flow meters are installed and flow volumes recorded on lines from pumps or in supply pipelines or ditches (e.g. Weir notch or Parshall flume) or a record of flow volumes is provided by the water district					
6.0 Water quality – Source and resource					
6.1 Irrigation water is tested at least every 3 years for quality, including pH, total salt, nitrates, and biological problems. If they are present on the farm, the quality of water in distribution reservoirs is tested.					
6.2 If a water quality problem exists it is addressed					
6.3 I have accessed resource maps to determine if my field(s) are in Ground Water Protection Areas (GWPA)[32]					
6.4 If a field is in a GWPA, I have accessed and read the legal requirements for handling restricted use pesticides in that GWPA and they are on file in the farm office					
6.5 I have identified and mapped areas on the farm that are potential sites for pesticides and fertilizers to enter the ground water					

[32] http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpamaps.htm

6.6 The wellhead is situated so no surface water can reach it or a berm has been placed around the wellhead that prevents surface water from reaching it					
6.7 Return water wells, older wells and abandoned wells are sealed to prevent ground water contamination					
6.8 Irrigation practices create no off-site movement of chemical residues and sediments					
6.9 If storm water run-off occurs one or more of the following mitigation practices are implemented: filter fabric fencing; filter strip; straw bale check dam; straw bale water bars; sediment basin; or other containment system					
6.10 Cover crops/vegetation is maintained on drain ditches and non-paved minor roadways to minimize rainfall run-off from field					
6.11 Soil percolation problems in the field have been addressed to minimize off-site movement of irrigation or storm water					

Self-Assessment for Raisin Production

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Funded by a California Department of Food and Agriculture
Specialty Crop Block Grant to SureHarvest

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Project History

Over the last 10 years the field of sustainable agriculture has become more and more important in the eyes of food retailers, buyers and consumers. As is often the case when new concerns arise in relation to food and food production, the spot light shines on the grower. Sustainable agriculture is challenging to define, and once defined it can be challenging for a grower to figure out how to implement it on the farm in an economically viable way. To meet these challenges a group of specialty crop trade associations, NGO's, and other specialty crop stakeholders met to discuss the topic of sustainable agriculture. One outcome of these discussions was an application to the California Department of Food and Agriculture Specialty Crop Block grant program for funds to hire sustainable agriculture professionals to help develop a plan to meet the challenges presented by sustainable agriculture. The Great Valley Center coordinated the grant application and engaged SureHarvest to provide the technical expertise. SureHarvest is a company with extensive experience in sustainable agriculture strategic planning, program design, and program implementation. The grant application was successful and began in September of 2009. The Great Valley Center directed the project and contracted with SureHarvest for project design, facilitation and implementation.

The grant had two primary goals. The first was to develop, through a stakeholder process, a sustainable agriculture strategic plan that each of the participating groups could use internally to help lay the foundation for their own sustainable agriculture program specific to their specialty crop. The second was to develop a tool, or tools, that could be used by their member growers to put the strategic plan into action on the farm.

The following paragraphs contain the sustainable agriculture strategic plan developed by the project leadership team, the members of which are listed in Table 1.

Sustainability Strategic Plan for the Multi-Commodity Project

The sustainability strategic plan for the Multi-Commodity Project is based on SureHarvest's 5 P's of sustainability framework. The 5 P's are: Principles, Processes, Practices, Performance Metrics, and Progress. They are defined as follows:

1. Principles – This is the sustainable vision for the project. It consists of the goals that the participants want to achieve from the design and implementation of the project.
2. Processes – These are the resource areas on the farm that need to be addressed in order to meet the principles or goals of the project. For example, this could be water, energy, and human resources management.
3. Practices – These are the practices that are implemented on the farm that impact the processes or resource areas. They are the on-the-ground actions that are carried out to assure that the principles or goals of the sustainable program are met.
4. Performance Metrics – These are the metrics used to measure the outcomes resulting from the practices implemented on the farm. There are many - examples include crop quality, water use, energy use, and worker satisfaction. Performance Metrics are used to measure the level of success in meeting the principles or goals of the project.
5. Progress – The process used to improve performance over time and communicate the results internally and externally. In other words, tracking the degree of progress one is

making towards achieving the goals of the project. Measuring progress will require some kind of system for assessing the farm's performance over time, creating action plans to improve particular areas of performance, and reassessment over time to track progress.

Table 1. Multi-Commodity Project Leadership Team

Organization	Representative
Almond Board of California	Gabriele Ludwig*, Robert Curtis*
Bolthouse Farms	Troy Elliott*, Justin Groves*
California Grape & Tree Fruit League	Chris Valadez*, Barry Bedwell
California Specialty Crop Council	Lori Berger*
California Garlic & Onion Research Advisory Board	Robert Ehn
California Olive Council	Patty Darragh
California Pear Advisory Board	Bob McClain
California Pepper Commission	Glen Fischer*
California Pistachio Board	Robert Klein*
California Raisin Marketing Board	Gary Schultz
California Tomato Farmers	Ed Beckman*
California Tree Fruit Agreement	Gary VanSickle*, Lauren Friedman
California Walnut Board	David Ramos
Del Monte Foods	Pat McCaa
Sun-Maid Growers	Rick Stark*

*Leadership Team Member

Multi-Commodity Project Principles (1st P):

The principles for the Multi-Commodity Project were established by the Project Leadership Team. They are:

1. Create a resource area/practice template that:
    a. Will focus on increasing the economic performance for the participant.
    b. Is scalable and can be used by participating groups to accomplish the goals of their own sustainability programs.
    c. Provides the participant the ability to gauge the state of sustainability of the industry and their farm.
    d. Encourages continual improvement on the farm.
    e. As a whole encourages ecological harmony.
    f. Better defines the 3 E's of sustainability (economic viability, environmental soundness and social equity/responsibility) in a way we can all agree upon.
    g. Is open to and usable by any individual or group in the future that was not involved in the original effort.
    h. Benefit the participants and not result in unintended negative consequences.
2. The program should provide the information/data needed for groups to tell their sustainability story better to all their audiences, e.g. buyers, regulators, consumers, NGO's.

3. The outcomes from the project cause no harm to producers.

The Leadership Team of the Multi-Commodity Project decided the best tool for implementing their sustainability strategic plan was a self-assessment of practices template that stakeholders from specific specialty crops could then fine tune for their own use. The team chose to use the model developed by the California Sustainable Almond Program (CASP), which is a California Almond Board program developed in partnership with SureHarvest. The Leadership Team formed a stakeholder committee to draft the self-assessment template that covered the practice areas listed in the Multi-Commodity Project Strategic Plan. The Stakeholder Committee members are listed in Table 2.

Individual Contact	Title	Expertise
Billy Heller	Grower, Pacific Triple E Farms	Crop management
Bob Giampaoli	Grower, Live Oak Farms	Crop management
Cliff Sadoian	Grower	Crop management
Pat McCaa	Manager, Pest Management, Del Monte Foods	Crop management
Mechel S. Paggi (Mickey)	Director, Center for Agricultural Business, California State University, Fresno	Ag Business & economics
Glen Fischer	Ag Representative, Saticoy Foods Inc.	Crop management
John Trumble	Professor of Entomology, University of California Riverside	Pest management
Jeff Mitchell	Extension Specialist, University of California, Davis	Soils & plant nutrition
Pete Goodell	UC IPM Area Advisor, University of California, Davis	Pest management
Terry Prichard	Extension Specialist, University of California, Davis	Irrigation & crop water relations
Bill Peacock	Representing raisin growers via the Raisin Marketing Board and Tree Fruit Growers	Crop management
Troy Elliott	Director of Agronomy, Bolthouse Farms	Crop management

Table 2. Multi-Commodity Project Stakeholder Committee

The second phase of the Multi-Commodity Project began with SureHarvest obtaining a CDFA Specialty Crop Block Grant to finish the self-assessment template with the Multi-Commodity Leadership Team and Stakeholder Committees and then fine-tune the template into workbooks for individual specialty crops working with willing growers and stakeholders from each specialty crop community. The self-assessment workbook for raisins which is presented on the following pages was developed using the Multi-Commodity self-assessment template through a series of reviews and edits by growers, other stakeholders and SureHarvest staff. The Raisin Marketing Board’s Sustainability Committee, RMB staff , Steve Vasquez from the University of California Cooperative Extension, and Bill Peacock, were particularly helpful during the review process in organizing and participating in several review sessions. The final version was produced by SureHarvest and submitted to CDFA along with their final report in June of 2013.

Air Quality Management

The San Joaquin Valley (SJV) is out of attainment of the Federal Clean Air Act. Because of this, the region is in danger of losing federal highway dollars if attainment cannot be achieved. Therefore pressure is being placed on urban and rural industries, including agriculture, to reduce air pollutants throughout the Valley. California's raisin industry has been an active SJV partner in helping to reduce air pollutants. This section of the self-assessment will help raisin growers identify practices that influence air quality, see what you are doing well, and determine areas that could be improved.

Air Quality Management		**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In Field and Adjacent Land						
1.1	I am aware of the importance to minimize airborne dust and PM 10[5] particles to improve air quality, and for mite management. I implement practices, such as reduced tillage, reduced or no burning, and watering roads to improve air quality					
1.2	I have a DOV vineyard and to minimize airborne dust and PM 10 particles, I use minimal-till floor management					
1.3	When tillage is necessary, moisture content of the soil is taken into consideration to minimize airborne dust and PM 10 particles					
1.4	Vineyard prunings are shredded and/or incorporated into the soil rather than burned					
1.5	I only burn vineyard debris when necessary, such as when taking out an old vineyard, and do so according to state law					
Roads						
2.1	Vehicle access and speed is restricted on dirt roads around fields to minimize creation of dust, which is also very important for mite management					
2.2	Avenues and unpaved access roads are graveled, watered, chipped, mulched (crop residues), sanded or treated with an					

[5] PM 10 are particles 10 microns in diameter or smaller and pose a health risk because they pass through the throat and nose and penetrate the lungs.

	anti-dust agent that meets the 50% PM10 control for a Fugitive PM 10 Management Plan[6]					
Engines and Fuel Consumption						
3.1	Engines are maintained on a regular schedule to ensure they are running at optimum performance and efficiency and emissions are maintained or reduced according to state law					
3.2	Some vehicles are equipped with engines able to use alternative fuels with lower emissions (e.g., compressed natural gas, flex fuel, biodiesel, propane)					
3.3	Stationary diesel engines have been replaced (or retrofitted) to Tier 3 or better, or retrofitted with technology relying on cleaner burning fuel (e.g. propane, natural gas, biodiesel) or replaced with electric pumps					
Pesticide Management and Air Quality						
4.1	Soil fumigants are used only when necessary and applied appropriately (e.g. pre-planting where soil sampling has identified a significant pest problem, proper soil moisture conditions exist and all regulations have been met)					
4.2	Practices are implemented that reduce pesticide drift such as equipment selection, equipment calibration, use of air induction nozzles, turning sprayers off while turning, not spraying when a temperature inversion exists in the field, and when wind exceeds 10 mph or the velocity specified on the label					

[6] For details see http://www.airquality.nrcs.usda.gov/Documents/files/Dust_Control_Products.htm

Energy Management

Energy is essential for crop production and it comes in several forms; as fuel to power our internal combustion motorized vehicles and pumps, and as electricity to power our shop, office lights and electronic equipment. Tracking energy is very important because it continues to increase in cost, increasing the cost of producing raisins. Reducing energy consumption saves money and reduces greenhouse gas (GHG) production (put an educational box here on GHGs?). This section will help improve your understanding of energy use in your operation and give you ideas for implementing practices that conserve energy.

Energy Management		**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1	The total amount (gallons) of fuel used annually on the farm in all operations is recorded and comparisons made from year-to-year. Each fuel type is recorded					
1.2	Annual fuel consumption and/or electrical use for irrigation pumps are recorded and comparisons made from year-to-year					
1.3	Pumping plant efficiency (energy per acre foot pumped) is checked every 1 to 3 years based on use and changes in water table level and adjustments made if necessary					

Financial Management

Financial management is key to a successful and sustainable farming operation. This section is designed to help you recognize where gaps are in your financial management plan that could be improved.

Financial Management **(The most appropriate person to fill out this section is the CEO/owner of the farm)**		**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Planning and Risk Management						
1.1	A marketing and production plan has been developed for the farm and seasonal outcomes are compared to this plan					
1.2	A succession[7] plan and business continuation plan have been developed for the farm					
1.3	A written will, living trust and/or estate plan have been developed for the farm[8]					
1.4	A risk management plan (put footnote to explain) has been developed for the farm					
1.5	Key personnel in the company have health and disability insurance					
1.6	All personnel have worker's compensation insurance, which also provides monies in the case of accidental death on the job					
Accounting and Financial Analyses						
2.1	Vineyard and equipment maintenance are not deferred and vineyards that are not profitable are redeveloped					
2.2	A review of cash and accrual financial statements, including balance sheets, income statements, and cash flow, is done annually					
2.3	A financial advisor consultation is utilized on an annual basis					
2.4	Financial profitability analyses for investments are done if investments are made					
2.5	A review of financial management reports that track revenue and returns for each field/management unit for all important farming practices. For new practices, implemented costs and returns for the practices they replaced are compared					

[7] A succession plan is one where the change in leadership in the company has been determined, whether it is expected such as the CEO voluntarily stepping down/retiring, or unexpected such as due to illness or accident.
[8] An estate plan is a plan for the financial assets to pass from one generation to the next. It does not deal with the human and intellectual capital and passing that transition to the next generation. That is succession planning.

2.6	Farm business expenses and revenues are analyzed to determine potential financial risk over time					
Purchasing and Borrowing						
3.1	Multiple quotes are obtained for major input purchases such as equipment, pesticides and fertilizers					
3.2	When major equipment and infrastructure purchases/changes are considered, experts are consulted to consider new technologies					
3.3	Interest rates and services from multiple lending institutions are compared before borrowing a significant amount of money					

Food Safety Management

Food safety has become a common theme in agricultural food production. Minimizing microbial contamination is key to maintaining open markets for agricultural products. This section is designed to help you think about, develop, and implement a comprehensive Food Safety Management Plan for your raisin production operation.

Food Safety Management		**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Food Safety Management Planning						
1.2	A written food safety policy is in place for the farm that includes a commitment to food safety and training, how it is implemented,how it is communicated to the employees, and is reviewed annually					
1.1	The food safety plan addresses potential physical (footnote/education box to give examples of physical, chemical, etc. hazards), chemical, and biological hazards and hazard control procedures, including monitoring, verification and record keeping, for the following areas: water, soil amendments, field sanitation, production environment and worker practices					
1.3	Records are kept to demonstrate the food safety plan is being implemented					
1.4	An employee has been designated as being responsible for implementing the Food Safety Management Plan					
1.5	All employees are trained in food safety procedures and practices on the farm and training is documented					
1.6	Trace-back procedures are in place as the basis of a system to identify the source of raisins back to a block and/or grower					
1.7	My company participates in a third party food safety certification program (e.g. Agriculture Marketing Service GAP Certified, Scientific Certification Systems, Primus, Global GAP)					
Sanitation						
	I use a labor contractor who adheres to the practices below					
2.1	Toilet and washing facilities are readily available to all field employees and are located according to Cal OSHA regulations					
2.2	Toilet and washing facilities are clean and maintained on a regular basis					

2.3	Field employees are trained on the importance of sanitation in the field					
2.4	Field sanitation units are accessible to all employees in accordance with State Law					
2.5	A response plan is in place in the event of a spill from toilet or sanitation facilities and employees are trained to implement it					
2.6	Workers are educated on sanitation issues such as not working on the job while sick or injured (e.g. infected cuts)					
Harvesting and Transportation						
3.1	A traceability system is in place and appropriate for my crop					
3.2	All harvesting containers, harvesters, and bulk hauling vehicles that come into direct contact with harvested crop are cleaned and/or sanitized and kept in good repair on a scheduled basis using a written record system					
3.3	Packaging materials used in field operations are properly stored and protected from contamination					

Soil Management

Soil and its ecosystem is complex. A soil's fertility potential, water holding capacity and pest populations are important to consider with establishing a vineyard and producing raisins. Knowledge of site's soil characteristics can help produce quality fruit and maintain long-term sustainability of the farm.

The following section will help document the practices used to help manage soil sustainably as well as suggest areas where improvements might be made.

Soil Management		**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Knowledge of soil properties						
1.1	The soil types in the vineyard have been identified using NRCS soils maps or soil scientist					
1.2	I am aware of the soil properties for each soil type in the vineyard and their implications in producing raisins					
1.3	Prior to planting a vineyard, the soil is analyzed for physical problems such as hard pan, and chemical problems such as salts and amended when necessary					
Soil properties management						
2.1	If water infiltration is poor, the problem is identified whether it is chemical or physical and is addressed accordingly					
2.2	Cover crops or resident vegetation are grown when necessary to improve soil organic matter, nutrients and/or water infiltration					
2.3	Equipment is chosen or is modified to minimize soil compaction (e.g. lightest equipment possible, track-layers, wider or bigger diameter tires, tire pressures as low as possible)					
Crop nutrition management						
3.1	I have a written crop nutrient management plan that uses a 'budgeting approach'[9] in determining the nutrient needs of the crop and takes into consideration factors like: vine vigor, tissue analysis, soil type, time of year, soil moisture, crop load, etc.					
3.2	Results are interpreted by me or my field consultant and used in					

[9] A budgeting approach means that the amount of nutrients leaving the field in the crop is estimated and the amount of nutrients added back to the field is based on this estimate. A one -to-one replacement is not implied or required since factors such as soil type affect nutrient availability to the crop and these factors must also be taken into account.

	my crop nutrient management plan					
3.3	Plant tissue samples are taken and analyzed at least once a season and the results used in my crop nutrient management plan					
3.4	I record the amount of nitrogen applied per acre including that found in irrigation water, and calculate the amount of N applied per unit crop production					
3.5	I record the amount of potassium applied per acre and calculate the amount applied per unit of production					

Pest Management

Integrated pest management (IPM) is a fundamental part of a sustainable farming program. It is cost-effective, flexible, and resilient. IPM has evolved into the best way to manage vineyard pest problems.

University of California Statewide IPM Program crafted the following as the definition of IPM[10]:
Integrated Pest Management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment

Farming is carried out within the ecosystem and is a long-term endeavor that benefits from management practices that are ecosystem-based and long-term in nature. By using a combination of pest management practices, we develop a broad-based management strategy that will be successful even when one strategy is not effective. This section aims to help identify IPM strategies that improve pest management while reducing the impact of chemicals on non-target organisms[11].

Integrated Pest Management		**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pest Management Framework for Farm						
1.1	I use integrated pest management (IPM) that includes monitoring, economic thresholds for key pests, and consider biological, cultural and chemical control options for key pests after reviewing the UC Statewide IPM Program's pest management guidelines					
Risk Assessment						
2.1	Key pests for my vineyard have been identified in the following groups: diseases, insects, nematodes, mites, weeds, vertebrate pests and birds					
2.2	Monitoring protocols have been established and are followed					

[10] http://www.ipm.ucdavis.edu/IPMPROJECT/about.html
[11] Ohmart, C. P. and C. P. Storm. 2008. Chapter 6. Pest Management *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 187- 267.

	for key pests					
2.3	I and/or my Pest Control Advisor (PCA) have established and use economic thresholds for key pests					
2.4	I and/or my PCA keep written spray records containing the information required by California Department of Pesticide Regulation as well as weather conditions					
2.5	I am aware of the environmentally sensitive areas in and near my field such as distance to ground water, surface water, wetlands, houses, schools, public and private roads					
Monitoring						
3.1	I and/or my PCA use the UC IPM year round program forraisins[12]					
3.2	I monitor pest populations in my vineyard(s)					
3.3	A licensed PCA monitors pest populations in my vineyard(s) and acts accordingly					
3.4	I and/or my PCA monitor for pest natural enemies if they are important in controlling key pests and take their numbers in to consideration when making pest management decisions					
3.5	Cultural factors, such as time to harvest, current pest damage, plant moisture stress, vine vigor, canopy condition, and crop load, are considered in pest management decision-making if they have significant effects on the risk of damage due to key pests					
3.6	If I rely on a PCA pest management recommendation, I and/or my farm manager review with them the pest situation before making a decision to take a management action					
3.7	I train my employees to report any pest problems (e.g. pests they have never seen before) and report it to the appropriate person					
3.8	Invasive pests (e.g. vine mealybug, grapevine mo) are monitored for and when found removed from the vineyard					
Pesticide Application Management – make note according to State law						
4.1	Pesticide drift is minimized by using well maintained and calibrated spray equipment as well as using the sprayer pressure, application method (air induction nozzles, dust, concentrate, dilute, chemigation), and ground speeds that minimize drift, and spraying when weather conditions ensure minimum drift					
4.2	I rotate the use of pesticides according to ‘mode of action’ to minimize pesticide resistance					
4.4	A written spray drift management plan has been drawn up for each vineyard that includes a map of the field and location					

[12] http://www.ipm.ucdavis.edu/PMG/C302/m302yi01.html

	of sensitive areas and sprayer operators follow the plan					
4.5	Buffer zones have been established for each vineyard based on pesticide label specifications as well as adjacent crops and other sensitive sites					
4.6	Pesticide mixing and loading area is more than 100 feet from the wellhead unless it is protected by a berm or other physical characteristics that prevent surface water running from the perimeter to the wellhead					
4.7	I follow State Law by either having a double-check valve, reduced pressure principle backflow prevention device or an air gap is in place and maintained between the well pump and sprayer tank					
4.8	Spray mixing, loading and calibration are planned so that the tank is empty at the end of the spray job and it is not necessary to store materials					
4.9	I use the following safe pesticide storage practices: storage area is segregated and locked, dry pesticides stored above liquids, storage area has impermeable floor and sump to contain leaks, and only undamaged containers are stored					
4.10	I follow State Law by having an emergency response plan for pesticide and fertilizer spills and exposure posted in the appropriate places and workers are trained to follow the plan					
Prevention and Cultural Practices						
5.1	I use resistance rootstocks to manage some of my key soil pests such as nematodes					
Biological control						
6.1	If a pest natural predator is important for a key pest, I implement practices that preserve and/or enhance their populations by practices such as releasing natural enemies, like planting cover crops, nectar sources near the vineyard, and avoid using pesticides that may be harmful to natural enemies					
Effects of Pest Management on Non-Target Sites & Organisms Rewrite this section						
7.1	Effects of a pesticide on pollinators are considered when selecting the material to apply					
7.2	I select pesticides that are reduced risk to non-target organisms existing on my farm, such as birds and small mammals					

Social Responsibility

People are the most important part of any farming operation. The human element is also the most expensive part of raisin production. It is therefore important to have in place a sound Human Resources Management program to ensure employee wellness, a motivated workforce, and optimum performance. Furthermore, since raisin production occurs within a community, it is important that a farming enterprise has good community relations. This section lists practices that are important in Human Resource Management and community relations and may also give you some ideas of new practices to implement or improve over time.

Human Resources Management		**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Employee Orientation, Safety Training, and Career Development – Note what is state law						
1.1	An orientation program is provided for new non-seasonal employees					
1.2	Safety training is done according to Cal OSHA regulations, i.e. when an employee begins a new job assignment, or any new process, procedure or use of a material or equipment that creates a new hazard					
1.3	All employees participate in training and safety seminars at least annually to enhance their skills in the workplace					
1.4	If labor is contracted, a check is made to ensure contract labor company is licensed, has proper insurance, provides clean restrooms, adequate soap, hand washing water and towels, adequate drinking water, SB-198 Illness and Injury Prevention Plan, and has done heat illness prevention training with its employees					
1.5	Safety statistics such as time lost due to accidents are tracked and retained for at least 2 years					
1.8	My company pays for training when required and/or provides tuition reimbursement for work-related classes					
1.9	A meeting of top management is held annually to discuss company goals and exchange ideas					
Staying Informed						
2.1	I stay informed with important raisin industry issues by reading trade journals, being a member of a local, regional or state grower organization, and/or attend educational meetings sponsored by trade associations, Colleges and Universities, or Ag supply companies					

2.2	Trade journals/appropriate trade literature (including literature on worker issues, safety issues, Farm Bureau, trade association literature, etc.) are made available for the farm management team (FMT) to read					
2.3	The FMT has current membership in local grower association(s)					
2.4	The FMT regularly attend regional and/or statewide industry meetings (e.g. irrigation district, Farm Bureau, Water Coalition, etc), trade shows (e.g. World Ag Expo), and seminars (e.g. UC, CDFA, CSU seminars, research meetings from Commodity Boards)					
2.5	The FMT takes a leadership role in local, regional or state industry associations (e.g. Western Growers, California Raisin Marketing Board, Raisin Administrative Committee)					
Performance, discipline, grievance process, and employee recognition						
3.1	An employee job evaluation process is in place and is linked to pay and promotions					
3.2	A form and process is in place for employees to comment on job satisfaction					
3.3	My company has a grievance process in place and it is documented in the employee handbook					
3.4	Filed grievances are recorded and processed in a timely manner					
3.5	A suggestion box is provided in a convenient location so that employees can provide ideas for improvements in company practices, working environment, and other areas.					
Health benefits, paid time off, and other benefits						
4.1	Basic health benefits are provided to non-seasonal employees					
4.2	Non-seasonal employees have paid holidays and vacation time					
4.3	Employees are provided sick leave and/or personal days					

Community Support		Not Familiar	Familiar, not tried	Have tried it	Currently Use	Not applicable
5.2	My business is involved in initiatives, through time commitment and/or donations, that enhance the community such as service organizations, schools/education programs, churches, public health, affordable housing					
5.3	My business is involved in state, regional or local issues like land					

	use, water issues such as the regional water quality coalition, irrigation districts, ground water use planning, and/or the irrigated lands waiver program planning						

Waste Management

Sustainable agriculture provides a strategy for managing all aspects of your farming enterprise, including the management of the crop, soil, water, pests and human resources. It also relates to the farm's infrastructure as well as your offices and shop. While the primary aspect of sustainable farming addresses what happens in the field, it is important not to forget important issues like waste management.

Waste Management		**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In field, shop and office						
1.1	The vineyard has a waste management plan that includes waste reduction goals, recycling goals, hazardous material use reduction goals					
1.2	The vineyard has an established recycling program for metal, cardboard, plastics, paper and glass					
1.3	Employees are encouraged to recycle					
1.4	Nonoperational and/or old equipment such as tractors, ATVs, electrical equipment, are taken to the appropriate recycling center					
1.5	Hazardous materials such as solvents, cleaning materials, compressed gases, fuel, acids, and lubricants present on the farm are known and their use is tracked on an annual basis					
1.6	Employees are trained on the proper handling and disposal of hazardous materials					
1.7	Employees are trained on legal requirements related to cleaning of farm equipment with water or steam cleaners and the resulting runoff					
1.8	Hazardous materials no longer used, as well as their containers, are disposed of according to State Laws					
1.9	The vineyard participates in the pesticide container disposal program[13]					
1.16	Bi-lingual signs are posted near the dumpster and/or recycling containers indicating what can or cannot be put in the container					

[13] Use the following link to find out how to participate in an Ag Container recycling program: http://www.acrecycle.org/contact_us.html

Water Management and Water Quality

California is the leading agriculture state in the US. This is due in large part to the high value of the many specialty crops grown in the state. The demands for high quality, affordable water make it essential that it be used efficiently and effectively by Californian's. This section is designed to help document practices raisin producers are using to achieve optimum water quality and use efficiency and identify areas where improvements can be made.

Irrigation Management		**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pre-plant Planning						
1.1	Before planting a vineyard, a site evaluation should take place in relation to the irrigation system to be used (see educational box), the site was ripped or chiseled to improve water infiltration. The site was leveled according to soil type and irrigation run (furrow) or leveled to manage surface drainage (drip irrigation). Amendments are added when necessary to avoid high sodium or soil reaction issues (pH). Irrigation systems are designed to maximize irrigation efficiency for the site and water supply					
1.2	Water source was sampled and evaluated for water quality					
Irrigation Performance and System Maintenance – Pumps & Filters						
2.1	Pumping plant efficiency has been measured periodically (for areas where water table fluctuates considerably). and if efficiency is significantly reduced I have improved it					
2.3	Energy use for irrigation is tracked on an annual basis					
2.4	Pumping systems are designed to take advantage of time of use metering					
2.5	A flow meter is installed on wells and/or pumps or on individual lines and flows monitored and recorded					
2.6	Pressure check points are installed on key lines from pumps					
2.7	Filter status (and flushing system) is manually checked at least twice a season and corrected if necessary					
2.8	Pressure gauges are installed for measuring pressure drops through filters					
Irrigation Performance & System Maintenance – Drip & Micro-sprinklers, if you do not have a drip or micro-sprinkler, system go to 4.0						

3.1	Distribution uniformity of the irrigation system is tested at least every 2 years					
3.2	Drip irrigation systems are designed to optimize uniformity					
3.3	The irrigation system is monitored for leaks, breaks, and clogging every irrigation/when needed					
3.4	An interlock system is installed so the injection pump shuts down if the irrigation pump shuts down to prevent water source contamination					
3.5	Irrigation lines are flushed at the start of the season and then again at mid season, or more often as needed, chlorine is used if biological agents like algae, moss, or bacterial slimes are a problem, and acids are used if the irrigation water has a tendency to form chemical precipitates					
4.0 Irrigation Performance & System Maintenance – Flood & Furrow, if you do not have vineyards with flood or furrow irrigation, go to 5.0						
4.1	The field was laser leveled before planting the vineyard and according to soil type and water availability					
4.2	Locations of checks in the field are based on observed infiltration rates (i.e. each check is appropriately sized for maximum water application uniformity) and vineyard row runs are designed in accordance to soil type and water rate availability					
4.3	Flow meters are installed and flow volumes recorded on lines from pumps or in supply pipelines or ditches (e.g. Weir notch or Parshall flume) or a record of flow volumes is provided by the Water District					
5.0 Irrigation Scheduling & Rates						
5.1	I measure and record the total amount of water used in each vineyard annually					
5.2	I have a water management plan for my vineyard(s) that takes into consideration annual rainfall, crop water requirement, frost protection, leaching requirements, soil type, water quality, irrigation efficiency, phenology of the vine					
5.4	Irrigation is initiated and subsequent scheduling follows based on measured soil moisture depletion and vine water stress					
5.6	Soil moisture depletion is tracked using soil-installed moisture monitoring devices					
5.7	Irrigation is initiated at the start of the season based on directly measuring plant moisture stress (e.g. pressure bomb)					
5.8	Irrigation scheduling is influenced by peak energy pricing					
5.9	Water percolation rate and infiltration depth is monitored during the irrigation season					
5.10	Amount of irrigation and timing are dictated by the amount and timing of water available through my Water District					

5.11	Amount of irrigation and timing are based on visual cues of the crop					
5.12	Amount of irrigation and timing are based on irrigation history from past growing seasons					
5.13	Amount of irrigation and timing are based on historical crop evapotranspiration (ET) (put this up at the top)					
5.13	Water demand of the crop is estimated by determining ETo[14] through using data from the nearest CIMIS weather station and is used in irrigation rate and scheduling					
5.14	Water demand from the crop is estimated by converting ETo to Etc by using the appropriate crop coefficient factor (Kc) which takes into account crop canopy and used in irritation rate and scheduling					
6.0 Water quality – Source and resource						
6.1	Irrigation water is tested for contaminates such as pH, total salt, nitrate nitrogen, toxic elements like boron and chloride, and bicarbonates and corrective actions are taken if necessary					
6.2	I have accessed resource maps to determine if my field(s) are in Ground Water Protection Areas (GWPA)[15]					
6.3	If a field is in a GWPA I have accessed and read the legal requirements for handling restricted use pesticides in GWPA areas and they are on file in the farm office					
6.4	Older wells and abandoned wells are sealed to prevent groundwater contamination					
6.5	The wellhead is situated so no surface water can reach it or a berm has been placed around the wellhead that prevents surface water from reaching it					
6.6	Return water wells, older wells and abandoned wells are sealed to prevent ground water contamination					
6.7	Irrigation practices create no off-site movement of chemical residues and sediments					
6.8	Irrigation is managed to minimize offsite movement					
6.9	Soil percolation problems in the field have been addressed to minimize off-site movement storm water					

[14] ETo is the reference evapotranspiration and is calculated using measurements of climatic variables including solar radiation, humidity, temperature and wind speed and is expressed in inches or millimeters of water. It is based on water use for a short, mowed, full coverage grass crop.

[15] http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpamaps.htm

Self-Assessment for Strawberry Production

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Ladi Asgil[4]
Editors
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Funded by a California Department of Food and Agriculture
Specialty Crop Block Grant to SureHarvest

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Project History

Over the last 10 years the field of sustainable agriculture has become more and more important in the eyes of food retailers, buyers and consumers. As is often the case when new concerns arise in relation to food and food production, the spot light shines on the grower. Sustainable agriculture is challenging to define, and once defined it can be challenging for a grower to figure out how to implement it on the farm in an economically viable way. To meet these challenges a group of specialty crop trade associations, NGO's, and other specialty crop stakeholders met to discuss the topic of sustainable agriculture. One outcome of these discussions was an application to the California Department of Food and Agriculture Specialty Crop Block grant program for funds to hire sustainable agriculture professionals to help develop a plan to meet the challenges presented by sustainable agriculture. The Great Valley Center coordinated the grant application and engaged SureHarvest to provide the technical expertise. SureHarvest is a company with extensive experience in sustainable agriculture strategic planning, program design, and program implementation. The grant application was successful and began in September of 2009. The Great Valley Center directed the project and contracted with SureHarvest for project design, facilitation and implementation.

The grant had two primary goals. The first was to develop, through a stakeholder process, a sustainable agriculture strategic plan that each of the participating groups could use internally to help lay the foundation for their own sustainable agriculture program specific to their specialty crop. The second was to develop a tool, or tools, that could be used by their member growers to put the strategic plan into action on the farm.

The following paragraphs contain the sustainable agriculture strategic plan developed by the project leadership team, the members of which are listed in Table 1.

Sustainability Strategic Plan for the Multi-Commodity Project

The sustainability strategic plan for the Multi-Commodity Project is based on SureHarvest's 5 P's of sustainability framework. The 5 P's are: Principles, Processes, Practices, Performance Metrics, and Progress. They are defined as follows:

1. Principles – This is the sustainable vision for the project. It consists of the goals that the participants want to achieve from the design and implementation of the project.
2. Processes – These are the resource areas on the farm that need to be addressed in order to meet the principles or goals of the project. For example, this could be water, energy, and human resources management.
3. Practices – These are the practices that are implemented on the farm that impact the processes or resource areas. They are the on-the-ground actions that are carried out to assure that the principles or goals of the sustainable program are met.
4. Performance Metrics – These are the metrics used to measure the outcomes resulting from the practices implemented on the farm. There are many - examples include crop quality, water use, energy use, and worker satisfaction. Performance Metrics are used to measure the level of success in meeting the principles or goals of the project.

5. Progress – The process used to improve performance over time and communicate the results internally and externally. In other words, tracking the degree of progress one is making towards achieving the goals of the project. Measuring progress will require some kind of system for assessing the farm's performance over time, creating action plans to improve particular areas of performance, and reassessment over time to track progress.

Table 1. Multi-Commodity Project Leadership Team

Organization	**Representative**
Almond Board of California	Gabriele Ludwig*, Robert Curtis*
Bolthouse Farms	Troy Elliott*, Justin Groves*
California Grape & Tree Fruit League	Chris Valadez*, Barry Bedwell
California Specialty Crop Council	Lori Berger*
California Garlic & Onion Research Advisory Board	Robert Ehn
California Olive Council	Patty Darragh
California Pear Advisory Board	Bob McClain
California Pepper Commission	Glen Fischer*
California Pistachio Board	Robert Klein*
California Raisin Marketing Board	Gary Schultz
California Tomato Farmers	Ed Beckman*
California Tree Fruit Agreement	Gary VanSickle*, Lauren Friedman
California Walnut Board	David Ramos
Del Monte Foods	Pat McCaa
Sun-Maid Growers	Rick Stark*

*Leadership Team Member

Multi-Commodity Project Principles (1st P):

The principles for the Multi-Commodity Project were established by the Project Leadership Team. They are:

1. Create a resource area/practice template that:
    a. Will focus on increasing the economic performance for the participant.
    b. Is scalable and can be used by participating groups to accomplish the goals of their own sustainability programs.
    c. Provides the participant the ability to gauge the state of sustainability of the industry and their farm.
    d. Encourages continual improvement on the farm.
    e. As a whole encourages ecological harmony.
    f. Better defines the 3 E's of sustainability (economic viability, environmental soundness and social equity/responsibility) in a way we can all agree upon.
    g. Is open to and usable by any individual or group in the future that was not involved in the original effort.
    h. Benefit the participants and not result in unintended negative consequences.

2. The program should provide the information/data needed for groups to tell their sustainability story better to all their audiences, e.g. buyers, regulators, consumers, NGO's.
3. The outcomes from the project cause no harm to producers.

The Leadership Team of the Multi-Commodity Project decided the best tool for implementing their sustainability strategic plan was a self-assessment of practices template that stakeholders from specific specialty crops could then fine tune for their own use. The team chose to use the model developed by the California Sustainable Almond Program (CASP), which is a California Almond Board program developed in partnership with SureHarvest. The Leadership Team formed a stakeholder committee to draft the self-assessment template that covered the practice areas listed in the Multi-Commodity Project Strategic Plan. The Stakeholder Committee members are listed in Table 2.

Individual Contact	Title	Expertise
Billy Heller	Grower, Pacific Triple E Farms	Crop management
Bob Giampaoli	Grower, Live Oak Farms	Crop management
Cliff Sadoian	Grower	Crop management
Pat McCaa	Manager, Pest Management, Del Monte Foods	Crop management
Mechel S. Paggi (Mickey)	Director, Center for Agricultural Business, California State University, Fresno	Ag Business & economics
Glen Fischer	Ag Representative, Saticoy Foods Inc.	Crop management
John Trumble	Professor of Entomology, University of California Riverside	Pest management
Jeff Mitchell	Extension Specialist, University of California, Davis	Soils & plant nutrition
Pete Goodell	UC IPM Area Advisor, University of California, Davis	Pest management
Terry Prichard	Extension Specialist, University of California, Davis	Irrigation & crop water relations
Bill Peacock	Representing raisin growers via the Raisin Marketing Board and Tree Fruit Growers	Crop management
Troy Elliott	Director of Agronomy, Bolthouse Farms	Crop management

Table 2. Multi-Commodity Project Stakeholder Committee

The second phase of the Multi-Commodity Project began with SureHarvest obtaining a CDFA Specialty Crop Block Grant to finish the self-assessment template with the Multi-Commodity Leadership Team and Stakeholder Committees and then fine-tune the template into workbooks for individual specialty crops working with willing growers and stakeholders from each specialty crop community. The self-assessment workbook for strawberries which is presented on the following pages was developed using the Multi-Commodity self-assessment template through a series of reviews and edits by growers, other stakeholders and SureHarvest staff. The editors thank in particular A. J. Kawamura for reviewing and commenting on this document. The final version was produced by SureHarvest and submitted to CDFA along with their final report in June of 2013.

Air Quality Management

We all appreciate good air quality. Unfortunately, the San Joaquin Valley is out of attainment of the Federal Clean Air Act. Because of this the region is under threat of losing federal highway dollars if attainment cannot be achieved. Therefore a lot of pressure is being brought to bear on urban and rural industries, including agriculture, to reduce air pollutants in the Valley in any way that is possible. This section of the self-assessment will help you identify practices that influence air quality, see where you are doing well, and determine areas that need improvement.

Air Quality Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In Field and Adjacent Land					
1.1 To minimize airborne dust and PM10[5] particles a reduced tillage program is in place					
1.2 To minimize airborne dust and PM10 particles a no-till program is in place					
1.3 If tillage is done, moisture content of the soil is taken into consideration to minimize dust					
1.4 Mulch, either plastic or natural material, is used in the field to minimize dust (and conserve soil moisture)					
1.5 To minimize airborne dust and PM10 particles in perennial crops, a cover crop is maintained at least every other row					
1.6 Vegetation is maintained on non-cropped areas such as headlands, roadsides, and field edges to reduce wind erosion causing airborne dust					
1.7 Crop residues incorporated into the soil or composted					
Roads					
2.1 Vehicle speed is restricted on dirt roads around fields to minimize airborne dust					
2.2 Dirt roads are treated with an anti-dust agent that meet the 50% PM10 control for a Fugitive PM10 Management Plan[6] 9 (note: committee recommended put the list in this document, it will be added to the fine-tuned workbooks. The list is about 2 pages long, see the website below for copy)					
2.3 Dirt roads are graveled, watered, chipped, mulched (crop residues),					

[5] PM 10 are particles 10 microns in diameter or smaller and pose a health risk because they pass through the throat and nose and penetrate the lungs.
[6] For details see http://www.airquality.nrcs.usda.gov/Documents/files/Dust_Control_Products.htm

sanded or seeded					
2.4 Heavily used roads are paved (e.g. main thoroughfares on farm)					
Engines and Fuel Consumption					
3.1 Engines are maintained on a regular schedule to ensure they are running at optimum performance and efficiency and emissions are minimized					
3.2 At least some vehicles are equipped with engines able to use alternative fuels with lower emissions (e.g., compressed natural gas, flex fuel, biodiesel, propane)					
3.3 Some off-road farm vehicles are battery powered (e.g. golf carts)					
3.4 Vehicle miles are tracked on an annual basis					
3.5 Stationary diesel engines have been replaced (or retrofitted) to Tier 3 or better					
3.6 Stationary diesel engines have been replaced (or retrofitted) with technology relying on cleaner burning fuel (e.g. propane, natural gas, biodiesel) or replaced with electric pumps					
3.7 Selection of vehicle power plants and stationary engines is in part determined by lower emissions ratings					
3.8 Some of the farm's energy requirements are obtained through renewable sources such as wind or solar					
Pesticide Management and Air Quality					
4.1 Soil fumigants are used only when necessary and applied appropriately (e.g. pre-planting where soil sampling has identified a significant pest problem, proper soil moisture conditions exist and that all regulations have been met)					
4.2 No soil fumigants are used					
4.3 During pre-planting, either ethyl bromide or methyl iodide is used as a fumigant with no plans to switch to an alternative					
4.4 During pre-planting, an alternative to methyl bromide or methyl iodide is used as a fumigant or pre-plant soil treatment such as anaerobic soil disinfestation, steam, or heat.					
4.5 One or more of the following practices are used to reduce or eliminate the use of fumigants: crop rotation, cover cropping, use of plastic mulch, compost applications, cultural controls, or careful management of beneficial predators with supplemental releases of beneficial arthropods where needed.					
4.6 Totally impermeable film (TIF) is used to prevent fumigant leakage, thereby increasing the fumigant's effectiveness.[i] (see text box below)					
4.7 When choosing a pesticide to apply its VOC 'footprint' is considered[7]					

[7] A VOC calculator is found at: http://apps.cdpr.ca.gov/voc-calculator/

4.8 Practices are implemented that reduce pesticide drift such as use of air induction nozzles, turning sprayers off at turn-arounds, , not spraying when a temperature inversion exists in the field, and when wind exceeds 10 mph or the velocity specified on the label.					
Greenhouse Gas Emissions					
5.1 I am aware of the role of CO_2, N_2O, and methane as greenhouse gases and where they are produced in my farming operations					
5.2 CO_2 and N_2O production are calculated and tracked					

What are VOC's?

VOC stands for volatile organic compound. These are carbon based compounds contained in products used on the farm, such certain pesticides, that volatilize (evaporate) when exposed to the air. Ground-based ozone is produced by chemical reactions involving VOC's, nitrogen oxides (NOx) and sunlight. While not direct air pollutants themselves, VOC's are important ozone precursors and considered key targets for reduction in the Central Valley of California in regions where air quality is an issues. The California Department of Pesticide regulation does not know the reactivity of every VOC and ideally reactivity should be used to precisely determine VOC emissions. That said, appropriate data and analytical methods do exist at this time to make accurate estimates. The Department does hope to use reactivity at some point in the future. It calculates VOC emissions based on the best available science (Dr Matt Fossen, pers. comm., Environmental Scientist, Calif. Dept. Pesticide Regulation). Air Quality and greenhouse gas emissions are such important topics in the Central Valley of California it is important to consider the various sources of potential air quality problems.

Totally Impermeable Film[8]

UC scientists report that use of totally impermeable film in strawberry fields can improve the effectiveness of a widely-used methyl bromide alternative known as 1,3-D (1,3, dichloropropene). Use of the film reduces the amount of 1,3-D needed to maintain yields, while lowering field emissions overall. The strawberry industry is highly dependent on soil fumigation to control pests and maintain high yields. The methyl bromide alternative, 1,3-D, can be used only in certain quantities, due to air quality concerns.

In a recent trial, totally impermeable film (TIF) was laid out over Salinas fields to prevent the fumigant from leaking. The new film was compared with the standard film used by growers. Fumigant concentrations under TIF were 46 percent to 54 percent higher than under standard film, and the higher concentrations were correlated with higher strawberry yields and better weed control. Scientists report these findings in detail in the October–December 2011 electronic edition of the University of California's California Agriculture journal.

Impermeable films have three benefits, according to lead author Steven Fennimore, UC Cooperative Extension specialist and weed scientist in UC Davis Department of Plant Sciences. The films trap the fumigant in the soil for a longer time and thereby increase its effectiveness; they reduce fumigant emissions, which after reacting with nitrogen oxides, can convert to ground-level ozone; and they reduce the amount of fumigant needed for effective pest control.

[8] University of California Cooperative Extension, Agriculture & Natural Resources Ventura County, *New film traps fumigants and increases strawberry yields,* http://ceventura.ucdavis.edu/?blogpost=6085&blogasset=19305.

Energy Management

Energy is essential for crop production and it comes in several forms; as sunlight to power photosynthesis, as fuel to power our internal combustion motorized vehicles and pumps, and as electricity to power our shop and office lights and electronic equipment. Tracking energy is very important because it is getting more and more expensive all the time, increasing our cost of production. Burning of fuel produces GHG's affecting air quality and contributing to climate change. So minimizing energy consumption saves money and reduces GHG production. Completing this section should help improve your understanding of energy use in your operation and encourage you to consider some forms of energy conservation.

Energy Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 The total amount (gallons) of fuel used annually on the farm in all operations is recorded and year to year comparisons are made. Each fuel type is recorded.					
1.2 The total amount of fuel used annually per acre and per unit of crop production is determined and year-to-year comparisons are made[9]					
1.3 The total amount of fuel used annually is calculated for each field and year-to-year comparisons are made. Each fuel type is recorded.					
1.4 Annual fuel consumption and/or electrical use for irrigation pumps is recorded and comparisons made from year-to-year.					
1.5 Electrical use for office(s), shop(s), and outdoor security lighting is tracked using energy bills and year-to-year comparisons are made					
1.6 Fuel and electricity used are converted to a common metric such as British Thermal Units (BTU's) so they can be combined to calculate the total amount of energy used annually for crop production and year to year comparisons are made[10]					
1.7 The amount of energy used annually per acre and per unit of crop production is calculated and year to year comparisons are made					
1.8 The amount of energy used annually in each field is calculated and year-to-year comparisons are made					

[9] This can be a simple calculation of dividing the total gallons of fuel used for the year divided by the total amount of crops produced for the year

[10] Energy conversion calculators for kilowatt hours to BTU's and gas or diesel to BTU's are readily and freely available on the Internet. For example using Google type 'convert gas to BTU's and you will be directed to a website where a calculator is available to make your conversion. Simply type in the number of gallons of gas and the calculator will produce the number of BTU's it represents.

1.9 An energy management plan is being implemented on the farm that includes yearly goals for overall energy use as well as energy used per unit of crop production.[11]					
1.10 A process is in place to ensure that the most appropriate piece of equipment is used for a given job (e.g. the most appropriate horse power engine for the job)					
1.11 One or more solar energy systems are installed on the property to generate electricity					
1.12 One or more wind generators are installed on the property to generate electricity					
1.13 Residue from crop production is used in a cogeneration plant					
1.14 Engines (stationary and mobile) and motors are maintained on a regular schedule to ensure they are running at an optimum fuel efficiency or optimum efficiency.					
1.12 Pumping plant efficiency (energy per acre foot pumped) is checked every 1 to 3 years (based on use) and adjustments made if necessary (FSU website recommends every 1-3 years based on use)					
1.13 At least some light switches are fitted with motion detectors or photo cells to reduce time of use					
1.14 At least some office and shop lights have been fitted with low energy consumption compact florescent bulbs or LED lights.					

Indirect Energy Use/Consumption:

Energy is directly expended when driving a vehicle, operating a pump, photocopying, or turning on and using a light bulb. Energy is also expended to manufacture inputs that are used on the farm, such as fertilizers, compost and pesticides. This type of energy consumption is called imbedded energy. If you want to figure out the total amount of energy consumed to produce a crop then calculations should also be made to determine the amount of embedded energy that was consumed to produce the fertilizers, compost, and pesticides that were used to produce the crop.

Note: The Stakeholder Committee and Leadership Team thought it might be good to have one or more boxes where a grower could insert comments for any of the practices they marked as ‘N/A’.

[11] Ideally one would convert all energy consumption to BTU’s (British Thermal Units) but initial energy management plans could start with using gallons of gasoline and diesel and kilowatt hours for electricity.

Financial Management

The economic E of sustainable farming is literally where the buck stops. If a farm is not profitable it is not sustainable. People farm not because they want to be accountants. They farm because they want to grow things. However, while financial management may be a burdensome part of farming, doing it well is one of the keys to a successful and sustainable farm. This chapter will help you recognize where your strengths are in financial management as well as point out areas where improvements are needed.

Financial Management **(The most appropriate person to fill out this section/chapter is the CEO/owner of the farm)**	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Planning and Risk Management					
1.1 A marketing and production plan has been developed for my farm and seasonal outcomes are compared to these plans					
1.2 A succession[12] plan is in place for the farm					
1.3 I have a written will and estate plan for the farm[13]					
1.4 A business continuation plan (disaster[14] management plan) has been developed for the farm					
1.4 A risk management plan has been developed for the farm					
1.5 Key personnel in the company have health insurance					
1.6 Key personnel in the company have disability insurance					
1.7 Key personnel have life or accidental death insurance					
Accounting and Financial Analyses					
2.1 I use a financial accounting system to track and report farm finances and use it to make decisions about my farming operation					
2.2 I understand how to interpret both cash and accrual financial statements including a balance sheet, income statement, cash flow, and financial ratios					
2.3 I meet with a financial advisor on an annual basis					
2.4 Financial profitability analyses for investments are done if investments are made					

[12] A succession plan is one where the change in leadership in the company has been determined, whether it is expected such as the CEO voluntarily stepping down/retiring, or unexpected such as due to illness or accident.
[13] An estate plan is a plan for the financial assets to pass from one generation to the next. It does not deal with the human and intellectual capital and passing that transition to the next generation. That is succession planning.
[14] Disaster in this case is not just weather but also unexpected death of one or more key company personnel.

2.5 The revenue and returns are tracked for each field/management unit in my financial management reports					
2.6 Costs and returns are tracked for all important farming practices					
2.7 Costs and returns are tracked for implementing new sustainability practices and compared to costs and returns of practices they replaced					
2.8 Sensitivity analysis, i.e. change in crop prices over time, is used to analyze financial risk over time					
Purchasing and Borrowing					
3.1 More than one quote is obtained for major input purchases such as pesticides and fertilizers					
3.2 Interest rates and services from more than one lending institution are compared before borrowing a significant amount of money					

Food Safety Management

What is safe food? This is a question that is being debated by everyone all along the supply chain. New food safety compliance is costing some growers a lot of money. When you think about it, proving a food to be safe is a very difficult thing to do because in reality one has to prove that it is not safe.

Note: The content of this section may change significantly depending on the specialty crop being addressed by this self-assessment template.

Food Safety Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Food Safety Management Planning					
1.1 A written food safety policy is in place for the farm that includes a commitment to food safety, how it is implemented, and how it is communicated to the employees.					
1.2 A written food safety plan is in place that identifies all locations of the farm and products covered by the plan. The plan addresses potential physical, chemical, and biological hazards and hazard control procedures, including monitoring, verification and record keeping, for the following areas: water, soil amendments, field sanitation, production environment and worker practices					
1.3 The food safety plan is reviewed at least annually					
1.4 Record keeping is kept to demonstrate the food safety plan is being followed					
1.5 A person has been designated as being responsible for food safety functions on the farm					
1.6 All employees are trained in food safety procedures and practices on the farm					
1.7 Trace-back procedures are in place as the basis of a system to identify the source of strawberries.[ii]					
1.8 A Food Security Program is in place to preserve the safety and security of products from farm to table and addresses preventative and corrective measures that reduce the risk of intentional contamination of biological, chemical, or physical hazards into the product.					
Food Safety Risk Assessment of Field					
2.1 An assessment has been made of the production field focusing on the likelihood of intrusions by animals that pose significant food safety					

risks (e.g. deer, pigs, livestock) and, if necessary, actions are taken to reduce the likelihood of intrusion					
2.2 An evaluation has been made on land and waterways adjacent to the field for possible sources of human pathogens of concern (e.g. manure storage, CAFO's, grazing/open range areas, surface water, sanitary facilities and composting operations)					
2.3 An assessment of historical land use has been made to determine any potential issues from these uses that might impact food safety (e.g. hazardous waste sites, landfills, etc.)					
2.4 My company participates in a third party food safety certification program (e.g. Agriculture Marketing Service GAP Certified, Scientific Certification Systems, Primus. Global GAP)					
2.5 High quality pathogen-free cultivar transplants are used and the Strawberry Certification Program such as the one sponsored by the California Department of Food and Agriculture to help maintain my field free of pathogens					
2.6 Field sanitation is practiced, working the "cleanest" (pathogen free) fields first, rinsing the equipment with hot water to remove soil and plant debris before working another field					
2.7 I try to ensure that manure or other organic amendments added to the fields have been properly composted or sterilized.					
2.8 Previous land uses, paying particular attention to landfill sites, livestock operations, etc.[iii]					
2.9 Adjacent land uses are documented and characterized, especially livestock or poultry operations					
3.0 Soil tests for microbial contaminates are performed where previous land uses could have potential for microbial risks, such as dairy operations, poultry farms, or high uses of animal manure[15]					
3.1 In order to ensure the reduction in pathogens in composted soil, the following questions are asked of the compost producer: • What is the percentage and physical make-up of the composted material? • On what date did the compost process begin? • Was the compost produced through a process that combined plant and animal materials with an initial C:N ratio of between 25:1 and 40:1? • Were daily temperature readings registered of 131° Fahrenheit or higher? • Did the compost remain at 131° Fahrenheit for 15 days or longer for windrow composting? • Were windrows turned a minimum of five (5) times? • Was microbiological testing conducted?					

[15] Testing is suggested following flooding, leakage or unusual run-off from adjacent land uses. Growers using organic amendments should consider testing prior to planting. California Strawberry Commission Food Safety Program (2005), http://www.calstrawberry.com/fileData/docs/FSP_English.pdf.

Water					
4.1 The water system description for the field/ranch has been created that indicates, either with drawings or maps, the location of permanent fixtures, such as pumps, wells, underground lines, gates & valves reservoirs, and returns					
4.2 Irrigation water and water used in harvest operations is tested for microbial quality, and if microbial levels are above specific action levels, corrective actions are taken					
4.4 Records of all water tests are retained, along with Certificates of Analysis, for at least 2 years					
4.5 Irrigation pipe and drip tape are stored in a manner that reduces or eliminates the potential for pest infestation					
4.6 Water applied to edible portions of the crop, either as overhead irrigation or pesticide applications, is tested for microbial quality					
4.7 Open water sources (reservoirs, canals, uncapped wells, etc.) in the field are tested for fecal coliform/*E. coli* and copies of water quality reports are maintained[iv]					
4.8 Closed water sources (capped wells) are tested for fecal coliform/*E. coli* or a copy of municipality/district water quality report is obtained. Copies of these reports are maintained					
4.9 Primary and secondary sources of water have been identified and documented, including well water (capped or uncapped), open water (canal, reservoir, or collection pond) or municipal/district water systems					
4.10 The water delivery system has been identified and documented					
4.11 The type of filtration system and where filters are located in the irrigation and water delivery system have been identified					
4.12 Samples of water are taken after it has been filtered from an area still common to the field(s) serviced from the given water source					
4.13 Water is tested at the source as follows with the results kept on file					
4.14 Closed, underground or capped well systems is tested annually at the beginning of the season					
4.15 Uncapped wells, open canals, reservoirs and collection ponds are tested quarterly throughout the season					
4.16 If the water source is from a municipality or water district, copies of water quality reports are obtained from the municipality or water district and filed (monthly, quarterly, or annually)					
4.17 Microbiological testing of irrigation waters in conducted and includes tests for fecal coliform (*E. coli)*					
4.18 If wells or water sources are found contaminated with *E.coli*, corrective measures are taken, such as disinfecting, filtration, or chlorinating of the well or water source					
4.19 After corrective measures are taken, the water sources are resampled, and if the sample is found to be decontaminated, the					

berries are tested that had been irrigated with the infected water					
4.20 Microbial risks in overhead irrigation are minimized by using potable water					
4.21 Water used in mixing pesticide or foliar feed can be a source for microbial contamination. Tanks are rinsed and cleaned after each use following all applicable federal and state pesticide laws and regulations regarding equipment and rinse water					
4.22 Adjacent farming operations or other land use activities may pose a potential risk for run-off or leaching of microbiological contaminants. The following practices are employed to address this concern: • Nearby landfill sites, sewage treatment facilities, septic tanks, leach fields, and/or potential run-off or leaching from adjacent farming operations, such as dairy farms or compost producers, are identified and documented • Corrective actions are taken and documented, such aconstruction of physical barriers (ditches, berms or fencing), disinfecting wells, and use of a catch pond					
4.23 If recycled water[16] is used in farming operations, the following practices are followed: • Monthly reports are obtained, reviewed, and maintained for record-keeping. • Special attention is paid to specific analysis information for *E. coli* as an indicator for fecal contamination • Necessary steps are taken to reduce or minimize direct recycled water contact with the edible portion of the crop, e.g., plugging leaks in drip irrigation systems that could create puddles and using an alternative water source (municipal or potable well water) for sprinkler irrigation during frost control and pesticide application • Actions such as chlorination or filtration are documented					
4.24 Untreated recycled water is never used					
4.25 Treated sewage water is never used					
4.26 Contaminated wells are disinfected[17] using the following steps: • A chlorine solution containing at least 50 mg/l (or parts per million) available chlorine, is added to the well					

[16] Recycled water is domestic/municipal wastewater that has been highly treated and disinfected so that it meets the California Department of Health guidelines for irrigation of crops that are consumed without cooking. As defined and used in Title 22 Water Recycling Criteria by the California Department of Health Services, recycled water means "disinfected tertiary recycled water."

[17] Disinfection of all contaminated wells is recommended to eliminate pathogenic organisms as well as organisms that can grow in wells and thereby cause clogging and affect the quality of water produced. California Strawberry Commission Food Safety Program (2005), http://www.calstrawberry.com/fileData/docs/FSP_English.pdf.

• The pump column or drop pipe is washed with the chlorine solution as it is lowered into the well • After it has been placed into position, the pump is turned on and off several times (i.e., "surged") so as to thoroughly mix the disinfectant with the water in the well. The water is pumped until it has the odor of chlorine. This procedure is repeated several times at one-hour intervals • The well is allowed to stand without pumping for 24 hours • The water is then be pumped to waste until the presence of chlorine is no longer detectable • A bacteriological sample is taken and submitted to a laboratory for examination • If the laboratory analysis shows the water is not free of bacterial contamination (e.g. fecal coliform<2.2/100 milliliters), the disinfection procedure is repeated. The water is then be retested. If repeated attempts to disinfect the well are unsuccessful, a detailed investigation to determine the cause of the contamination is undertaken					
Organic Soil Amendments					
5.1 Raw manure or a soil amendment that contains un-composted or incompletely composted or non-thermally treated animal manure is not applied to field					
5.2 If compost is applied, it is sourced from a supplier that provided their written Standard Operating Procedures that prevents cross-contamination of finished compost with raw materials through equipment, runoff or wind					
5.3 If organic soil amendments are used microbial testing is performed by the supplier prior to application					
5.4 Storing or applying organic (compost, manure, etc.) amendments next to maturing crops is avoided because of possible drift. These amendments are stored as far away as possible from areas where strawberries are grown and harvested.					
5.5 If compost is applied, I use only treated or "cured" compost.[18]					
5.6 If compost is applied, I ask the composter for the percentage and physical make-up of composted material, and documentation showing that: • Compost was produced through a process that combined plant and animal materials with an initial C:N ratio of between 25:1 and 40:1 • Compost maintained temperatures between 131°F and 170°F for fifteen days or longer in a windrow composting system; • Compost windrows were turned a minimum of five times					

[18] Doing so will help minimize the potential for microbiological contamination. California Strawberry Commission Food Safety Program (2005), http://www.calstrawberry.com/fileData/docs/FSP_English.pdf.

during composting • Microbiological test results showing *E. coli* <1,000 MPN/gram and *Salmonella* <3MPN/4gram (MPN = Most probable number); and • Document the type of amendments used, the rates, and the dates and locations of the applications.					
Sanitation					
6.1 Toilet facilities are readily available to all field employees and are located according to Cal OSHA regulations					
6.2 Toilet facilities are clean and maintained on a regular basis					
6.3 Field employees are trained on the importance of sanitation in the field					
6.4 Field sanitation units are accessible to all employees					
6.5 A response plan is in place in the event of a spill from toilet or sanitation facilities and employees are trained to implement it					
6.6 Workers are educated on sanitation issues such as not working on the job while sick or injured (e.g. infected cuts)					
6.7 Hand washing and drinking water containers are cleaned daily.					
6.8 Hand washing and drinking water is changed daily.					
6.9 Toilet paper, soap, single-use paper towels and drinking water cups are provided					
6.10 Toilet and hand washing facilities are provided that meet required standards for quantity, cleanliness, and accessibility					
6.11 Workers are reminded of proper hygiene practices and observe that practices are followed					
6.12 I have pesticide use records and posted warning signs as required					
6.13 Detailed trace-back procedures are maintained					
6.14 Pest (insects, birds and rodents) control programs for packaging storage and cooler facility are checked					
6.15 Packaging is properly stored in a safe, secure location					
6.16 I and/or my shippers inspect trailers/cargo containers for cleanliness prior to loading.					
6.17 I document the number of workers, toilets and hand washing facilities provided, and maintenance of facilities.					
6.18 Tailgate meetings on worker safety and proper hygiene practices.					
6.19 Documentation of field worker safety training is verified					
6.20 Monthly pesticide use records are submitted to the County Agricultural Commissioner's office					
6.21 I annually review a written training program for general sanitation, personal hygiene practices, pesticide safety training, and good agricultural practices on the farm					
6.22 Portable toilets are cleaned outside the perimeter of the fields, not in					

the fields					
6.23 Animals are not allowed in the strawberry fields					
6.24 Grazing livestock are not allowed near the strawberry fields					
6.25 Workers are not allowed to eat, drink, chew gum, chew tobacco, or smoke in or near the plant beds					
6.26 Glass objects are prohibited inside the field perimeter					
6.27 Primary containers (e.g. clamshells, pint containers, etc.) never have contact with the soil					
6.28 No packaging has direct contact with the soil					
Harvesting and Transportation					
7.1 A traceability system is in place and appropriate for my crop					
7.2 A mock recall has been done to check the effectiveness of the traceability system (mock recalls would usually be done in conjunction with a packer/shipper or processor)					
7.3 All harvesting containers and bulk hauling vehicles that come into direct contact with the harvest crop are cleaned and/or sanitized on a scheduled basis using a written record system					
7.4 Packaging materials used in field operations are properly stored and protected from contamination					
7.5 Harvesting equipment that comes into contact with the crop is kept in good repair					
7.6 In order to protect the strawberries from field temperatures, I move fruit from field to cooler within 2 hours of harvest.[v]					
7.7 While accumulating fruit in the field, I cover the tops of pallets in order to avoid exposing strawberries on the top tier of flats to direct sunlight					
7.8 Drivers always go directly from field to cooler and avoid stops for breaks or refueling while transporting the strawberries					
7.9 Strawberries are moved from the truck to the cooler immediately upon arrival					
7.10 If strawberries must be held outside due to constraints of the facility, shade structures are used to cover the trucks or pallets					
7.11 Cooler personnel are trained on the principles of forced-air cooling, emphasizing the importance of sealing all openings around the pallet that air could be drawn through instead of being forced through the boxes of strawberries					
7.12 Detailed thermal mapping of the cold storage areas are periodically conduct by placing temperature monitors in a 3D grid throughout the cold storage areas					
7.13 The cooler temperature is maintained at 31-32° F.					
7.14 Seals around dock doors are inspected and, if needed, repaired on a routine basis					

7.15 If the dock area cannot be properly refrigerated, loads are staged in the cold storage area instead					
7.16 Detailed thermal mapping of the dock area is periodically conducted by placing temperature monitors in a 3D grid throughout the dock area to help identify the variation in temperature from location-to-location and over time					

Soil Management

Soil is the most complex ecosystem on earth. Gaining a greater understanding of the soil resource in your fields is critical for making informed soil management decisions. Knowing your soil resource gives you greater control over yield and crop quality and is especially important in determining the long-term sustainability of your farm.

Soil provides the crop with three vital things: water, nutrients and air. These three things are best provided by a soil with good depth and structure i.e. a soil in which the particles are bound together into small clumps (aggregates) of varying size. Soil aggregation is a measure of soil structure. Soil organic matter is important in maintaining soil structure by gluing soil minerals together into aggregates. Spaces between large aggregates (measured as millimeters) permit rapid drainage and easy root growth, and spaces between small aggregates (measured as less 1 millimeter down to 0.001 millimeter) trap water for use between irrigation and rain events. One of the more important aspects controlling aggregate stability is the amount of microbial activity and soil organic matter. Stable aggregates occur in varying sizes and are created by the cementing action of microbes and their byproduct and soil organic matter. The assemblage of soil aggregates creates habitat to promote faunal and microbial diversity, an important index of soil quality. Due to the warm to hot California climate soil organic matter is low in many soils due to rapid breakdown of soil organic matter.
The following self-assessment template will help document the practices producers are using to managing their soil sustainably as well as suggest areas where improvements might be possible.

Soil Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Knowledge of soil properties					
1.1 The soil types in the field has/have been identified using NRCS soils maps					
1.2 The soil types in the field has/have been identified using soil samples taken pre-planting (for permanent crops soil pits were dug to establish soil series)					
1.3 Soil properties for each soil type in the field is recorded, including soil moisture holding capacity, texture, and rooting depth					
1.4 A soil sample has been taken in the field more than 6 years ago and analyzed for macro and micro nutrients					
1.5 A soil sample has been taken in the field within the last 6 years and analyzed for macro and micro nutrients as well as soil chemistry (e.g. pH, CEC, salts)					
1.6 A soil sample has been taken in the field within the last 4 years and analyzed for macro and micro nutrients as well as soil chemistry (e.g. pH, CEC, salts)					

1.7 A soil sample has been taken in the field within the last 2 years and analyzed for macro and micro nutrients as well as soil chemistry (e.g. pH, CEC, salts)					
1.8 If soil pH is less than 5.5 it is amended with lime and if it is above 8.0 it is amended with an acidifying agent					
Soil properties management					
2.1 If water infiltration is poor (water puddles and runs off when soil is dry underneath) the soil is amended either chemically (e.g. with gypsum or organic matter such as compost or manure) or physically (e.g. chiseling or shallow ripping)					
2.2 Cover crops are planted to add organic matter and nutrients to the soil and to improve water infiltration					
2.3 For permanent crops, resident vegetation is allowed to grow as a cover crop to add organic matter to the soil and improve water infiltration					
2.4 If soil organic matter is low for the soil series in my field I have an ongoing program to build soil organic matter either through additions of compost, manure and growing cover crops or a combination of them					
2.5 Equipment is chosen or is modified to minimize soil compaction (e.g. lightest equipment possible, track-layers, wider or bigger diameter tires, tire pressures as low as possible)					
2.6 For permanent crops the soil is never tilled unless a problem develops that requires one pass to alleviate the problem (e.g. soil is too uneven for safe operation of equipment)					
2.6a For permanent crops tillage is done every 5 years or less (this does not include aerating the soil with equipment like an Aerway)					
2.7 For permanent crops tillage is done every 3 to 5 years					
2.8 For permanent crops tillage is done every year					
2.9 For annual crops conservation tillage is practiced					
2.10 For annual crops, tillage passes are fewer than most neighboring farms producing the same commodity					
2.11 For annual crops, tillage passes are about the same as most neighboring farms producing the same commodity.					
2.10 Surface tillage is practiced on a regular basis					
2.11 Deep tillage is practiced on a regular basis					
2.12 I manage my field in such a way that minimizes pathogen infestation and increases beneficial organisms					
Crop nutrition management					

3.1 I have a written crop nutrient management plan that uses a 'budgeting approach'[19] in determining the nutrient needs of the crop and takes into consideration factors like crop tissue analyses, soil type, time of year, soil moisture, crop load, etc. (insert an educational box discussing the 4 R's of nutrient management; see http://www.ipni.net/4r)					
3.2 The crop's nutrient management plan is based solely on the recommendations as given by my field consultant and/or from the soil testing lab					
3.3 With the help of my field consultant I am able to interpret the lab results from the field soil samples and we use them in the crop nutrient management plan					
3.4 I am able to interpret the lab results from the soil samples and I use them in my crop nutrient management plan					
3.5 Plant tissue are taken and analyzed at least once a season and used to help assess crop nutrient needs					
3.6 I record from year-to-year the amount of nitrogen applied per acre and calculate the amount of N applied per unit crop production					
3.7 I record from year-to-year the amount of phosphorus applied per acre and calculate the amount of P applied per unit crop production					
3.8 I record from year-to-year the amount of potassium applied per acre and calculate the amount of K applied per unit crop production					
3.9 Fertilizers are applied using Fertigation					
3.10 The total amount of nitrogen needed for the season is applied in one application					
3.11 The total amount of nitrogen needed for the season is applied in a split application(s)					
3.12 Fertilizers are applied using a 'spoon feeding' approach where only the amount of nutrients required by the crop at the time are applied and multiple applications are made throughout the growing season based on crop growth stage and nutrient demand					
3.13 Micro nutrients are applied on a regular basis without reference to crop needs or crop history					
3.14 Micro nutrients are applied based on past crop history					
3.15 Micro nutrients are applied based on soil sample test results					
3.16 Micro nutrients are applied based on crop tissue sample test results					
3.17 I rotate strawberries with other crops to return important nutrients to the field and/or improve soil structure					
3.18 Fertilizer material spills are avoided during all phases of transport, storage, and application through the following practices:					

[19] A budgeting approach means that the amount of nutrients leaving the field in the crop is estimated and the amount of nutrients added back to the field is based on this estimate. A one -to-one replacement is not implied or required since factors such as soil type affect nutrient availability to the crop and these factors must also be taken into account.

a. Organized training sessions are provided for field personnel					
b. When transporting fertilizer, tanks or trailers are not overfilled, and loads are properly capped or covered					
c. When transporting fertilizer into on-farm storage or into a fertilizer applicator, I take care not to let materials accumulate on the soil					
d. Fertilizer storage facilities are maintained in a way that meets government and industry standards and protects them from the weather					
e. All fertilizer spills are promptly cleaned up					
f. Fertilizer applicators are shut off during turns and check valves are used on application equipment.					
g. Proper calibration of fertilizer application equipment is maintained					
h. Whenever fertilizer is injected into irrigation water, I ensure that backflow does not occur					
i. Rinse water from fertilizer application equipment is distributed evenly throughout the field					
3.19 N is placed where maximum plant uptake will occur through the following:					
a. N fertilizer is incorporated into the crop bed by banding fertilizer 2-4 cm beneath the transplants or by broadcasting fertilizer and then listing it up into the bed					
b. The conversion rate of organic N to other forms is determined when incorporating manures and other organic amendments to the soil					
3.20 Nitrate leaching losses are minimized by:					
a. When winter rains prohibit planting, a cover crop is grown rather than leave the fields fallow.					
b. Excessive upfield runoff is prevented from entering or ponding in field					
3.21 Irrigation systems are managed to minimize deep percolation and N losses by:					
a. Monitoring soil moisture between irrigations and use the information to guide irrigation timing decisions					
b. Considering strawberry variety and growth stage, climate, and soil type when determining irrigation amount and timing					
c. Knowing the flow rates and time required to apply the desired amount (inches) of water					
d. Using the maximum leaching fraction that will prevent stand development problems or yield reductions from salinity					
e. Following state regulatory requirements and industry guidelines for backflow prevention when injecting fertilizer into irrigation water					
f. If irrigation efficiency remained or remains low after all practical					

improvements have been made, I converted or will convert to a more efficient system.					
g. When fertigating with a sprinkler or drip system, fertilizer is run in the later part of the set so as not to leach nutrients beyond the root zone					
Soil erosion					
4.1 Vegetation is maintained along farm roads, on field edges, and along irrigation canals not controlled by the irrigation district					
4.2 I know the infiltration/run-off rates of the field's soil and the rate of irrigation water is applied and is adjusted according					
4.3 No tillage is done on field borders or along irrigation canals					
4.4 Ditches have been grassed or hardened to prevent downcutting					
4.5 Culverts are properly sized to accommodate high flows, and inlets and outlets have been hardened to prevent scour or energy dissipaters have been installed					

Ecosystem Management

An ecosystem is the complex community of living organisms and their physical environment functioning as an ecological unit. Components of an ecosystem are inseparable and interrelated. An ecosystem management approach to growing specialty crops acknowledges that people are a part of and have a significant impact on ecosystem structures and processes, and that people depend on and must assume responsibility for the ecological, economic, and social systems where they live. Ecosystem management is currently being encouraged and implemented by communities, government agencies, businesses, academics and various conservation organizations throughout the world[20].

Ecosystem Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Habitat maintenance and enhancement					
1.1 Field borders, roadsides, and ditch-banks are kept free of vegetation					
1.2 Hedgerows of trees and/or shrubs are maintained on at least some field edges					
1.3 Vegetation such as grasses, trees or shrubs are maintained along roadsides, ditch-banks and headlands					
1.4 Vernal pools or swales are preserved and managed with setbacks to reduce probability of soil disturbance					
1.5 Trees have been planted to provide habitat for wildlife					
1.6 Trees are maintained to provide habitat for wildlife					
1.7 Nesting boxes for owls have been placed around the farm and they are cleaned annually					
1.8 Perches for raptors have been placed around the farm					
1.9 If water courses exist on my property crops are planted up to the edge of water courses					
1.10 If water courses exist on my property setbacks are in place to minimize disturbance					
1.11 If water courses exist on my property resident vegetation is maintained on the banks					
1.12 If water courses exist on my property banks are vegetated with a mix of grasses, trees and shrubs					
Whole farm issues					
2.1 I am an active member in the local watershed coalition					

[20] Reeves, K. 2008. Chapter 1. Ecosystem Management *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 15- 63.

2.2 I participate in a watershed stewardship planning group if one exists in my region					
2.3 Invasive pests (e.g. puncture vine, arundo) are monitored for and when found removed from the farm					
2.4 A formal or informal environmental survey of the farm has been done noting the presence of sensitive areas, such as vernal pools, swales, oak trees, habitat for endangered species, and other environmental features which affect farming and actual farmable acres such as an NRCS conservation survey[21]					
2.5 I manage my property to protect and/or enhance habitat for threatened and endangered species					
2.7 Some or all of the natural areas of my property is protected by a conservation easement (see education box below)					
2.8 Some or all of my property are protected by an agricultural easement program					
2.9 The farm is managed to optimize ecosystem services such as wildlife, pollinators, and/or arthropod natural enemies and increased biodiversity (see box below for definition of an ecosystem service)					
2.10 Indicators of biodiversity on the farm are monitored and recorded, such as animal and plant populations , pollinators, or arthropod natural enemies					
2.11 Unfarmed areas are maintained to increase biodiversity on the farm including wildlife, pollinators and/or arthropod natural enemies					

Education box: What is an ecosystem service?

The biological communities in an agricultural ecosystem provide benefits over and above the commercial crops they produce. These benefits are known as **ecosystem services**. They include removing carbon dioxide from the atmosphere, reducing greenhouse gases, the recycling of nutrients, regulation of microclimate and local hydrological processes, in some cases they result in the suppression of pest plants and animals through the production of pest natural enemies, and detoxification of noxious chemicals that enter the environment.

Education Box: What are Conservation and Agricultural Easements?

Conservation and Agricultural Easements

Conservation easements for protection of natural resources are legal agreements that allow landowners to donate or sell some "rights" on portions of their land to a public agency, land trust, or conservation organization. In exchange, the owner agrees to restrict development and farming in natural habitat, and assures the easement land remains protected in perpetuity. A 1996 study conducted by the National Wetlands Conservation Alliance indicated that the leading reasons landowners restored wetlands were to provide habitat for wildlife; to leave something to future

[21] NRCS has a lot of resources available for helping with environmental planning on the farm. Contact your local NRCS office and see if they can help you.

generations; and to preserve natural beauty. Only 10% of landowners surveyed in the study restored wetlands solely for financial profit. This would also apply to other habitats besides wetlands. A conservation easement can provide you with financial benefits for the protection, enhancement, and restoration efforts for the natural environments on your property. The belief that natural resources such as wildlife, especially sensitive species, will reduce your land value is not true. Many easement programs include some sort of cash payment for a portion of the costs associated with habitat restoration and enhancement.

Agricultural conservation easements are for the explicit purpose of keeping farmland in production. They are similar to natural resource conservation easements, but, specifically protect farmland and maintain the practice of farming. In 1996, the state established the California Farmland Conservancy Program to protect farmland by buying easements. Based on a study conducted by UC Cooperative Extension and published in 2002, there were 34 local conservation organizations, land trusts, and open space districts that protect farmland through conservation easements (see – *Agricultural Easements: New Tool for Farmland Protection California Agriculture,* January-February 2002, Volume 56:No. 1). Local opportunities may exist for one or both kinds of conservation easements on your property.

Pest Management

Integrated pest management (IPM) is a fundamental part of any sustainable farming program. It is cost-effective, flexible, and resilient. IPM was developed to respond to some significant pest management challenges that developed in the 1950's and 1960's. Events such as the development pesticide resistance by many pests, secondary pest outbreaks, and environmental contamination due to the use of certain problematic pesticides led a forward-looking group of entomologists at the University of California to conclude that agriculture was heading toward a pest management crisis. They realized we had forgotten the fact that pest problems are complex and connected to ecosystem processes. They concluded that the solutions to complex ecological problems must be broad-based and take the farm ecosystem into account. These researchers developed the IPM concept to meet the pest management crisis. Since its inception in 1959, IPM has evolved into the best way to manage pest problems on the farm.

University of California Statewide IPM Program crafted the following as the definition of IPM[22]:
Integrated Pest Management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.

Farming is carried out within the ecosystem and is a long-term endeavor so we want to use management practices that are ecosystem-based and long-term in nature. By using a combination of control techniques to manage a pest problem, we develop a broad-based management strategy that will still be successful even if one particular technique does not work. Also, based on our experience with chemical controls, we know that pest control decisions must take into account not only economic risks, but effects on the environment and people's health, as well[23].

Pest Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pest Management Framework for Farm					
1.1 I have an integrated pest management framework/plan for my farm that takes into account the landscape within which I farm, an					

[22] http://www.ipm.ucdavis.edu/IPMPROJECT/about.html
[23] Ohmart, C. P. and C. P. Storm. 2008. Chapter 6. Pest Management. *in* Ohmart, C. P., C. P. Storm and S. K. Matthiasson. Lodi Winegrower's Workbook 2nd Edition. Lodi Winegrape Commission. pp. 187- 267.

understanding of the cropping system and how it affects the population levels of key pests, includes monitoring protocols and economic thresholds for key pests, monitoring protocols and important pest natural enemies, and the key biological, cultural and chemical control options available for key pests					
1.2 Each year I review the pest management framework with all those involved in pest management on my farm and make adjustments according to my goals and pest management results from the past year					
Risk Assessment					
2.1 Key pests for my farm have been identified in the following groups: diseases, insects, mites, weeds, mammals and birds; and targeted for management					
2.2 Monitoring protocols have been established and are followed for key pests					
2.3 I and/or my Pest Control Advisor (PCA) have established and use economic thresholds for key pests					
2.4 I and/or my PCA keep written spray records containing the information required by California Department of Pesticide Regulation as well as weather conditions and effectiveness					
2.5 I am aware of the environmentally sensitive areas in and near my field such as distance to ground water, surface water, wetlands, vernal pools, swales, houses, schools, public and private roads					
2.6 I have mapped the environmentally sensitive areas in and near my field such as distance to ground water, surface water, wetlands, vernal pools, swales, houses, schools, public and private roads					
Monitoring					
3.1 I and/or my PCA follow the UC IPM year round program for strawberries.					
3.2 I and/or my PCA use the UC IPM pest management guidelines for strawberries.					
3.3 I and/or my PCA use the UC IPM pest management manual if available for my crop					
3.4 I monitor pest populations in my fields					
3.5 A licensed Pest Control Advisor monitors pest populations in my fields					
3.6 I and/or my PCA monitor for pest natural enemies if they are important in controlling key pests and take their numbers in consideration when making pest management decisions					
3.7 Cultural factors, such as time to harvest, preexisting plant damage, plant moisture stress, plant health, and crop load, are considered in pest management decision-making if they have significant effects on the risk of damage due to key pests					
3.8 I or my PCA keeps qualitative (descriptive) written pest monitoring records and they get shared during the decision making process					

3.9 I and/or my PCA keeps quantitative (numeric) written pest monitoring records and they get shared during the decision making process					
3.10 If I rely on pest management recommendations from a PCA, I and/or my farm manager review with them the pest situation before making a decision to take a management action					
3.11 I encourage my crew supervisors and farm managers to report any pest problem that is out of the ordinary (e.g. pests they have never seen before) and report it to the appropriate person					
3.12 Pictures of important invasive pests are posted in convenient places so employees can monitor for their presence					
3.13 I and/or my PCA work closely to insure that only registered pesticide products are used and that they are applied in compliance with all state and federal laws, rules and regulations, and labeled recommendations.					
Pesticide Management					
4.1 'Smart'[24] sprayers are used when applying pesticides to some or all of my fields					
4.2 Pesticide drift is minimized by using technologies such as air induction nozzles, or some pesticides are applied using chemigation					
4.3 I rotate the use of pesticides according to 'mode of action' to minimize development of resistance					
4.4 I keep a written record of pesticide use by 'mode of action' as a part of my pesticide resistance strategy					
4.5 A written spray drift management plan has been drawn up for each field that includes a map of the field and location of sensitive areas and sprayer operators follow the plan					
4.6 Calibration and spray coverage tests are done at least once a season on my sprayer and are based on manufacturers' recommendations as well as site characteristics such as crop canopy present					
4.7 Buffer zones have been established for each field based on pesticide label specifications as well as adjacent crops and other sensitive sites					
4.8 Sprays are timed such that there is minimal or no human activity in adjacent areas					
4.9 Dormant season pesticide applications are made when wind speeds exceed 10mph[25]					
4.10 Dormant sprays are not done in dead calm when a temperature inversion exists to avoid long distance pesticide drift					
4.11 Sprayer nozzles are shutoff at row ends near environmentally sensitive areas					
4.12 There is a berm around the wellhead that prevents surface water running from the perimeter to the wellhead					

[24] A smart sprayer is one equipped with sensors that detect present or absence of target and shuts off when target is not present.
[25] CDPR Rule for Dormant Season Insecticides Fact Sheet

4.13 Pesticide mixing and loading area is more than 100 feet from the wellhead unless it is protected by a berm or other physical characteristics that prevent surface water running from the perimeter to the wellhead					
4.14 A separate water supply tank is used for pesticide mixing or chemicals are added to the tank at least 100 feet away from the well.					
4.15 Either a double-check valve, reduced pressure principle backflow prevention device or an air gap is in place and maintained between the well pump and sprayer tank[26]					
4.16 Pesticide mixing and loading is done using a closed system or with water soluble pesticide packets when available for the pesticide being applied					
4.17 Spray mixing, loading and calibration is planned so that the tank is empty at the end of the spray job					
4.18 The following safe pesticide storage practices are used: dry pesticides stored above liquids, pesticides are stored more than 300 feet from nearest well, storage area has impermeable floor and sump to contain leaks, an only undamaged containers are stored					
4.19 An emergency response plan for pesticide and fertilizer spills and exposure is posted in the appropriate places					
4.20 Workers are trained to follow the emergency response plan for pesticide spills or exposure					
4.21 A pesticide risk model such as PRiME[27], WIN PST or UC IPM's Water Tox[28] is used when considering which pesticides to apply					
4.22 The VOC 'footprint' of a pesticide is considered when deciding which pesticides to apply[29]					
4.23 I inform all affected parties in close proximity to the area intended to be treated with pesticides of my intent to apply pesticides in advance of the application, and I post fields and file post-application paperwork with the appropriate state and/or federal agency.					
4.24 During preplant, pesticide usage is mitigated to minimize air and water contamination using any of the following practices by:					
a. Making arrangements with the nursery to obtain transplants of the desired cultivar and certification level					
b. Surveying previous crop and adjacent areas for weeds, lygus bug hosts, whiteflies, and/or vertebrates					
c. Reviewing the cropping history of the field					
d. Analyzing soil for nutrients and salts; consider an application of slow-release fertilizer					
e. Analyzing irrigation water for salinity and nitrogen content					

[26] This is a legal requirement
[27] PRiME is the Pesticide Risk Mitigation Engine and can be accessed at http://ipmprime.org/cigipm/
[28] The model output is accessible at http://www.ipm.ucdavis.edu by viewing the webpage for the pest in question and clicking on the link labeled 'Water Quality Compare Treatments)
[29] http://apps.cdpr.ca.gov/voc-calculator/

f. Using soil treatments for soilborne pests and weeds, including soil fumigation, drip fumigation, and/or soil solarization					
g. Preparing the field by making sure it is properly graded with good drainage					
h. Shaping beds to minimize water retention on bed tops					
i. Visiting the transplant nursery in the last month of the propagation cycle (before it gets cold) to evaluate nursery fields for: 1) pest problems that my be carried on transplants (spider mites, cyclamen mites, anthracnose, angular leaf spot, botrytis fruit rot, powdery mildew); 2) uniformity in planting, indicating possible disease or plant quality issues; and/or 3) pesticide usage					
j. Applying herbicides, if needed, before applying mulch					
k. Applying plastic mulch appropriate to my needs for weed control, managing soil temperature, and/or controlling plant size					
4.25 During planting, pesticide usage is mitigated to minimize air and water contamination using the following practices by:					
a. Inspecting transplants for gray mold, uniformity, quality, and proper root length and follow proper procedures for placement of strawberry transplants					
b. Using fungicide dips and/or water wash to reduce fungal diseases (anthracnose, phytophthora crown rot, red stele)					
c. Monitoring salinity of irrigation water					
d. Irrigating as needed					
e. Applying fertilizer at planting if preplant application was not made					
f. Confirming correct planting depth of transplants					
4.26 During prebloom, pesticide usage mitigated to minimize air and water contamination by using the following practices by:					
a. Monitoring for spider mites and caterpillars, including spider mites, cutworms, and armyworms, and keep records and treat as needed according to PMGs					
b. Confirming correct planting, noting any need for replanting					
c. Looking for insects and mites, flagging locations with problems, e.g., aphids, cyclamen mites, and whiteflies					
d. Looking for diseases, flagging locations with problems, e.g., angular leaf spot, anthracnose, common leaf spot, leaf blotch, phytophthora crown and root rot, powdery mildew, and/or red stele root rot					
e. Looking for vertebrates, flagging locations with problems, e.g., deer, ground squirrels, moles, pocket gophers, and/or voles					
f. Surveying for weed emergence, applying preemergent herbicide as needed according to PMGS and handweeding as needed					
g. Removing runner in summer plantings as needed					

h. Monitoring salinity of irrigation water					
i. Monitoring soil moisture and irrigate as needed					
j. Applying fertilizer as needed					
4.27 During flowering to first harvest, pesticide usage is mitigated to minimize air and water contamination using the following practices:					
a. Monitoring for spider mites and caterpillars (cutworms, armyworms) and keep records and treat as needed according to PMGs					
b. In Central Coast plantings and Southern California summer plantings, monitoring lygus bug and surveying weed hosts and considering calculating degree-days to time egg hatch, followed by keeping records and treating as needed according to PMGs					
c. Treating diseases as needed according to PMGs, including botrytis fruit rot and powdery mildew					
d. Looking for insects and mites and flag locations with problems, including aphids, cyclamen mites, thrips, and/or whiteflies					
e. Looking for diseases and flag locations with problems, including angular leaf spot, anthracnose, common leaf spot, leaf blotch, phytophthora crown and root rot, red stele root rot, and/or verticillium wilt					
f. Looking for vertebrates and flag locations with problems, including deer, ground squirrels, moles, pocket gophers, and voles					
g. Surveying for weed emergence and manage as needed according to PMGs					
h. Monitoring for salinity of irrigation water					
i. Monitoring soil moisture and irrigate as needed					
j. Applying fertilizer as needed					
4.28 During harvest, pesticide usage is mitigated to minimize air and water contamination by using the following practices by:					
a. Monitoring weekly for lygus bug and, if using degree-days, continue the calculations and keep records					
b. Monitoring for spider mites and caterpillars, including cutworms, armyworms, and leafrollers, keep records and treat as needed according to PMGs					
c. Treating diseases as needed according to PMGs, including botrytis fruit rot and powdery mildew					
d. Looking for insects and mites, including aphids, cyclamen mites, thrips, vinegar flies, and whiteflies, and flag locations with problems					
e. Looking for diseases, including angular leaf spot, anthracnose, common leaf spot, leaf blotch, phytophthora crown rot, red stele root rot, and verticillium wilt, and flag locations with problems					
f. Looking for vertebrates, including deer, ground squirrels, moles,					

pocket gophers, and voles, and flag locations with problems					
g. Surveying for weed emergence and manage as needed according to PMGs					
h. Removing and discard decayed fruit and fruit with water damage					
i. Looking for bird damage on fruit, especially in locations with a history of bird presence					
j. Monitoring salinity of irrigation water					
k. Monitoring soil moisture and irrigating as needed					
l. Applying fertilizer as needed					
4.29 During post-harvest, pesticide usage is mitigated to minimize air and water contamination by using the following practices by:					
a. Rotating crops to reduce pest problems and improve soil structure, organic matter, and water penetration					
b. Using a cover crop to reduce runoff and erosion					
c. Thoroughly working-in crop residue immediately after harvest, allowing it to completely decompose before the next strawberry crop					
d. Analyzing field records for pest problems, including aphids, beet armyworm, cabbage looper, cutworms, cyclamen mites, spider mites, whiteflies, angular leaf spot, anthracnose, botrytis fruit rot, phytophthora crown and root rot, powdery mildew, red stele, and verticillium wilt, and note yield differences based on management strategies to plan a management program for the next strawberry crop					
4.30 When planning for possible pesticide applications, practices are considered that minimize environmental and efficacy problems, including the following by:					
a. Choosing a pesticide from the UC IPM Pest Management Guidelines for the target pest considering: (1) impact on natural enemies; (2) potential for water quality problems using the UC IPM WaterTox database; (3) impact on aquatic invertebrates; and (4) chemical mode of action if pesticide resistance is an issue					
b. Selecting an alternative chemical or nonchemical treatment when risk is high using the following procedures: (1) choose sprayers and application procedures that keep pesticides on target; (2) identify and take special care to protect sensitive areas (for example, waterways or riparian areas) surrounding my application site; (3) review and follow label for pesticide handling, storage, and disposal guidelines; (4) check and follow restricted entry intervals (REI) and preharvest intervals (PHI); (5) after an application is made, record application date, product used, rate, and location of application; and (6) follow up to confirm that treatment was effective					
c. Considering water management practices that reduce pesticide					

movement off-site, including the following: (1) install an irrigation recirculation or storage and reuse system; (2) use drip rather than sprinkler or flood irrigation; (3) limit irrigation to amount required using soil moisture monitoring and evapotranspiration (ET); (4) consider vegetative filter strips or ditches; and (5) redesign inlets into tailwater ditches to reduce erosion					
d. Considering management practices that reduce air quality problems, including, when possible, to choose pesticides that are not in emulsifiable concentrate (EC) form which release volatile organic compounds (VOCs).					
Prevention and Cultural Practices					
5.1 Resistance varieties/rootstocks are used to manage some of my key pests					
5.2 Crop rotation is used to manage some of my key pests					
5.3 Timing of planting of crops is used to avoid key pests					
Biological control					
6.1 I monitor for pest natural enemies if they are important in controlling key pests					
6.2 If a pest natural enemy is important for a key pest practices are implemented that augment their populations like planting cover crops, nectar sources and avoid using pesticides that may be harmful to natural enemies					
6.3 Pest natural enemies are released that have been proven to be effect controls for a key pest					
6.4 Conservation of pest natural enemies is considered when choosing a pesticide to use in the field					
6.5 Conservation of natural enemies is considered when deciding on spray timing					
6.6 Areas adjacent to the field are established to augment natural enemies by growing plants that provide shelter, nectar, and pollen for them					
Effects of Pest Management on Non-Target Sites & Organisms					
7.1 Effects of a pesticide on pollinators are considered when selecting the material to apply					
7.2 I am a member of the local Irrigated Lands Water Quality Coalition					
7.3 Effects of a pesticide on non-target organisms existing on my farm, such as birds and small mammals, are considered when selecting the material to apply					

Social Responsibility

Each specialty crop will add an introductory paragraph to this section to reflect their goals as they relate to Social Responsibility.

Human Resources Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Staffing and Recruiting Strategy					
1.1 A long term (2-5 years) staffing and recruiting strategy is in place					
1.2 A variety of recruiting methods is used depending on job opening, e.g. word of mouth, newspaper, web recruiting, job fair, temporary or contract services					
1.3 A standard interviewing process is used in recruitment which includes a specific set of review questions					
1.4 A job description exists for each type of job and it is given to the employee and their supervisor					
1.5 Job descriptions are reviewed and updated at least once every two years					
1.6 For non-seasonal employees, an exit interview is conducted to determine why employees left the company					
Employee Orientation, Safety Training, and Career Development					
2.1 An orientation program is provided for new non-seasonal employees					
2.2 Safety training is done according to Cal OSHA regulations, i.e. when employee begins a new job assignment, or any new process, procedure or use of a substance or equipment that creates a new hazard					
2.3 All new employees undergo safety training					
2.4 If labor is contracted, a check is made to ensure contract labor company adheres to all relevant Cal OSHA safety regulations					
2.5 Safety statistics such as time lost due to accidents are tracked and retained for at least 2 years					
2.6 Employees are instructed as necessary to attend training seminars or other educational programs at least once a year that enhance their skills in the workplace					
2.7 Employees are encouraged to attend training seminars or other educational programs at least once a year that enhance their skills in the workplace (e.g. SpraySafe)					
2.8 My company pays for training when required and/or provides tuition reimbursement for work-related college classes					
2.9 A formal career planning process is in place for non-seasonal					

employees					
2.10 Every non-seasonal employee is provided an employee handbook that includes at a minimum the company's work standards and policies and an overview of benefits					
2.11 The employee handbook is written in an appropriate language(s)					
2.12 An employee meeting is held at least once a year to discuss company goals and to exchange ideas					
2.13 A meeting of top management is held annually to discuss company goals and exchange ideas					
Staying Informed					
3.1Trade journals/appropriate trade literature (including literature on worker issues, safety issues, Farm Bureau, trade association literature, etc.) are made available for the farm management team (FMT) to read					
3.2 The FMT has current membership in local grower association(s)					
3.3 The FMT regularly attend regional and/or statewide industry meetings (e.g. irrigation district, Farm Bureau, Water Coalition, etc), trade shows (e.g. World Ag Expo), and seminars (e.g. UC, CDFA, CSU seminars, research meetings from Commodity Boards)					
3.4 The FMT takes a leadership role in local, regional or state industry associations (e.g. Western Growers, California Grape & Tree Fruit League, Grower-Shipper Association)					
Performance, discipline, grievance process, and employee recognition					
4.1 A job performance process is in place and is linked to pay and promotions					
4.2 A form and process is in place for employees to comment on job satisfaction					
4.3 My company has a grievance process in place and it is documented in the employee handbook					
4.4 Filed grievances are recorded and processed in a timely manner					
4.5 A formal process is in place by which employees are recognized for good job performance and/or years of service					
4.6 A suggestion box is provided in a convenient location so that employees can provide ideas for improvements in company practices, working environment, and other areas.					
Health benefits, paid time off, and other benefits					
5.1 Basic health benefits are provided to non-seasonal employees					
5.2 Non-seasonal employees have paid holidays and vacation time					
5.3 Employees are provided sick leave and/or personal days					
5.4 Non-seasonal employees are provided (or employees are encouraged to) a formal pension plan or a company 401k					
Pesticide Safety Training					

6.1 Documentation is maintained with regard to compliance with federal, state, and local regulations including: (1) use permits and posting requirements; (2) application and use records; (3) application-specific information for pesticide handlers and field workers (e.g., identification of treated area, time/date of application, restricted entry interval, product name); (4) private applicator certification and PCB/PCA licensing and registration; (5) proper training; and (6) applicator, mixer/loader, and field worker safety requirements.[vi]					
6.2 During restricted entry intervals, no one, except a properly trained and equipped person, can enter a treated area.					
6.3 Field workers are informed of pesticide applications taking place or when a restricted entry interval is in effect on an employer's establishment, orally and/or via official warning signs.					
6.4 Pesticide Safety Information Series A-9 (Hazard Communication Information for Employees Working in Fields) is available at the worksite.					
6.5 Pesticide applicators ensure that no pesticide is applied so as to contact anyone directly or through drift.					
6.6 Annual training is provided so that each employee who handles any pesticide understands, for each pesticide to be used, all issues applicable to the particular handling task, including (but not limited to) immediate and long-term hazards involved, safetry procedures, procedures for handling non-routing tasks or emergency situations, applicable laws and regulations, employee's rights, and warnings about taking pesticides home.					
6.7 A written training program is in place for all pesticides that are handled by employees and maintained at a central workplace location that is accessible to employees. The written program describes the materials and information that will be provided and used to train employees.					
6.8 Pesticide use records, PSISs, and MSDSs are kept in a central location at the workplace. This location is identified in PSIS A-8 and is provided to employees.					
6.9 Upon request of the employee, employee's representative, or employee's physician, access is provided within 48 hours of request to any records or other documents required to be maintained.					
6.10 Copies of the appropriate PSISs are posted in a prominent location at the workplace. Alternatively, if PSISs are not posted at the workplace, copies of the Safety Series are provided to each employee who handles pesticides.					
6.11 Employees always wear eye protection when mixing/loading pesticides unless the label does not specify that protection is needed, the spray boom is mounted below the applicator and the nozzles pointed downward, or it is safe to apply the pesticide without wearing eye protection.					
6.12 Rubber or neoprene gloves are worn while mixing/loading or					

applying pesticides or handling contaminated equipment and are provided each work day.					
6.13 Clean outer clothing is provided to employees when working daily with pesticides in Category I or II.					
6.14 When recommended on the label, respirators are worn while mixing or spraying pesticides or as necessary to prevent exposure.					
6.15 Annual training is provided in the use, sanitary care, and limitations of any respiratory equipment that will be required for use.					
6.16 Mixing, loading, or applying a pesticide in toxicity Category I for production of an agricultural commodity undergoes periodic supervision, once every two hours during daylight and every hour while working at night, whenever working with pesticides having the signal word "DANGER" on the label.					
6.17 Category I liquid pesticides or diluted liquid mixes derived from dry pesticides in Toxicity Category I for the production of an agricultural commodity are loaded through a closed system. This does not apply to employees who handle a total of one gallon or less of pesticides in Toxicity Category I per 24-hour period exclusively in original containers of one gallon or less.					
6.18 Pesticides are mixed in a well-ventilated and well-lit area.					
6.19 Pesticides are weighed or measured accurately using devices that are calibrated to the smallest unit in which the pesticide is being weighed or measured, being careful not to exceed the required amount as it appears on the label for the crop being treated.					
6.20 Pesticide is not sprayed when drift may contaminate non-target plants, persons, wildlife, or surrounding areas.					
6.21 Pesticides are never transported in the passenger compartment of any vehicle or on a flatbed truck unless the pesticides on the flatbed truck have been tied down securely.					
6.22 Pesticides are never placed in a container of a type commonly used for food, drink or household uses.					
6.23 Pesticides are never stored or placed near food or feed.					
6.24 Insecticides and fungicides should be kept separate from herbicides to prevent contamination.					
6.25 Pesticides are kept in locked storage areas or watched at all times. A pesticide shipment is delivered to a responsible person or placed in a locked storage area.					
6.26 Accidents involving the use of pesticides are reported immediately and accurately to the county agricultural commissioner, giving the location and pesticide involved					
6.27 There are special use handling requirements for pesticides designated "Minimal Exposure Pesticides."					

Community Support	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
1.1 My company is involved in regional land use planning					
1.2 My company is involved in initiatives, through time commitment and/or donations, that enhance the community such as the Chamber of Commerce, schools/education programs, churches, public health, affordable housing					
1.3 My company is involved in regional water issues such as the regional water quality coalition, irrigation districts, ground water use planning, and/or the irrigated lands waiver program planning					

Waste Management

Sustainable agriculture provides a strategy for managing all aspects of your farming enterprise, including the management of the crop, soil, water, pests and human resources. It also relates to your farms infrastructure as well such as your offices and shop. While the most interesting part of sustainable farming addresses what happens in the field it is important not to forget important issues like waste management. In a lot of situations, waste management is one of the most straightforward processes to address on the farm.

Waste Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
In field, shop and office					
1.1 The farm has a written waste management plan that includes waste reduction goals, recycling goals, hazardous material use reduction goals					
1.2 Crop residue or crop byproduct is recycled by either selling to another user (e.g. for cattle feed, co-generator/digester), composted, or returned to the field for incorporation into the soil					
1.3 The farm has an established recycling program for metal, cardboard, plastics, paper and glass					
1.4 The value of recycling is part of the orientation and training of employees					
1.5 The amount of metals, cardboard, plastics, paper and glass recycled annually vs. the amounts thrown away is determined and year to year comparisons are made					
1.6 The number of tires, batteries used per year and the amount of lubricants purchased vs the amount sent back or recycled per year is recorded and year to year comparisons are made					
1.7 All unused or worn out items such as appliances, tractors, ATVs, electrical equipment, are taken to the proper recycling centers for disposal					
1.8 The total amount of hazardous materials, other than pesticides and fertilizers, present on the farm is known and their use is tracked on an annual basis (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.9 Employees are trained on the proper handling and disposal of hazardous materials (e.g. solvents, cleaning materials, explosives, compressed gases, fuel, acids, and lubricants)					
1.10 Employees are trained on legal requirements related to cleaning of					

farm equipment with water or steam cleaners and the resulting runoff					
1.11 Hazardous materials no longer used, as well as their containers, are disposed of according to legal requirements					
1.12 The farm participates in the pesticide container recycling program[30]					
1.13 Dumpsters and/or recycling containers are on cement pads to contain spills					
1.14 Dumpsters and/or recycling containers are covered to keep out rain					
1.15 Dumpsters and/or recycling containers are periodically inspected for leaks, spills, and litter. Problems noticed are corrected					
1.16 Bi-lingual signs are posted near the dumpster and/or recycling containers indicating what can or cannot be put in the container					

[30] Use the following link to find out how to participate in an Ag Container recycling program: http://www.acrecycle.org/contact_us.html

Water Management and Water Quality

California is the leading agriculture state in the US by a significant amount. This is due in large part to the high value of the many specialty crops grown in the state. It is also due to the excellent growing conditions such as fertile soils, a Mediterranean climate, and the availability of affordable high quality surface and ground water for irrigation. California is also the most populace state in the US, and therefore, affordable high quality water is needed to support this population. It is clear that because of the demands for high quality, affordable water, this critical resource needs to be used efficiently and effectively by specialty crop producers. The following template will help document practices producers are using to achieve optimum water quality and use efficiency as well as bring to their attention areas where improvements can possibly be made.

Irrigation Management	**Not Familiar**	**Familiar, not tried**	**Have tried it**	**Currently Use**	**Not applicable**
Pre-plant Planning					
1.1 Pre-plant analyses of the site was done to identify factors that affect quantity of irrigation water delivery and percolation rate such as existence of soil compaction, a root restricting layer, soil type, soil texture, soil chemistry (pH, salinity, etc.) and soil organic matter					
1.2 Ripping, plowing, chiseling, or other practices were implemented if pre-plant soil tests indicated water percolation and/or drainage problems					
1.3 Soil amendments were applied to correct soil chemical or physical issues if sampling identified factors that would affect water percolation					
1.4 Water source was sampled and evaluated for water quality					
1.5 The irrigation system was designed to deliver the quantity of water required for the crop and accommodate for variation in topography as well as in soil texture that affects water percolation and water holding capacity					
Irrigation Scheduling & Rates					
2.1 I measure and record the total amount of water used in each field every season and calculate water use per unit of crop production.					
2.2 I have a written water management plan for my field(s) that includes goals for the growing season and takes into consideration annual rainfall, crop variety, crop maturity, water-related pest management issues, soil type, soil preparation, slope, water quality, irrigation efficiency, irrigation uniformity, energy efficiency					
2.3 Irrigation is initiated at the start of the season based on visual cues from the crop					

2.4 Irrigation is initiated at the start of the season based on measured soil moisture depletion					
2.5 Irrigation is initiated at the start of the season based on directly measuring plant moisture stress (e.g. with pressure bomb)					
2.6 Irrigation scheduling is influenced by peak energy pricing					
2.7 Water percolation rate and infiltration depth is monitored during the irrigation season					
2.8 Soil moisture depletion is estimated by visual inspection of the crop (e.g. growth or development) that indicates plant water stress					
2.9 Soil moisture depletion is tracked through soil coring					
2.10 Soil moisture depletion is tracked using soil-installed moisture monitoring devices					
2.11 Soil moisture depletion is tracked by directly measuring plant moisture stress (e.g. with a pressure bomb)					
2.12 Amount of irrigation and timing are dictated by the amount and timing of water available through my Water District					
2.13 Amount of irrigation and timing are based on visual cues of the crop					
2.14 Amount of irrigation is and timing are based on irrigation history from past growing seasons					
2.15 Amount of irrigation and timing are based on historical crop evapotranspiration (ET)					
2.16 Water demand of the crop is estimated by determining ETo[31] through using data from the nearest CIMIS weather station and used in irrigation rate and scheduling					
2.17 Water demand from the crop is estimated by converting ETo to Etc by using the appropriate crop coefficient factor (Kc) which takes into account crop canopy and used in irritation rate and scheduling					
2.18 When appropriate less than full water demand is applied to the crop (deficit irrigation)					
Irrigation Performance and System Maintenance – Pumps & Filters					
3.1 Pumping plant efficiency has been measured within at least the last 3 years (for areas where water table fluctuates considerably pumping plant efficiency should be checked at least once very 2 years)					
3.2 Pumping plant efficiency has been measured within at least the last 5 years					
3.3 Energy use for irrigation is tracked on an annual basis and related to unit of production					
3.4 Electrical irrigation pumps are on time of use metering					
3.5 If pumping efficiency is significantly reduced I have improved it					
3.6 Diesel irrigation pumps are Tier 2 or higher					

[31] ETo is the reference evapotranspiration and is calculated using measurements of climatic variables including solar radiation, humidity, temperature and wind speed and is expressed in inches or millimeters of water. It is based on water use for a short mowed full coverage grass crop.

3.7 A flow meter is installed on wells and/or pumps and I monitor and record the flows					
3.8 Pressure check points are installed on key lines from pumps					
3.9 Filters status (and flushing system) is manually checked at least twice a season and corrected if necessary					
3.10 Pressure gauges are installed for measuring pressure drops through filters					
Irrigation Performance & System Maintenance – Drip & Micro-sprinklers					
4.1 Distribution uniformity of the irrigation system is tested at least every 2 years					
4.2 The system has pressure compensating emitters to help maintain system distribution uniformity					
4.3 The irrigation system is monitored for leaks, breaks, and clogging every irrigation					
4.4 The irrigation system is monitored for leaks, breaks, and clogging at least once a season					
4.5 Fertigation is used to apply most of the fertilizers for the field					
4.6 An interlock system is installed so injection pump shuts down if irrigation pump shuts down to prevent water source contamination					
4.7 Irrigation lines are flushed at the start of the season and then again at mid season, or more often as needed					
4.8 The irrigation uniformity of existing drip irrigation systems is improved by:					
a. For lateral hoses, using lengths that ensure uniformity					
b. Making sure that the drip tape has a small emitter discharge exponent to reduce flow variations that result from pressure differences					
c. Using filters, chemical treatments, and flushing as needed to prevent or correct clogging problems					
d. Utilizing the services of a mobile irrigation lab					
Irrigation Performance & System Maintenance – Sprinklers					
5.1 The irrigation system is monitored for leaks, breaks, and clogging every irrigation					
5.2 The irrigation system is monitored for leaks, breaks, and clogging at least once a season					
5.3 Sprinkler head rotation and nozzle clogging have been checked within the last 12 months and repaired if necessary					
5.4 Sprinkler head rotation and nozzle clogging are checked at least every other irrigation and repaired if necessary					
5.5 Sprinkler heads have been checked for wear in the past 5 years and replaced with the correct nozzle size if necessary to maintain distribution uniformity					
5.6 Fertigation is used to apply most of the fertilizers for the field					

5.7 An interlock system is installed so injection pump shuts down if irrigation pump shuts down to prevent water source contamination					
5.8 The irrigation uniformity of existing sprinkler systems is maintained by:					
a. Monitoring flows and pressure variations throughout the system to detect non-uniform application					
b. Maintaining the irrigation system by repairing leaks, replacing malfunctioning sprinklers, and maintaining adequate water pressure through the entire set					
c. Operating sprinklers during the least windy periods whenever possible. When applying sprinkler irrigation under windy conditions, the spacing between laterals is reduced if possible to optimize application uniformity					
d. Using offset lateral moves on successive irrigations to improve distribution uniformity					
e. Using flow-control nozzles when the pressure variation is too great throughout the system					
f. Making set times as short as possible during establishment to reduce runoff and erosion					
g. Considering irrigating smaller sub-blocks individually for very large blocks					
h. Utilizing the services of a mobile irrigation lab.					
Irrigation Performance & System Maintenance – Flood & Furrow					
6.1 The field was laser leveled before planting the crop					
6.2 Levee locations in the field are based on observed infiltration rates (i.e. each check is appropriately sized for maximum water application uniformity)					
6.3 Irrigation produces no tail-water					
6.4 Irrigation produces tail-water and a tail-water recovery system is in place					
6.5 Flow meters are installed and flow volumes recorded on lines from pumps or in supply pipelines or ditches (e.g. Weir notch or Parshall flume) or a record of flow volumes is provided by the water district					
Water quality – Source and resource					
7.1 Irrigation water is tested at least every 3 years for quality, including pH, total salt, nitrates, and biological problems. The quality of water in distribution reservoirs is tested if they are present on the farm.					
7.2 Nitrate and salt contamination of groundwater in existing wells is determined and the potential for transport of soluble contaminants such as nitrates and salts downward to the groundwater and laterally to surface waters is assessed[vii]					
7.3 I have developed and implemented a system for keeping long-term records on each field for water and nutrient/soil amendment inputs, cultural operations, pest problems, land leveling or other					

improvements, and crop yield and quality.					
7.4 If a water quality problem exists, it is addressed.					
7.5 I have accessed resource maps to determine if my field(s) are in Ground Water Protection Areas (GWPA)[32]					
7.6 If a field is in a GWPA I have accessed and read the legal requirements for handling restricted use pesticides in GWPA areas and they are on file in the office					
7.7 I have identified and mapped areas on the farm that are potential sites for pesticides and fertilizers to enter the ground water					
7.8 The wellhead is situated so no surface water can reach it or a berm has been placed around the wellhead that prevents surface water from reaching it					
7.9 Return water wells, older wells and abandoned wells are sealed to prevent ground water contamination					
7.10 Irrigation practices create no off-site movement of chemical residues and sediments					
7.11 If storm water run-off occurs one or more of the following mitigation practices are implemented: filter fabric fencing; filter strip; straw bale check dam; straw bale water bars; sediment basin; or other containment system					
7.12 Cover crops/vegetation is maintained on drain ditches and non-paved minor roadways to minimize rainfall run-off from field					
7.13 Soil percolation problems in the field have been addressed to minimize off-site movement of irrigation or storm water					

[i] Fennimore, Steven & Ajwa, Husein (2011). *Totally impermeable film retains fumigants, allowing lower application rates in strawberry*, http://californiaagriculture.ucanr.org/landingpage.cfm?article=ca.E.v065n04p211&fulltext=yes.
[ii] California Strawberry Commission Food Safety Program, http://www.calstrawberry.com/members/QAandFS.asp.
[iii] California Strawberry Commission Food Safety Program, http://www.calstrawberry.com/members/QAandFS.asp.
[iv] *Id.*
[v] http://www.calstrawberry.com/fileData/docs/Best_Handling_Practices_For_Fresh_Strawberries.pdf
[vi] California Strawberry Commission Food Safety Program, http://www.calstrawberry.com/members/QAandFS.asp.
[vii] Ferruzzi, Giulio (2004). *Nutrient Management Goals and Management Practices for Strawberries*, UC Division of Agriculture and Natural Resources, http://anrcatalog.ucdavis.edu/pdf/8123.pdf.

[32] http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpamaps.htm

SUSTAINABILITY GUIDE AND SELF-ASSESSMENT

FOR FRUIT AND VEGETABLE PRODUCTION

United Fresh Foundation

CENTER FOR GLOBAL PRODUCE SUSTAINABILITY

BACKGROUND

This *Sustainability Guide and Self-Assessment for Fruit and Vegetable Production* has been developed by the United Fresh Produce Association Foundation's Center for Global Produce Sustainability. The Center was established in 2009 within the United Fresh Foundation through a grant from Bayer CropScience, which has enabled the Foundation to address these important issues for both growers and partners throughout the produce supply chain.

This *Sustainability Guide and Self-Assessment* is intended to assist producers and partners in understanding four key areas of sustainability – Stewardship of Resources; Environmental Impacts; Social Accountability; and Economic Success/Viability. For fruit and vegetable producers, we believe these four areas define the most important aspects of sustainability in our industry and reflect areas where active management can enhance sustainability and cost control.

The *Sustainability Guide and Self-Assessment* also provides a means for producers to share their story about practices and processes that many already incorporate in their operations. Completing this self-assessment will allow producers to develop concrete information that they can use in their own business, or choose to share with others to explain their commitment to sustainable practices. This document is not an audit, nor is it meant to become a requirement. Rather, it is a tool that can be used to increase knowledge, track progress, and tell the story of our industry's commitment to sustainability.

The *Sustainability Guide and Self-Assessment* is designed to combine a practiced-based analysis of major steps producers take in enhancing sustainability, with key outcome-based information (i.e. metrics), where appropriate. The metrics portion of the tool highlights specific outcome measurements that producers can use to track results over time. This format allows producers to record their current practices in sustainability, consider plans for adopting new practices, and provides a tracking tool for their reference to assess changes over time. Most importantly, it is intended to be an educational tool for those wanting to know more about what practices enhance sustainability.

The format of this document also provides an easy means for producers to share information about their sustainability practices, if desired, with other stakeholders through the supply chain. This self-assessment has been shared with companies that buy produce to obtain their feedback. Both the practice-based and metrics portions of the Sustainability Assessment Tool are conducive to aggregating responses and creating either a written or online summary. This information may be of interest for those who wish to compare their own operations with their peer group.

ACKNOWLEDGEMENTS

United Fresh Produce Association and the United Fresh Research & Education Foundation wish to acknowledge the contributions of the volunteer leaders of the Center for Global Produce Sustainability Advisory Board (SAB) for their efforts in deliberating the issues and content of this *Sustainability Guide and Self-Assessment for Fruit and Vegetable Production*. Over the course of two years, the SAB met to outline the contents of this document and worked diligently to consolidate the ideas into a useful document that helps the entire produce supply chain define the key elements of sustainability for fruit and vegetable production. Special thanks go to SAB Chair Nikki Rodoni of Gills Onion and Rio Farms, and Burleson Smith, United Vice President of Environmental Affairs and Sustainability, who served as primary editor of the document.

This document is based on extensive agricultural research, extension, industry and multi-stakeholder efforts in developing and implementing agricultural best practices and, more recently, sustainability performance metrics. From 1990 to 2010, a number of projects that included growers in the design of farm stewardship practices assessment tools emerged in a wide range of crops including corn and soy (Harp et al., 1996), almonds (Dlott et al., 1996), potatoes (Lynch & Benbrook 1998; Sexson & Connell 2004;), winegrapes (Ohmart & Matthiasson 2000, Dlott et al., 2002) and other crops. More recently, several initiatives have focused on developing sustainability metrics including the Stewardship Index for Specialty Crops[1] and Field to Market (2012). At least two trade association-led programs, the California Sustainable Winegrowing Alliance[2] and California Almond Sustainability Program[3], have integrated sustainability best practices and metrics into their initiatives.

Lastly, United Fresh wishes to acknowledge the following contributions: Clarkston Consulting, FoodLogiQ, McEntire Produce, and McDonald's Corporation for assistance with the drafting and development of this document; SureHarvest for the assessment categories adapted with permission from its work with the Almond Board of California (Sonke et al., 2010) and a Multi-Commodity Sustainability Assessment Program funded by California Department of Food and Agriculture (CDFA) Specialty Crops Block Grants[4] (Ohmart 2012); introductory text for several sections adapted from the Multi-Commodity Self-Assessment Template (Ohmart 2012); and, the following members of the Center for Global Produce Sustainability Advisory Board for their efforts in reviewing and commenting on this *Guide and Self-Assessment*.

MEMBERS OF THE CENTER FOR GLOBAL PRODUCE SUSTAINABILITY ADVISORY BOARD | 2011-2012

[1] See *www.stewardshipindex.org*
[2] See *www.sustainablewinegrowing.org*
[3] See *www.almondboard.com/Growers/Sustainability/Pages/Default.aspx*
[4] California Department of Food and Agriculture Specialty Crops Block Grant #10004, Multi-Commodity Sustainability Program: Assessment and Implementation.

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FORMAT OF THE TOOL AND HOW IT WORKS

The *Sustainability Assessment Tool* is comprised of four sections intended to reflect the key management areas of a fruit and vegetable production operation. One of the challenges of many sustainability initiatives to date has been trying to capture or measure every possible aspect of sustainability. This approach attempts to define those that have the most impact and importance for a fruit and vegetable producer.

A. Economic Success/Viability – Company Business Strength and Viability

B. Stewardship of Resources – Including Land Selection, Planting, Irrigation, Fertilization, Soil Preparation, Pest Management, Crop Protectants, Container Recycling, Product Safety and Soil Conservation

C. Environmental Impact – Including Energy, Effluent, Water, Material Waste and Biodiversity

D. Social Accountability – Including Community, Workers and Training

PART I: Practice-Based Assessment

The practice-based assessment consists of a series of Yes/No and multiple choice items, providing a simple format to allow the user to assess the integration of key practices into their growing operation. The questions asked and data recorded can give the producer a sense of where they fit in the sustainability continuum. If desired, producers could share this data to be aggregated across operations in order to provide industry benchmarks and an indication of changes over time.

In addition to the Yes/No questions, a series of check boxes and open comment fields provide the opportunity for a producer to flag specific items that are not applicable to the operation, may be considered in the future, or for personal comments and notes regarding different practices.

PART II: Metrics-Based Assessment

The metrics-based assessment provides a list of specific outcome-based information to be recorded. These include the major sustainability metrics of annual energy use, water use, greenhouse gas emissions and community investment, which are intended to be measured on a whole-farm basis. These outcome-based items were chosen because of their importance in documenting resource management, environmental impact and social accountability, but also because the information should be readily available to producers from existing sources of data to facilitate easy measurement. Another purpose for metrics is to help producers measure their own performance in order to make improvements over time.

INSTRUCTIONS

Part I

As you complete the following items in the self-assessment, answer “Yes” if you are currently using a practice in your operation. If you are not using the practice, answer “No”. If the practice does not apply to your operation, mark “Not Applicable” and then provide a comment to indicate why. If you are not using the practice but believe it might be useful, mark “Consider trying” and then mark a target date in the Comments section for when you want to implement the practice. If you have tried a practice but found that it was not useful, practical, or applicable, then mark “Have tried but stopped” and add the reason in the Comments section. If the practice is not familiar, or you need to look into it before knowing whether to implement it, mark “Not familiar”.

At a future date, go back to the Self-Assessment and review the items that you flagged under “Consider trying” and “Not familiar”. Have you started using the practice? Have you obtained more information and determined whether you are prepared to start implementing a practice? Revise your answers as needed and mark the date that you have made the change. Remember, this is your tool. Writing down your perspectives in the Comments section and periodically revisiting this document will help you speak effectively about sustainability in your operations, with employees and other stakeholders.

Part II

For the outcome-based items, it will be necessary to obtain your fertilizer, electricity, gas and fuel invoices in order to record the amount of nitrogen fertilizer and energy used during the year for the whole farm. Records for water usage should also be collected. These should be readily available documents, and when aggregated through this process, will give you a good overview of both sustainability measures and costs in your operation

In the social accountability section, you’ll want to tell the story about how you support your community. Here, identify the number of hours that have been donated to support the community; identify in-kind contributions; and record the charitable contributions that have been made. You’ll likely be surprised at the many different forms of community support you provide, and this merging of information will aid in identifying the best story to share with others.

ECONOMIC SUCCESS AND VIABILITY

ECONOMIC SUCCESS

Without economic success, a farming operation is not profitable and it is not sustainable. Profits returned to the business allow the operation to invest in new equipment, innovate new products, and provide the flexibility and resilience to overcome unexpected events including: changes in market demands and prices; bad weather; severe pest outbreaks; transportation interruptions; and, a myriad of other business risks that challenge the best managers. This section is included to help producers document important steps they are taking to proactively manage their business and maintain profitability over the long-term.

ECONOMIC VIABILITY

Everyone in business understands that economic viability is a key component of sustainability. The Economic category is designed to define the operational activities that are in place to maintain or optimize the economic viability of your business and consists of a multiple choice item and a series of Yes/No items to describe, in general terms, the economic viability of your operation.

		Yes/No Or Multiple Choice	Not Applicable	Consider trying	Have tried but stopped	Not familiar	Comments
1	The operation has a long-term business plan in place, which is periodically evaluated and updated in response to changes in economic, marketplace, technology, or other conditions affecting its profitability.	o Yes o No					
2	The operation periodically evaluates its business practices or processes and is investing in new technologies to improve upon efficiencies of the business in the following areas (as applicable, check all that apply): a. Water efficiencies b. Labor efficiencies c. Fuel/Electricity efficiencies d. Equipment efficiencies e. Crop nutrient efficiencies f. Other (please describe) ________________	o a o b o c o d o e o f					

3	The operation has a system in place to evaluate current business practices or processes in order to increase efficiencies and/or reduce operational or per unit costs.	o Yes o No					
4	The business plan anticipates an economic return on operations sufficient to fund capital improvements over time.	o Yes o No					
5	Operation has the financial ability to remain a viable competitor in the marketplace.	o Yes o No					
6	Operation uses an electronic data management program to manage finances.	o Yes o No					
7	Management has a documented operational succession plan in place.	o Yes o No					
8	Management periodically evaluates risk management tools, including various forms of insurance, to determine if coverage is available and economical to cover various business risks.	o Yes o No					

STEWARDSHIP OF RESOURCES

STEWARDSHIP OF RESOURCES

Producers use and manage many resources in growing a crop. When purchasing inputs, a firm is more likely to actively manage these resources than other factors that are not directly purchased but may have a financial or environmental impact on the operation, such as soil conditions. The Stewardship of Resources category consists of a series of Yes/No and multiple choice items to help describe your operation's stewardship efforts while actively managing its land, water, nutrient and pest management inputs.

GENERAL STEWARDSHIP

The Stewardship category begins with a series of general questions and fundamental topics pertaining to land selection and management.

GOOD AGRICULTURAL PRACTICES (GAP): *The GAP subcategory addresses the foundational characteristics of your growing operation.*		Yes/No Or Multiple Choice	Not Applicable	Consider trying	Have tried but stopped	Not familiar	Comments
9	A written food safety plan is in place and has been considered in the development of the agricultural sustainability program.	o Yes o No					
10	The operation is audited against industry-recognized GAP standards.	o Yes o No					
11	The GAP audit is performed and documented by a qualified third-party.	o Yes o No					

LAND SELECTION: *The Land Selection subcategory describes the practices used in the development of your operation and documents that the land has not been used in a way that could pose chemical, physical, or microbiological risk to the crops grown in the field.*

12	A documented land use history verifies that the land has not been used in a way that could pose chemical, physical, or microbiological risk to the crops grown in the field.	o Yes o No					
13	A program is in place to monitor the possibility of foreign material contamination (e.g., birds, rodents, amphibians, insects, rabbits, slugs, plastic, paper, glass, metal, etc.) in all fields, buffer zones, equipment yards and storage areas.	o Yes o No					
14	A pre-planting assessment was performed identifying risks associated with but not limited to storage of non-synthetic soil amendments.	o Yes o No					
15	Written or electronic records of the pre-planting assessment in Item 14 are maintained.	o Yes o No					
16	Field selection and rotation plans include geographic distribution to minimize crop damage risk due to weather, insects, and disease.	o Yes o No					

PLANTING: *The Planting subcategory describes the agricultural practices employed in the preparation and planting of crops on your farm.*

17	Crop rotation scheduling places higher water demand crops on heavier ground to maximize available soil moisture.	o Yes o No					
18	Planting equipment is serviced and adjusted prior to planting to optimize placement and rate of seed/transplants, fertilizer, and other chemicals.	o Yes o No					
19	Planting depth is chosen according to regional and variety needs, and seed/transplants spacing and depth are assessed intermittently by uncovering a portion of the planted row.	o Yes o No					
20	Written or electronic records of planting, cultivation, and harvest dates are kept (3+ years).	o Yes o No					
21	Cultivation and planting are done under good soil moisture conditions, to avoid soil compaction that may result in restriction to root growth, excessive clods at harvest or conditions that favor disease development.	o Yes o No					
22	Technologies for precision agriculture, including self-centering equipment, GPS navigation or laser leveling are used when listing, shaping or preparing the planting bed.	o Yes o No					
23	Bed shape and size are optimized for the variety, region, soil type, and irrigation needs.	o Yes o No					

IRRIGATION

Proper management of irrigation water is critical to maintain optimal crop growth while avoiding the loss of water below the root zone. Although excess water may be captured as runoff or used as groundwater by pumping, overwatering can cause a loss of nutrients from the field to the environment. Water placement and timing are important and differ by crop needs, precipitation patterns, soil conditions, irrigation regime and preceding cropping history. University or published research results will often provide good guidance, but sustainable operations should evaluate and fine-tune such information with on-farm measurement of crop water conditions.

IRRIGATION: *The Irrigation subcategory describes the water management practices employed on your farm.*

24	Is irrigation used on the crop? If NO, then do not answer items 25 through 35.	o Yes o No					

25	Written or electronic records are kept of the amount of water used for irrigation of each field.	o Yes o No					
26	The operation is aware of all applicable laws and regulations to ensure that water is obtained legally.	o Yes o No					
27	Irrigation systems are calibrated prior to use on the crop.	o Yes o No					
28	Irrigation is scheduled using a soil probe / hand feel method or other instruments.	o Yes o No					
29	Irrigation is scheduled according to crop water use and soil-water-holding capacity.	o Yes o No					
30	Irrigation is scheduled using an evapotranspiration (ET) model.	o Yes o No					
31	Irrigation pump efficiency is evaluated every: a. 11 or more years b. 8-10 years c. 5-7 years d. 2-4 years e. 1 year	o a o b o c o d o e					
32	Well improvements are made based on the well efficiency test results.	o Yes o No					
33	Pump motors are selected and used to maximize well efficiency.	o Yes o No					
34	Irrigation system is engineered and/or calibrated to optimize efficiency.	o Yes o No					
35	For annual crops, sprinkler and drip are the predominate types of irrigation after thinning/weeding.	o Yes o No					

FERTILIZATION	Proper management of nutrients is critical to provide nutrition for optimal crop growth while avoiding excess nutrients which may be lost to the environment. Placement, timing and form (type) of nutrient are all important and differ by crop needs, soil conditions, irrigation regime and preceding cropping history. University or published research results will often provide good guidance, but sustainable operations should evaluate and fine-tune such information with on-farm trials.

FERTILIZATION: *The Fertilization subcategory describes the nutrient management practices employed on your farm.*

36	Sampling frequency, sampling method, and analysis are performed as per recognized regional needs (e.g., CCA, Cooperative Extension recommendations) and used for fertility management of N-P-K and pH adjustments if necessary.	o Yes o No					
37	In-season crop nutrition sampling is performed (e.g., petiole or soil testing) where appropriate according to regional needs such as long seasons, sandy soil, and irrigation practice.	o Yes o No					
38	On whole farm, soil sampling is done using grid or zone sampling methodology to identify field variability and analysis used to adjust fertility management.	o Yes o No					
39	Soil pH is tested and maintained within optimum range for the growing area.	o Yes o No					
40	Written or electronic fertilizer records are maintained as per state and federal regulations or for at least three (3) years.	o Yes o No					
41	Weather forecast is a consideration prior to nutrient application to prevent off-target movement.	o Yes o No					
42	Phosphorus is placed in sidebands or the root zone (in furrow) where necessary to avoid off-site pollution.	o Yes o No					
43	Multiple (split) fertilizer applications are used to apply recommended nutrient levels according to soil test.	o Yes o No					
44	Precision fertilization is practiced on the farm. This may include fertigation and real-time monitoring of nutrients using soil probes or sensors.	o Yes o No					

45	Soil amendments are applied at appropriate times and manner to prevent nutrient loss and contamination of ground and surface water.	o Yes o No					
46	Nitrogen-fixing cover crops are included in the planting rotation as a partial alternative to synthetic fertilizer (e.g. nitrogen-fixing crops) on at least 50% of the crop prior to planting.	o Yes o No					
47	On high-porosity soils with low water-holding capacity, multiple nitrogen applications or slow release fertilizers are used.	o Yes o No					

SOIL MANAGEMENT AND CONSERVATION

Understanding the soil in your fields is important for making informed soil management decisions. Knowing your soil resource gives you greater control over yield and crop quality and is important in determining the long-term sustainability of your farm.

The amount of soil organic matter is important as it plays a role in maintaining soil structure by binding soil minerals together into aggregates, while also providing nutrients when it is broken down (i.e. mineralized). Healthy soil microbial activity is often related to higher levels of soil organic matter, where microbes and macroscopic soil fauna (e.g. earthworms) use organic matter as a food source and release materials that aid in the development of stable soil aggregates. The balance between organic matter build-up and breakdown is controlled by many factors including: soil temperature, tillage and aeration, moisture status, plant growth/residue management, and additions of manure or compost.

SOIL PREPARATION: *The Soil Preparation subcategory describes soil management practices employed on your farm which may affect soil health, compaction or other soil properties.*

48	For annual crops, written or electronic soil test records are maintained for at least three (3) years.	o Yes o No					
49	For perennial crops, soil test records are maintained from crop establishment and monitored regularly to account for the growth stage and bearing status of the crop.	o Yes o No					
50	Soil compaction in tilled areas is avoided or minimized by at least one of the following: flotation tires, tracks, avoiding traffic when soils are wet, GPS tracking, etc.	o Yes o No					
51	When applicable, existing compaction is reduced by cultural practices, e.g., deep ripping or deep-rooted cover crops.	o Yes o No					

52	Advanced soil testing is done to monitor soil health (e.g., one or more of the following: potentially mineralizable nitrogen, soil biological activity/respiration, earthworm populations, etc.).	o Yes o No					

SOIL CONSERVATION: *The Soil Conservation subcategory describes the soil management practices employed on your farm to minimize erosion and water collection problems.*

53	Structural changes to the land, such as terraces, waterways, and tile drainage are done to reduce erosion or water collection problems.	o Yes o No					
54	Written or electronic documents indicate that soil health (organic matter content, soil biological activity, etc.) is optimized.	o Yes o No					
55	A plan addressing soil health is in place. This plan at minimum addresses soil structure improvement over time, increased soil microbiological activity and soil organic matter, resolution of salinity issues and stabilization of soil pH.	o Yes o No					
56	The operation has implemented a written or electronic whole-farm soil and water conservation plan.	o Yes o No					

PEST MANAGEMENT (IPM)

Integrated pest management (IPM) is a fundamental part of the management of weeds, insects and plant diseases in any sustainable farming system. It was developed in the 1950s and 60s to respond to significant challenges that emerged, such as the development of pesticide resistance, secondary pest outbreaks, and environmental contamination. At its most basic level, the practice of IPM uses a combination of control techniques to manage pests, including cultural, chemical and biological approaches. A broad-based strategy is more likely to be successful over time instead of relying on only one management technique. It also has the potential of extending the use of important pest control tools by deploying control strategies towards multiple stages of the pest's lifecycle.

In states that require the use of a qualified advisor for pest control decisions, ensure that state and local requirements are followed. Producer access to these pest management records maintained by a third-party applicator or pest advisor qualifies as such records being maintained in written or electronic form as long as they can be retrieved for three (3) or more years.

PEST AND DISEASE MANAGEMENT: *The Pest Management subcategory describes integrated pest management practices employed on your farm.*

57	The farm manager or crop advisor is aware of emerging pest problems in the region.	o Yes o No					
58	The farm manager or crop advisor understands the life cycle of major pests.	o Yes o No					
59	The farm manager or crop advisor can identify major pests.	o Yes o No					
60	The farm manager or crop advisor can identify beneficial insects, such as natural predators of crop insect pests.	o Yes o No					
61	Written or electronic records are kept of pest populations including results of scouting and control practices.	o Yes o No					
62	Overall crop health status is documented including success of pest and disease management programs.	o Yes o No					
63	Pest scouting is performed and documented extensively in set patterns throughout the whole crop.	o Yes o No					
64	Pest scouting is performed and documented for high risk areas in the field, such as wind breaks, migration points, or conducive microclimates.	o Yes o No					
65	Crop protectant application timing is based on action threshold levels, such as for aphids, thrips, leafminers, leafhoppers, etc.	o Yes o No					
66	Crop protectant application timing is selected to reduce risk of injury to beneficial insects.	o Yes o No					
67	Non-chemical method(s) have been identified to control or suppress pests and diseases have been tested on the crop.	o Yes o No					
68	Insects and/or diseases are partially controlled through chemical treatment of alternate hosts or sites, including field edges within your control.	o Yes o No					
69	Insects and/or diseases are partially controlled through cultural treatment of alternate hosts or sites, including field edges within	o Yes o No					

	your control.						
70	Non-chemical method(s) are used to control or suppress identified pests and diseases.	o Yes o No					
71	Non-chemical methods are used to control or suppress identified pests and diseases for ____ of the crop acres: a. Non-chemical methods are not used b. up to 25% c. 26 to 50% d. 51 to 75% e. over 75%	o a o b o c o d o e					
72	Weed seed sources on field edges are controlled through mechanical methods.	o Yes o No					
73	Mechanical equipment is cleaned when moved from fields with perennial weed problems.	o Yes o No					
74	In rotational crops, indexed or cleaned seed is used to minimize weeds.	o Yes o No					
75	Pests that are difficult to control in the current crop are partially controlled in rotation crops.	o Yes o No					
76	Predatory or parasitic beneficial insects are released on the farm.	o Yes o No					
77	Fields are assessed for virus infection levels.	o Yes o No					
78	Insect vectors responsible for virus transmission, such as aphids, are monitored until end of season.	o Yes o No					
79	Pest populations are monitored when bringing new non-cultivated area into production.	o Yes o No					

80	Farm manager participates on industry committees responsible for introduction of new varieties that offer potential benefits, such as fewer inputs, or is an early adopter of new varieties that offer potential benefits.	o Yes o No					
81	Farm is a participating site for testing of new crop varieties that offer potential benefits (i.e. fewer inputs).	o Yes o No					
82	Farm participates in regional insect and disease scouting programs or provides own written or electronic scouting results for information sharing.	o Yes o No					

CROP PROTECTANTS: *The Crop Protectant subcategory describes management and use of crop protectants in your farming operation.*

83	Crop protectants are used according to label directions including but not limited to rate, timing, soil type, and use precautions.	o Yes o No					
84	Crop protectants are evaluated and selected not only for efficacy, but also according to reduced-risk properties taking into account proximity to aquatic and avian habitat.	o Yes o No					
85	Crop protectants are selected to reduce development of pest resistance.	o Yes o No					
86	Crop protectant decisions regarding pest/disease are based on pest/disease monitoring or valid historical data.	o Yes o No					
87	Pre-plant crop protectant use decisions are based on historical pest records and regional information.	o Yes o No					
88	Written or electronic records of historical pest infestation levels and regional information used to make pre-plant crop protectant use decisions in Item 87 are maintained.	o Yes o No					
89	Post-emergence crop protectant use decisions are based on pest scouting reports, threshold levels, and/or crop stage.	o Yes o No					
90	Written or electronic records of pest scouting, threshold levels, and/or crop stage used in making post-emergence crop	o Yes o No					

	protectant use decisions in Item 89 are maintained.						
91	A written or electronic plan to optimize crop protectant use for ____ of the acres using targeted application methods (banded or spot sprays), mechanical tillage, or other non-chemical methods is in place: a. I have no written or electronic plan in place b. less than 25% c. 25-50% d. 51-75% e. more than 75%	o a o b o c o d o e					
92	Crop protectant equipment is serviced and calibrated before start of growing season, and when parts are replaced or carrier rate is changed.	o Yes o No					
93	Written or electronic documents indicate that crop protectant equipment is serviced and calibrated before start of growing season, and when parts are replaced or carrier rate is changed.	o Yes o No					
94	Written or electronic field sprayer calibration records are maintained.	o Yes o No					
95	All written or electronic crop protectant records are maintained (minimum 3 years, or longer if required by law).	o Yes o No					
96	Written or electronic weather records at the time of all chemical applications are maintained.	o Yes o No					
97	Spray application is conducted according to regional recommendations or regulations to minimize drift.	o Yes o No					
98	Spray pressure and nozzle selection are adjusted to minimize spray drift.	o Yes o No					

CONTAINER RECYCLING: *The Container Recycling subcategory describes the disposal of crop protectant containers used on your farm.*

99	Empty crop protectant containers are triple rinsed with rinse added to tank mixture.	o Yes o No					
100	Empty containers are disposed of according to federal, state or local requirements.	o Yes o No					
101	Empty containers are returned to an approved collection site for recycling.	o Yes o No					
CHEMICAL SAFETY AND TRAINING: *The Chemical Safety and Training subcategory describes the safety practices used in the application and handling of crop protectants on your farm.*							
102	Crop protectant applicator(s) has taken a crop protectant safety course and if required has achieved applicator certification.	o Yes o No					
103	Crop protectant applicator(s) participates in continuing education for updates on regulations through refresher courses.	o Yes o No					
104	A member of farm management has taken a crop protectant safety course and stays current with crop protectant regulations.	o Yes o No					
105	Written or electronic documents indicate that a member of farm management has taken a crop protectant safety course and stays current with crop protectant regulations.	o Yes o No					
106	The farm is used as a community educational site for crop protectant applicator training, worker training, or public awareness event.	o Yes o No					
107	Farm Manager or other farm personnel participate in demonstrations for crop protectant practices and/or training.	o Yes o No					
108	Written or electronic documents indicate that the Farm Manager or other farm personnel participate in demonstrations for crop protectant practices and/or training.	o Yes o No					
109	The farm is compliant with applicable (government) Worker Protection Standards.	o Yes o No					

110	Personal Protective Equipment (PPE) is in good repair and used by workers.	o Yes o No					
111	Crop protectants are properly stored to maintain product integrity, security, and prevent site contamination.	o Yes o No					
112	Company personnel or contracted personnel applying non-regulated materials have been trained on its proper use.	o Yes o No					
113	Crop protectant safety information forms (MSDS) are accessible to applicators and farm workers.	o Yes o No					
114	Obsolete crop protectants are disposed of properly according to regulations and guidelines.	o Yes o No					
115	Spill containment material, first aid kit, and clean water are readily available at mixing and application sites.	o Yes o No					
116	Crop protectant mixing and preparation are conducted away from environmentally sensitive areas, such as well heads and water bodies, in a manner to prevent site contamination.	o Yes o No					

ENVIRONMENTAL IMPACT

ENVIRONMENTAL IMPACT

A firm's commitment to protecting the environment is important to maintaining the long-term productivity of a sustainable operation. At the farming level, offsite movement of nutrients, crop protectants, or fuel can have impacts on the surrounding air, water, land and wildlife. Reducing the waste generated by an operation reduces the amount of material moving into landfills and may reduce the cost of disposal. The Environmental Impact category consists of a series of Yes/No and multiple choice items to help describe your operation's efforts to avoid undesirable impacts on the environment.

ENERGY MANAGEMENT & CONSERVATION

Energy use in agricultural production is both a significant cost of production and a directly manageable source of greenhouse gas (GHG) emissions. Tracking energy use allows producers to determine where this costly resource is used and can assist in the development of strategies to reduce fuel use, lower emissions, and reduce costs. Completing this section should help improve your understanding of energy use in your operation and encourage you to consider some forms of energy conservation.

ENERGY: *The Energy subcategory describes plans and practices in use on your farm to optimize the use of both direct and indirect energy. Examples of direct energy include gasoline, diesel, electricity, and natural gas while indirect energy is that embedded within fertilizers during manufacturing.*		Yes/No Or Multiple Choice	Not Applicable	Consider trying	Have tried but stopped	Not familiar	Comments
117	Energy use on the farm is monitored and documented.	o Yes o No					
118	A written or electronic plan is in place to optimize energy requirements per unit of production over the next 5 years by: a. I have no written or electronic plan in place b. 1-5% c. 6-10% d. 11-15% e. over 15%	o a o b o c o d o e					
119	When purchased, tractors and implements are selected to minimize fuel consumption.	o Yes o No					
120	Tractors and implements match the size and scope of farm acreage and lot size.	o Yes o No					
121	Written or electronic tractor maintenance programs include practices such as cleaning and/or replacing air filters regularly are conducted to maximize fuel efficiency.	o Yes o No					
122	When purchased, older tractors are being replaced with newer more fuel-efficient tractors.	o Yes o No					

EMISSIONS: *The Emissions subcategory describes the practices in place to reduce the amount of greenhouse gas emissions per unit of production resulting from the use of both direct (e.g. fuel use) and indirect (e.g. fertilizer) energy sources used in your operation.*

123	A written or electronic plan is in place to describe the steps you are taking to reduce indirect energy consumption, such as fertilizer and crop protection inputs, through the use of advanced Integrated Pest Management and Precision Agriculture techniques.	o Yes o No					
124	Written or electronic recommendations for application of fertilizers (organic or inorganic) are based on advice provided by qualified advisers.	o Yes o No					
125	All applications of both soil and foliar fertilizers have been recorded by fertilizer type, application rate, method of application and operator.	o Yes o No					
126	Farm manager recognizes connection between energy use and greenhouse gas emissions.	o Yes o No					
127	Operation has a written or electronic plan in place to reduce greenhouse gas emissions over the next 5 years by: a. I have no written or electronic plan in place b. 1-5% c. 6-10% d. 11-15% e. more than 15%	o a o b o c o d o e					

IRRIGATION AND WATER MANAGEMENT

Water is a critical resource that must be used efficiently and effectively by specialty crop producers. The following questions will help document practices producers are using to achieve optimum water quality and use efficiency, as well as highlight areas where efficiency might be increased.

WATER MANAGEMENT: *The Water subcategory identifies practices in place on your farm to optimize the use of water according to source and irrigation practices.*

128	Water use is based on crop requirements necessary for optimal yield and quality while minimizing detrimental impacts to the environment.	o Yes o No					
129	Written or electronic plans for water use are based on crop requirements necessary for optimal yield and quality while minimizing detrimental impacts to the environment.	o Yes o No					

130	The method of irrigation used is based on optimal water utilization.	o Yes o No					
131	Written or electronic plan documenting water withdrawal sources has been prepared and implemented. The plan defines efforts to mitigate or minimize detrimental impacts on the water source (unless from a municipal water system) and surrounding area.	o Yes o No					
132	A written or electronic risk management plan setting out strategies to minimize all identified risks, such as pollution or water table contamination, has been established and implemented.	o Yes o No					
133	Irrigation is applied using a low volume system (e.g., drip, micro-sprinklers or low-pressure drop nozzles) to deliver water close to the plant root zone to minimize losses due to evaporation for ____ of the crop acreage: a. 0% b. 1-10% c. 11-25% d. 26-50% e. over 50%	o a o b o c o d o e					

MATERIAL MANAGEMENT AND WASTE REDUCTION

Sustainable agriculture provides a strategy for managing all aspects of your farming enterprise, including the management of the crop, soil, water, pests and human resources. It also relates to the farm's infrastructure (including storage) as well such as your offices and shop. It is important to focus on waste management and proper storage of inputs.

MATERIAL WASTE: *The Material Waste subcategory focuses on plans to reduce the amount of material waste going to the landfill.*

134	The operation has a written procurement policy for purchasing products with packaging reduced to the extent practicable, and that utilizes post-consumer recycled paper or other material that reduce the overall impact of waste from the operation.	o Yes o No					

135	A written or electronic plan is in place to reduce the amount of material waste including packaging, drip tape, plastic and other non-crop materials taken to the landfill over the next 5 years by the following percentage: a. I have no written or electronic plan in place b. 1-25% c. 26-50% d. 51-75% e. over 75%	o a o b o c o d o e					

EFFLUENT: *The Effluent subcategory identifies the practices in place on your farm to minimize or prevent the accidental and/or intentional discharge of hazardous waste into surrounding ecosystems. Examples of effluent include nutrient, pesticide, fuel and cleaning agents running off from storage, mixing or loading facilities into waterways.*

136	A written or electronic plan to prevent direct discharge of any hazardous or toxic effluent or waste into surrounding ecosystems is in place.	o Yes o No					
137	A written or electronic plan is in place to prevent the occurrence of accidental discharges.	o Yes o No					

BIODIVERSITY/HABITAT CONSERVATION

Fruit and vegetable growers are faced with a unique challenge of balancing food safety requirements and biodiversity efforts. The food safety requirements set by state and federal regulators, and the requests of their buyers, may be in direct conflict with biodiversity and habitat conservation strategies.

Efforts to limit wildlife access to fields should be balanced with providing habitat for the maintenance of healthy ecosystems outside of production areas. Where such areas do not exist under the control of a producer, the operation can participate in local and regional efforts to promote habitat in stream courses, public lands and other open ground.

BIODIVERSITY: *The Biodiversity subcategory describes the plan(s) in place to optimize biodiversity, as appropriate, on your farm and adjacent property.*

138	A written or electronic farm plan/map for each field used in production has been established.	o Yes o No					

139	A written or electronic assessment for all new agricultural sites and existing sites where risks have changed, with regards to the environment has been prepared.	o Yes o No					
140	A written or electronic wildlife management and conservation plan acknowledging potential impacts of farming activities on the environment has been developed and implemented.	o Yes o No					
141	The existing written or electronic plan is compatible with sustainable agriculture, minimizes environmental impact and enhances the environment to benefit the local community and flora and fauna.	o Yes o No					
142	The written or electronic environmental conservation plan not only avoids damage to habitat but increases biodiversity by enhancing existing habitat.	o Yes o No					
143	Unproductive or marginally productive sites on farm have been/are being converted to conservation areas for the encouragement of natural flora and fauna.	o Yes o No					
144	Initiatives are in place to restore and/or protect habitat.	o Yes o No					
145	Written or electronic plans are in place to restore and/or protect habitat.	o Yes o No					
146	Time and finances are invested in the local community through activities such as habitat restoration, preservation of existing habitat, and/or development of new habitat for indigenous flora and fauna.	o Yes o No					

SOCIAL ACCOUNTABILITY

SOCIAL ACCOUNTABILITY

Social responsibility is an important part of any business operation. A firm's commitment to its employees and community are an important part of a sustainable operation. At the farming level, companies sometimes underestimate their own commitment to their communities, but are increasingly being asked to communicate their role. The Social Accountability category consists of a series of Yes/No and multiple choice items to help describe your operation's support of employees and the community.

COMMUNITY INVESTMENT

Agricultural businesses are the lifeline of many rural communities. These operations provide employment opportunities and contribute to the flow of financial capital into the local economy through wages and benefits provided to employees. They support other local businesses through their purchases, and their employees often live and shop nearby. Supporting local charitable and civic activities is an indication that the business is a 'good neighbor' that will continue to enjoy the support of local governments and the public.

COMMUNITY: *The Community subcategory is designed to highlight the operational activities and practices in place to support and grow the local community.*

		Yes/No Or Multiple Choice	Not Applicable	Consider trying	Have tried but stopped	Not familiar	Comments
147	Operation provides employment opportunities which generate revenue and community growth.	o Yes o No					
148	Operation contributes to the flow of financial capital into the local economy through wages and benefits provided to employees.	o Yes o No					
149	Operation sources the majority of production supplies and services locally, thereby, fueling the local economy.	o Yes o No					
150	Operation has programs and practices in place to promote volunteer initiatives within the community, including support of civic organizations and local and/or national charities.	o Yes o No					
151	Operation has programs and practices in place to improve the overall welfare of the local community.	o Yes o No					
152	Operation makes financial contributions to local and/or national charities.	o Yes o No					

153	Operation provides the opportunity for employees to engage in community service for local and/or national charities or events.	o Yes o No					
154	Operation makes available life skills training and education to employees.	o Yes o No					

EMPLOYEE WELL-BEING Proper compensation, training and recognition of employees are important to their well-being and the success of a company. Safe working conditions and an understanding of job responsibilities are critical to the success and productivity of any worker. Regulatory requirements vary for different operations, so this section offers general guidelines for assessing labor at the producer level.

EMPLOYEES: *The Worker subcategory is designed to identify and highlight the employment policies, practices and opportunities in place within your operation.*

155	Employment policy does not discriminate against any person on the basis of race, color, national origin, disability, or age in admission, treatment, or participation in its programs, services and activities, or in employment.	o Yes o No					
156	A member of management has been designated as responsible for identifying and mitigating risks to workers health, safety and welfare.	o Yes o No					
157	A mechanism is in place for workers to state grievances, make suggestions, or report problems to management without fear of reprisal (e.g. an anonymous suggestion box).	o Yes o No					
158	Worker health and safety is important and a written plan exists that identifies and mitigates the risk for workers health, safety and welfare.	o Yes o No					
159	Operation has a written or electronic code of conduct.	o Yes o No					
160	Workers are legally compensated and provided with wages and benefits that comply with applicable national and local laws.	o Yes o No					
161	Compensation calculations are available to workers in their native language.	o Yes o No					

162	Operation does not employ workers under the legal age of employment for the type of work in the country where the work is performed.	o Yes o No					
163	Workers are provided with a safe working environment, potable drinking water, adequate and clean restrooms, essential safety equipment, and access to emergency medical care.	o Yes o No					
164	Operation has a written employment practices document that is provided to the worker in their native language.	o Yes o No					
165	Operation has a designated member of management responsible for employee practices.	o Yes o No					
166	Operation has written or electronic programs and practices in place to promote healthy lifestyles of employees.	o Yes o No					
167	Operation provides access to health care and/or makes insurance available to their full-time employees.	o Yes o No					
168	Operation tracks lost work day injuries.	o Yes o No					
169	Operation has a written or electronic plan to reduce lost work day injuries.	o Yes o No					
170	Annual total lost work day injuries for our operation are ____ than the industry average: a. I do not know the industry average b. higher than or equal to c. 1-10% lower than d. 11-20% lower than e. more than 20% lower than	o a o b o c o d o e					

TRAINING: *The Training subcategory is designed to describe the training policies, practices, and opportunities in place within your operation.*

171	Employees receive training appropriate to their specific job or duties.	o Yes o No					

172	All workers have received adequate health and safety training.	o Yes o No					
173	Written or electronic employee training plans appropriate to specific jobs are in place and the training implemented.	o Yes o No					
174	Employee training is on-going.	o Yes o No					
175	The operation provides or financially supports courses that improve life skills training and education to employees.	o Yes o No					

PART II

The following tables list various data inputs needed to develop a total of direct and indirect energy use, total crop water use, and donations of time and financial resources to the community. As there is variability in the units of measure for different inputs, the tables also list common units of measure that are used for the water and energy sources.

Please fill in the form below with information from your growing operation. Use additional copies to record the energy and water information for each separate enterprise (geographically separate farm or crop) for which you have separate records.

DIRECT ENERGY SOURCES

Energy Source	Amount	Unit of Measure
Gasoline	______________	o Gallons o Liters
Ethanol	______________	o Gallons o Liters
Diesel	______________	o Gallons o Liters
Biodiesel	______________	o Gallons o Liters
Aviation fuel	______________	o Gallons o Liters
Kerosene or other petroleum	______________	o Gallons o Liters
LPG/Propane	______________	o Gallons o Liters o Pounds o Kilos
Electricity	______________	o kWh
Natural gas	______________	o Therms o Thousand cubic feet
Biomass	______________	o Tons (U.S.) o Tonnes (metric)

INDIRECT ENERGY SOURCE

Type	Amount	Unit of Measure
Fertilizer nitrogen	______________	o Pounds N

WATER USAGE

Water Source	Amount	Unit of Measure	
River/Stream	______________	o Gallons o Liters o Acre-inches	o Acre-feet o Cubic feet o Cubic meters
Reservoir	______________	o Gallons o Liters o Acre-inches	o Acre-feet o Cubic feet o Cubic meters
Ponds/Lakes	______________	o Gallons o Liters o Acre-inches	o Acre-feet o Cubic feet o Cubic meters
Wetlands	______________	o Gallons o Liters o Acre-inches	o Acre-feet o Cubic feet o Cubic meters
Well (groundwater)	______________	o Gallons o Liters o Acre-inches	o Acre-feet o Cubic feet o Cubic meters
Municipal Water Supply	______________	o Gallons o Liters o Acre-inches	o Acre-feet o Cubic feet o Cubic meters
Irrigation District	______________	o Gallons o Liters o Acre-inches	o Acre-feet o Cubic feet o Cubic meters
Precipitation (natural precipitation falling on land, recorded as rainwater equivalent)	______________	o Gallons o Liters o Acre-inches	o Acre-feet o Cubic feet o Cubic meters

On-Farm Holding (rainwater or other precipitation held for later application)	______________	o Gallons o Acre-feet o Liters o Cubic feet o Acre-inches o Cubic meters
Reuse from Other Sources (recycled wastewater)	______________	o Gallons o Acre-feet o Liters o Cubic feet o Acre-inches o Cubic meters
Ocean	______________	o Gallons o Acre-feet o Liters o Cubic feet o Acre-inches o Cubic meters

Please fill in the form below with information from your produce operations about contributions that support civic and charitable activities in the communities where your company operates. You may use additional forms to record community investment information for separate locations to better target your communications when you have separate records for each location.

COMMUNITY INVESTMENT

Type	Amount	Unit of Measure
In-Kind Contributions, e.g. employee time supporting community projects such as Boy Scouts, Rotary, etc.	______________	o Hours (man-hours) o Days (workday equivalents)
Direct Community Support, e.g. donations to local charities, monetary support for Little League teams, etc.	______________	o Dollars

Term	Definition
Action threshold	A level of pest population or damage at which the cost of a control action equals the crop value gained from that control action.
Beneficials	Living organisms that provide benefits to crop production such as pollination, or insect, disease or weed control.
Biodiversity	Agricultural practices that enhance the environment to the benefit of the local community and existing flora and fauna by avoiding damage to existing habitat. For example, integrated pest management or IPM optimizes plant production while minimizing impact on the ecosystem. Wherever possible, efforts are made to convert non-agricultural land to conservation areas.
Biological control, management or method	Use of living organisms or their products to manage pests through predation, parasitism, herbivory, or other natural mechanisms.
Biopesticide	Certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals.
Cover crop	Plant species grown at the same time or in a rotation with the primary crop to reduce soil erosion, preserve moisture or nutrients. Cover crops are typically not harvested and are often incorporated into the soil to maintain plant residue and organic matter. See also "green manure".
Crop	Cultivated plants grown for commercial purposes.
Crop advisor	An individual with specialized training who provides crop management advice, typically under contract with the farm.
Crop protectant	Material used to protect crops from pests which may include pesticides used in conventional or organic production systems (i.e. may be synthetic or naturally occurring).
Cultural controls	Modifications of the environment or landscape without chemicals, e.g., tillage, row covers, adjusting planting date, bug vacuums, propane flaming, hand weeding, etc. to achieve pest management.
Deep ripping	Disturbing soil below typical cultivation depths to break up compacted layers without inverting the soil in the process. Also referred to as sub-soiling.
Disinfected	Treated with a substance or process that kills pathogenic microorganisms on a surface, or in water or air.

Term	Definition
Early Adopter	An operator who trials new practices or varieties before they become widely used to determine whether they are commercially viable.
Economic Sustainability	Among the economic, environmental and social indicators of sustainability the most fundamental and foundational aspect is economic viability. Without a financial engine to drive continued improvement a company cannot be sustainable. Economic performance indicators illustrate flow of capital among different stakeholders; and the main economic impacts of the organization throughout society.
Effluent	Liquid waste or runoff, usually from a point source. May include nutrients, pesticides, fuel and cleaning agents running off from storage, mixing or loading facilities into waterways.
Environmental Sustainability	The environmental aspect of sustainability concerns an organization's impacts on living and non-living natural systems, including ecosystems, land, air and water. Environmental indicators cover performance related inputs (e.g., material, energy, water) and outputs (e.g., emissions, effluents, waste). They cover performance related to biodiversity, environmental compliance and other relevant information such as environmental expenditures and the impacts of products and services.
Evapotranspiration (ET)	Total water loss due to plant transpiration and evaporation from soil and plant surfaces.
Farm manager	An individual employed on the farm with decision-making and supervisory responsibilities.
Farm personnel	Any individual employed on the farm.
Food crop	Any crop grown for human consumption.
Fumigant	A pesticide active ingredient that is in gaseous form under treatment conditions.
Fungicide	A pesticide designed to act against fungal pathogens, e.g., late blight fungus.
Genetic Modification	An organism, e.g., plant, whose genetic material has been modified using genetic engineering, or recombinant DNA, techniques. This includes transgenic modification between species and cisgenic modification within one species.
Global Positioning System (GPS)	A navigation system that uses satellite signals to provide precise latitude and longitude location information.
Good Agricultural Practices (GAP)	An evolving set of principles and practices designed to ensure on-farm production results in safe and healthy food products.

Term	Definition
Greenhouse Gas Emissions	Greenhouse Gas (GHG) emissions result from the use of direct energy, such as electricity and diesel fuel, as well as indirect energy consumption, such as fertilizer and crop protection inputs.
Green manure	A cover crop, usually an annual plant, that is incorporated into the soil typically prior to flowering, to improve soil condition, add nutrients and organic matter, and/or manage pests.
Hand feel method	Estimating soil moisture by examining a clump of soil in the palm of one's hand and comparing results of moisture and appearance to a description chart of general soil textures.
Herbicide	A pesticide designed to act against weeds.
Integrated Pest Management (IPM)	Integrated pest management is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat modification, modification of cultural practices, and or use of resistant varieties. Pesticides are used only when needed and according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment. Source: University of California Statewide Integrated Pest Management Project
Life Skills Training and Education	Non-work related training to assist workers and family members to become more productive. Examples include personal financial management/planning, language proficiency, relaxation techniques, and personal well being.
Lost work day injury	An on-the-job injury that results in time away from work.
Low-volume Irrigation System	A high-efficiency irrigation system that delivers water to the crop with little or no runoff or spray drift. Examples include drip, low-pressure sprinklers, and micro-emitter sprinklers.
Monitoring	Careful observation of the crop or conditions over time to improve ability to intervene at the right time and with the correct response to optimize pest control, crop yield and quality.
Nematicide	Pesticide designed to act against nematodes.
Non-chemical method	Pest control techniques that include cultural controls and non-toxic compounds such as pheromone lures for insect mating disruption.
Pathogen	Disease-causing organism, e.g., *Phytopthora infestans*, the fungus that causes late blight.

Term	Definition
Personal Protective Equipment (PPE)	Clothing and equipment worn by pesticide mixers, loaders, applicators, re-entry workers, hazmat emergency responders, workers cleaning up Superfund sites, etc., which is worn to reduce exposure to potentially hazardous chemicals and other pollutants.
Pest	An organism that interferes with the availability or quality of a managed resource such as a crop. "Pest" is often used specifically in reference to insect pests; however the term can also include pathogens, weeds, nematodes and wildlife.
Pesticide	A substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture intended for use as a plant regulator, defoliant, or desiccant.
Phytotoxicity	Damage to plants resulting from an application of chemicals.
Potentially mineralizable nitrogen	The portion of nitrogen in the soil that is available or potentially available to plants.
Precision fertilization	Precise or managed application of nutrients to match soil fertility capabilities. May include fertigation and real-time monitoring of nutrients using soil probes or sensors.
Reduced-risk pesticides	Pesticides with low-impact on human health; low toxicity to non-target organisms such as birds, fish and plants; low potential for groundwater contamination; lower use rates; low pest resistance potential and compatibility with Integrated Pest Management (IPM).
Rotational crops	Different crops that are grown in sequence in the same field in the same or across multiple years.
Sampling	Collection of data from part of a larger population to evaluate the potential impact of that population on the crop. This typically involves scouting a portion of a field to estimate the pest population in the whole field. Sampling may also refer to collecting pests or infected plant parts for later identification.
Sanitizer	An agent that reduces the number of microorganisms on a non-living surface.
Scouting	Systematic, regular collection of information in the field typically to determine the presence or population level of pests.

Term	Definition
Social Accountability	The social aspect of sustainability concerns the impacts an organization has on the social systems within which it operates. Social Accountability addresses good labor practices, society, human rights and product responsibility. In agriculture, social responsibility involves economic contribution to the local economy resulting from total benefits paid, health and safety training and food safety.
Soil compaction	A compressed soil condition resulting in poor air and water-holding capacity, and reduced root health and plant performance for most plants. A subsoil compacted zone can inhibit root penetration and minimize the rooting area.
Soil erosion	Loss of soil typically due to the action of wind or water. This often results in the movement of productive topsoil from the field site to an undesirable location causing damage to the ecosystem.
Soilborne	Transmitted by or in soil.
Storage condition	The physical, biological, and pathogenic state of a crop commodity in storage.
Sustainable Energy Use	All direct and indirect energy types and use are monitored, documented and tracked to achieve optimal efficiency, reduce greenhouse gas emissions and maximize crop yield.
Sustainable Material Use	A material management policy to avoid or reduce the use of materials destined for landfill disposal or burning. Production materials, including cardboard and plastic packaging are purchased in a manner consistent with this policy. Farm generated organic waste is recycled, reused or composted and used for soil improvement
Sustainable Water Use	Water use efficiency is based on crop requirements necessary for optimal yield and quality while minimizing detrimental impacts on the environment. Water is not sourced from environmentally sensitive area.
Training	Initial and on-going training of all employees, including new employees, consistent with job requirements and activities.
Transpiration	The process of the absorption of water by plants, usually through the roots, the movement of water through plants, and the loss of the water to the atmosphere through small openings on the underside of leaves called stomata.
Whole-farm	Pertaining to the entire farm including all cultivated and uncultivated land on the farm.

Special thanks to

Bayer CropScience

whose support made possible the establishment of the Center for Global Produce Sustainability.

United Fresh
PRODUCE ASSOCIATION

United Fresh Foundation
CENTER FOR GLOBAL PRODUCE SUSTAINABILITY

www.unitedfresh.org

4 October 2012 Organic Trial by the Morse lab – Yorba Linda

5 treatments applied to 9 single tree replicates per treatment using a backpack sprayer and ca. 3 gallons of spray (1/3 gallon/tree)

Our intent was to evaluate impacts on eggs/nymphs but as the flush never developed and we had good adult levels, we evaluated the impact of treatments on adult ACP

Pre-treatment counts on 2 October

Counts used to create 9 blocks and randomly assign one tree from each block to each of 5 treatments:

- 3 lb/a Grandevo + 0.1% Silwet
- 1 lb/a Neemix 4.5 + 18 fl oz/a Pyganic EC 5.0 II
- 0.5% BFR 440 Supreme Oil
- 1.4% BPR 440 Supreme Oil
- Untreated Control

Yorba Linda field site – used small trees, ca. 8 feet in height

4 October 2012 Organic Trial – Yorba Linda

Adult ACP counts were taken by tap sampling – 11" x 16.5" plastic tray help below foliage, 3 "beats" per sample, 4 samples/tree

Treatment	Pre-count 10-2-12	+7 d Post 10-11-12	+14 d Post 10-18-12	+21 d Post 10-25-12
Control	19.8	36.0	19.9	25.4
0.5% 440 Oil	20.2	17.0	15.6	27.1
1.4% 440 Oil	17.9	20.6	14.0	22.9
Grandevo + Silwet	17.9	13.6	11.8	15.8
Neemix + Pyganic	18.0	8.9*	10.1*	15.2

* Results significantly different from means on control trees

Our first field trial (learning process) -- Week 1 counts taken during a light rain – ACP stuck to beat trays better (future studies – use a light soap / water spray on trays before each sample)

Field Trial #2 – Yorba Linda Site, 5 March 2013

Timed this study for feather flush and high levels of ACP eggs and young nymphs

Sampled small terminals with feather flush, 16 leaves per tree

Blocked data and assigned 6 trees randomly to each of 7 treatments

Mean number of eggs + nymphs (instars 1-3) varied over the treatments between 53.3 – 55.0 per tree (16 leaves, 3.33-3.44/leaf)

Instars 4-5 not seen yet, only a few adults in the pre-treatment samples

Treatments applied 5 March using the same backpack sprayer, 2 gallons of water to 6 trees (1/3 gallon/ tree)

Small leaves and flowers present at the time of treatment with high levels of ACP eggs and nymphs

Field Trial #2 – Yorba Linda Site, 5 March 2013

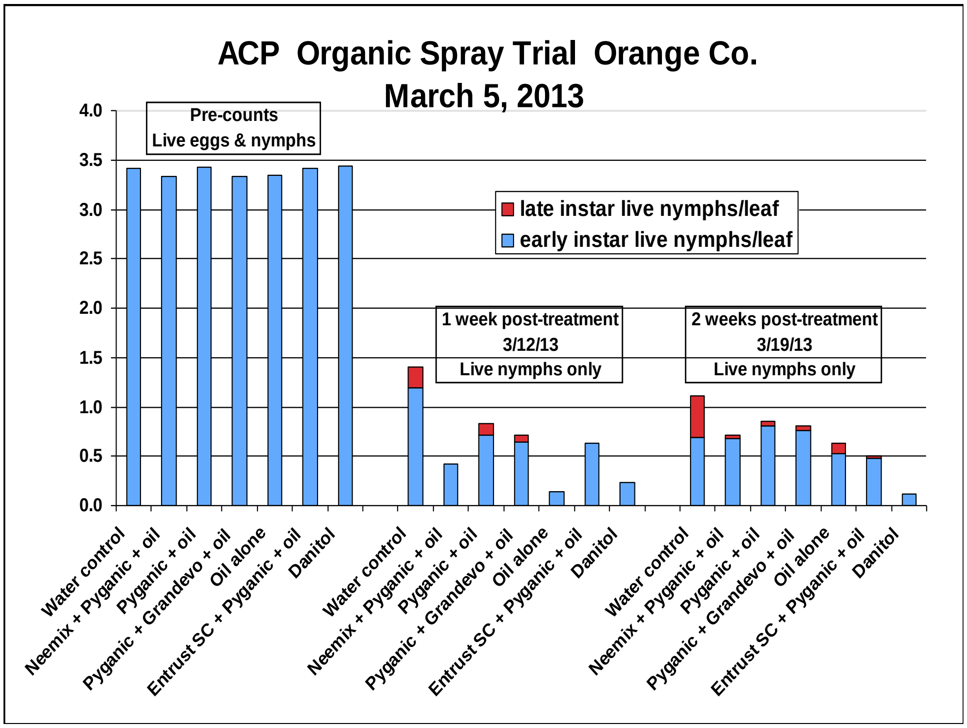
Treatments evaluated (all are rates per acre, 135 trees/acre):

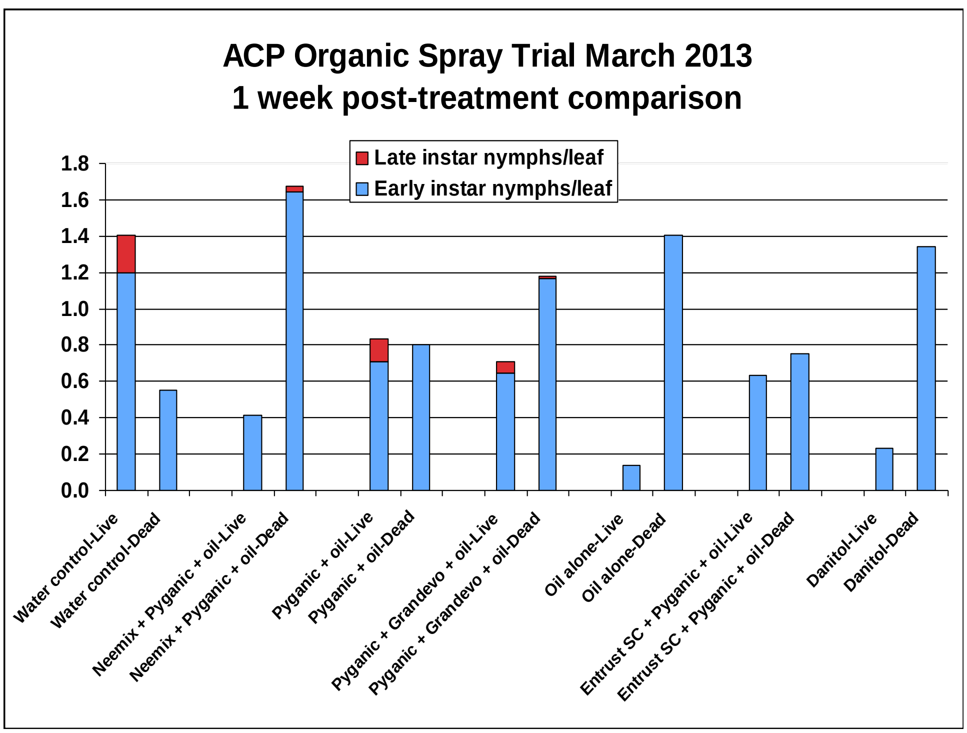
- 3 oz Entrust + 18 fl oz Pyganic + 1% NR-440 Oil
- 16 fl oz Neemix + 18 fl oz Pyganic + 1% NR-440 Oil
- 3 lbs Grandevo + 18 fl oz Pyganic + 1% NR-440 Oil
- 18 fl oz Pyganic + 1% NR-440 Oil
- 1% NR-440 Oil
- Water control
- 16 fl oz Danitol + 1% NR-440 Oil

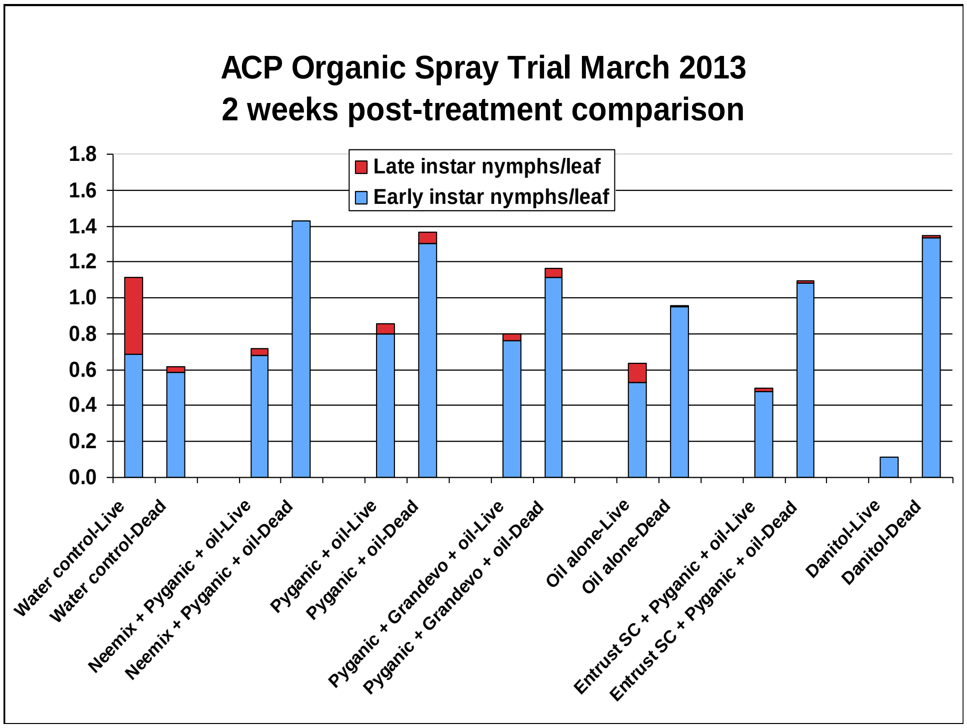
Yorba Linda field site, 5 March 2013 ACP trial

Each treatment has 2-3 “outside” trees out of 6 per treatment
Pre-count means varied 52.2 - 55.0 across treatments
Used all but 10 small trees (those with low pre-counts)

	Road	Road	Road	Road	Road	Road	Road	Road	
Road			Too big	x 6-7	x 5-7	x 4-7	x 3-7	x 2-7	Too big
	x 9-6	x	x	x	x	x	x	x	Too big
x 10-4	x	x	x	x	Too big	x	Too big	Too big	Too big
x	x	x	x	x	x	x	no tree	x	Too big
x	x	x	x	x	x	x	x	Too big	Too big
x 10-1	x	x	x	x	x	x	x	Too big	Too big
	x 9-1	x 8-1	x 7-1	x 6-1	x 5-1	x 4-1	x 3-1	x 2-1	x 1-1
Road	Road	Road	Road	Road	Road	Road	Road	Road	Road


ACP Organic Spray Trial Orange Co.
March 5, 2013
Pre-counts
Live eggs & nymphs
late instar live nymphs/leaf
early instar live nymphs/leaf
1 week post-treatment
3/12/13
Live nymphs only
2 weeks post-treatment
3/19/13
Live nymphs only
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Water control
Neemix + Pyganic + oil
Pyganic + oil
Pyganic + Grandevo + oil
Oil alone
Entrust SC + Pyganic + oil
Danitol


ACP Organic Spray Trial March 2013
1 week post-treatment comparison
Late instar nymphs/leaf
Early instar nymphs/leaf
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Water control-Live
Water control-Dead
Neemix + Pyganic + oil-Live
Neemix + Pyganic + oil-Dead
Pyganic + oil-Live
Pyganic + oil-Dead
Pyganic + Grandevo + oil-Live
Pyganic + Grandevo + oil-Dead
Oil alone-Live
Oil alone-Dead
Entrust SC + Pyganic + oil-Live
Entrust SC + Pyganic + oil-Dead
Danitol-Live
Danitol-Dead


ACP Organic Spray Trial March 2013
2 weeks post-treatment comparison
Late instar nymphs/leaf
Early instar nymphs/leaf
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Water control-Live
Water control-Dead
Neemix + Pyganic + oil-Live
Neemix + Pyganic + oil-Dead
Pyganic + oil-Live
Pyganic + oil-Dead
Pyganic + Grandevo + oil-Live
Pyganic + Grandevo + oil-Dead
Oil alone-Live
Oil alone-Dead
Entrust SC + Pyganic + oil-Live
Entrust SC + Pyganic + oil-Dead
Danitol-Live
Danitol-Dead

Asian Citrus Psyllid, Huanglongbing, and Biocontrol Efforts in California

Mark S. Hoddle
Entomology, UC Riverside

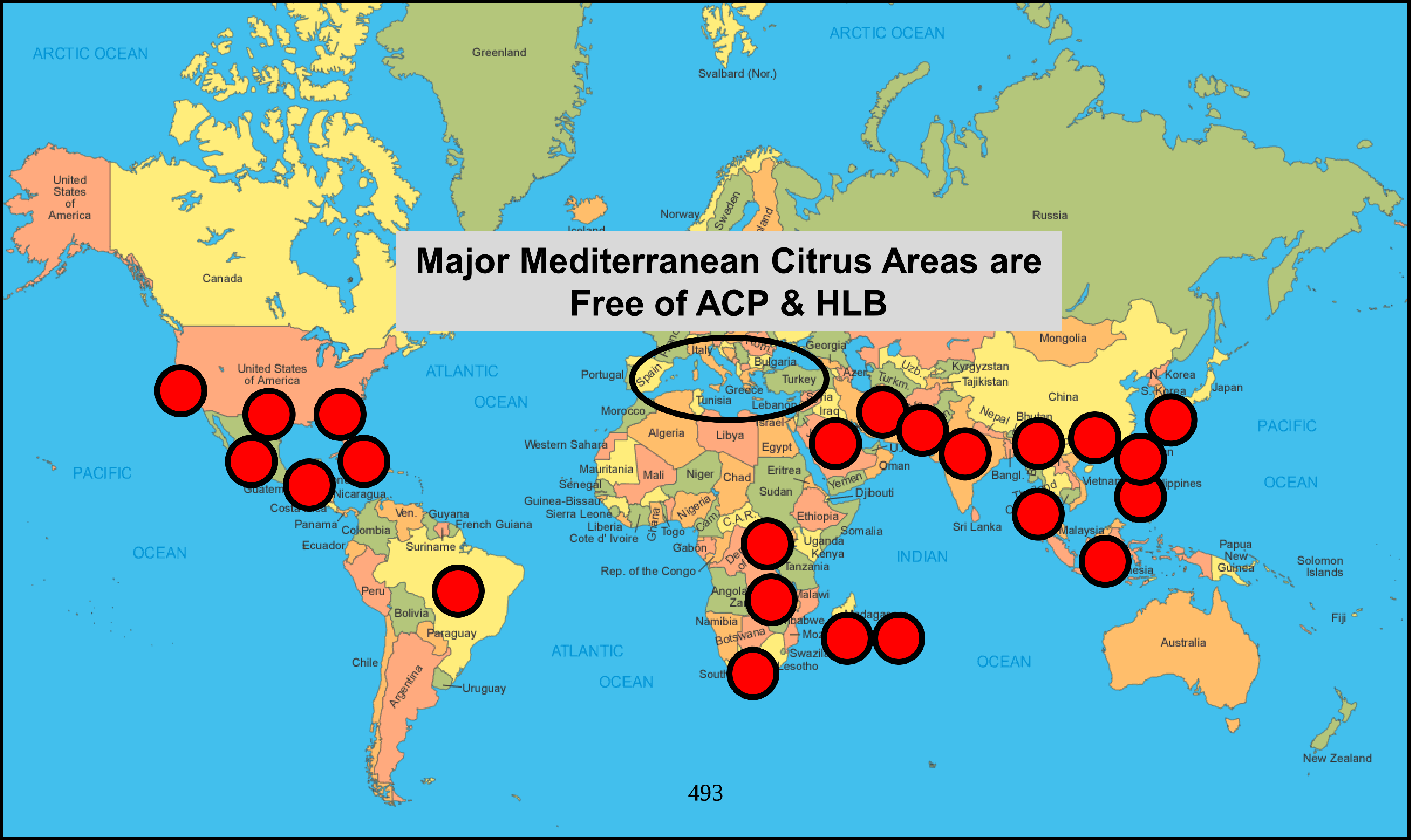
What Will We Talk About?

- ACP & HLB biology & distribution
- The problem in Florida, USA
- The problem in California, USA
- Work in Pakistan and ACP biocontrol in California
- Will citrus go extinct?
- Websites for more information

Asian Citrus Psyllid – *Diaphorina citri* (Kuwayama 1908) (Hemiptera: Liviidae)

- ACP area of origin the Punjab region of India-Pakistan?
- Widespread in Asia and the Arabian Peninsula
- It is a global citrus pest because it vectors HLB, a lethal citrus pathogen
- Partial invasion history
  - Taiwan (1907?)
  - USA
    - Florida (1998)
    - Texas (2001)
    - Alabama (2008)
    - California (2008)
  - Costa Rica (2003)
  - Honduras (1989?)
  - Reunion Island
  - Argentina (1997)
  - Brazil (1942)
  - Caribbean (1998 - Guadeloupe)
  - Mexico (2003)

ACP & HLB Distribution



ACP Life Cycle

Average number eggs laid at 28°C is 748

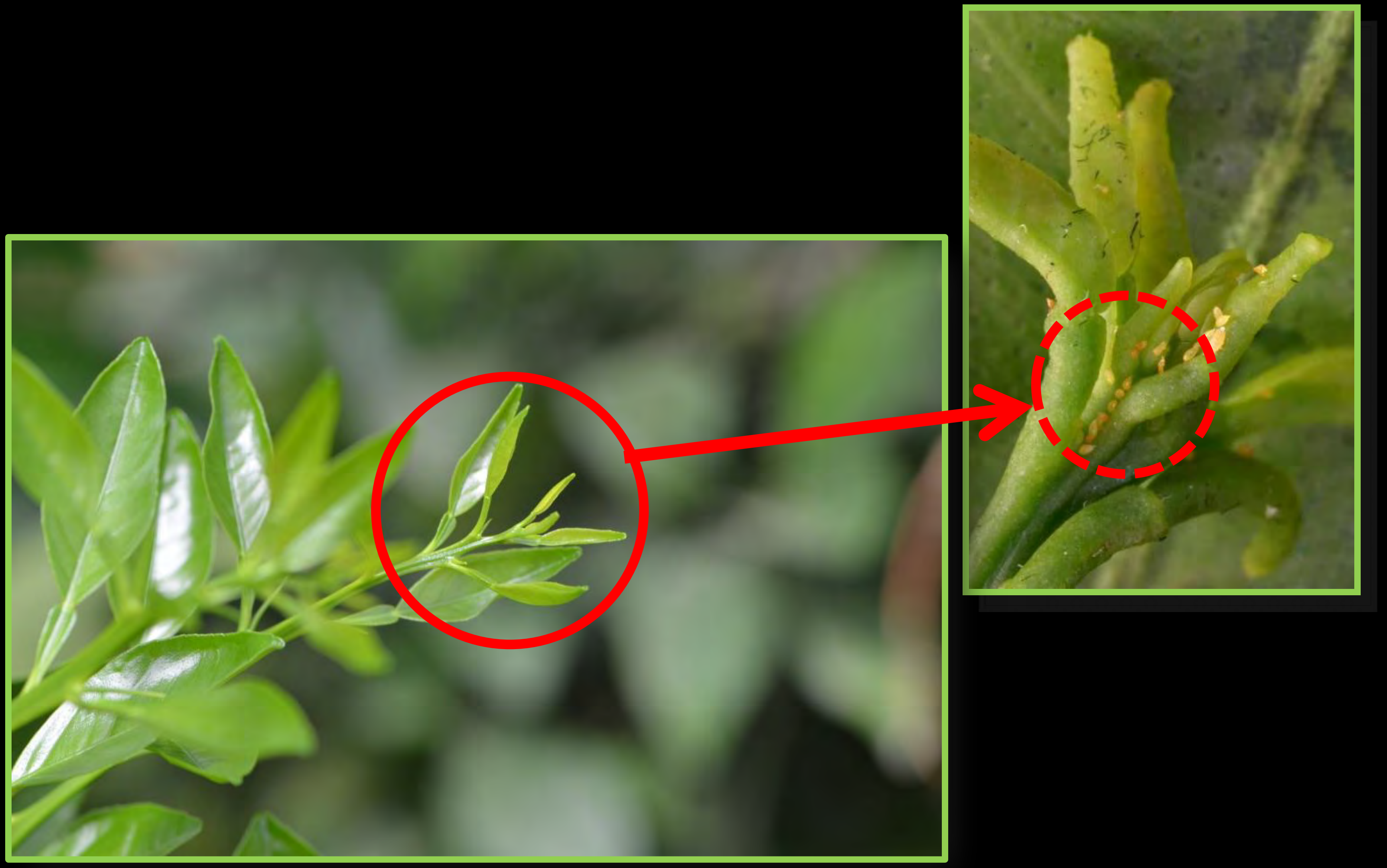
Adults can live for several months

Optimal Temperature for Development is 25-28°C

Eggs hatch in 2–4 days

Five nymphal instars complete development in 11-15 days

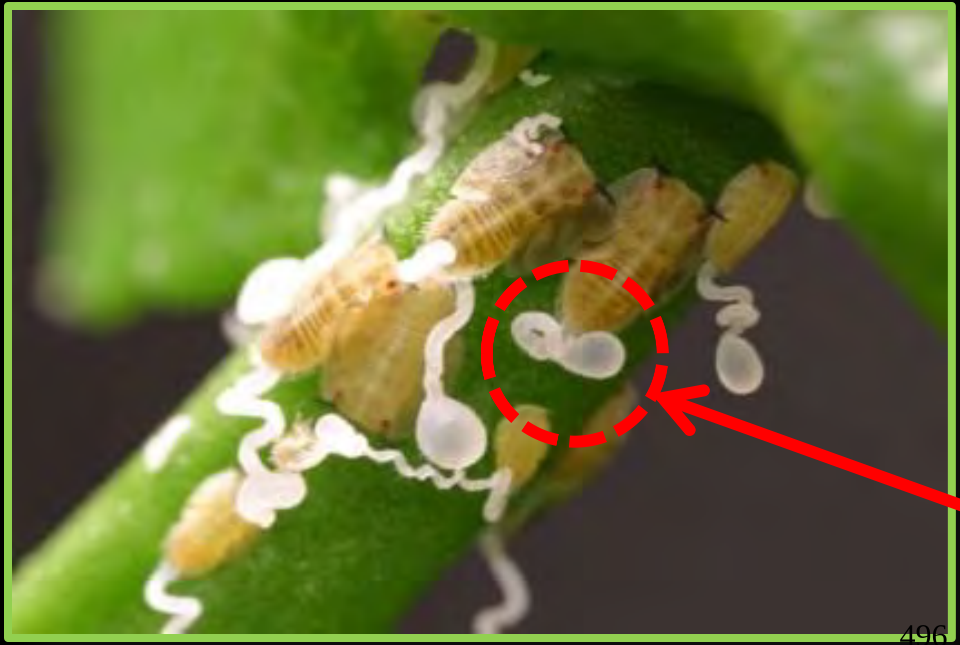
Where to Look for Eggs



The Nymphs

4th and 5th instar nymphs are large and can be seen with the naked eye. Honey dew excretions <u>may</u> betray the presence of nymphs

Wing pads on a 5th instar nymph



Honey dew excretions

Feeding Damage

ACP can inject “toxic” saliva into plants as they feed and this can cause growth distortions

High density ACP populations on citrus terminals

Distorted growth from ACP feeding

Host Plants for ACP

- **Citrus and plants in the Rutaceae (Sapindales) are highly preferred. Especially**
  - ***Citropsis* spp.**
  - ***Citrus* spp.**
  - ***Bergera* *(Murraya)* *koenigii***
  - ***Murraya exotica***

Native to the Indian sub-continent

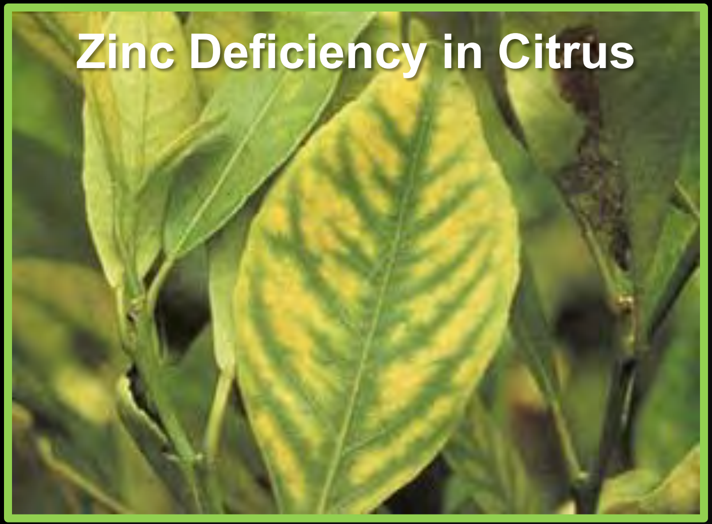
Huanglongbing – Yellow Shoot Disease

- Causal agents are gram negative phloem-dwelling bacteria
  - *Candidatus* Liberibacter asiaticus
  - *Candidatus* Liberibacter africanus
  - *Candidatus* Liberibacter americanus

Koch's postulates not demonstrated. Can't culture bacteria

- No cure for this disease
  - Disease restricted to citrus & close relatives

Candidatus Liberibacter asiaticus



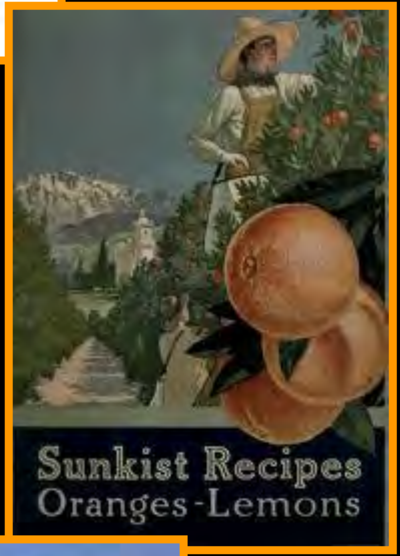
The Florida Citrus Industry

- Florida's citrus industry valued at US$9.3 billion
- ACP first found in 1998
- HLB detected in 2005
  - Now infects all 32 citrus producing counties in FL
- ~621,000 acres of citrus in Florida
  - >60,000 acres of trees destroyed by 2009
    - >$330 million/yr in losses
    - 8,257 jobs lost
- Three pronged management approach
  - Produce new plants in screened facilities
  - Area wide insecticide management of ACP
  - Removal of infected trees

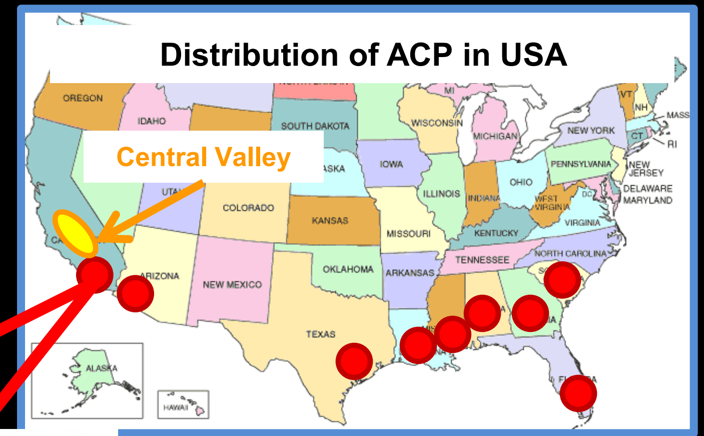
Slowed not eliminated HLB spread

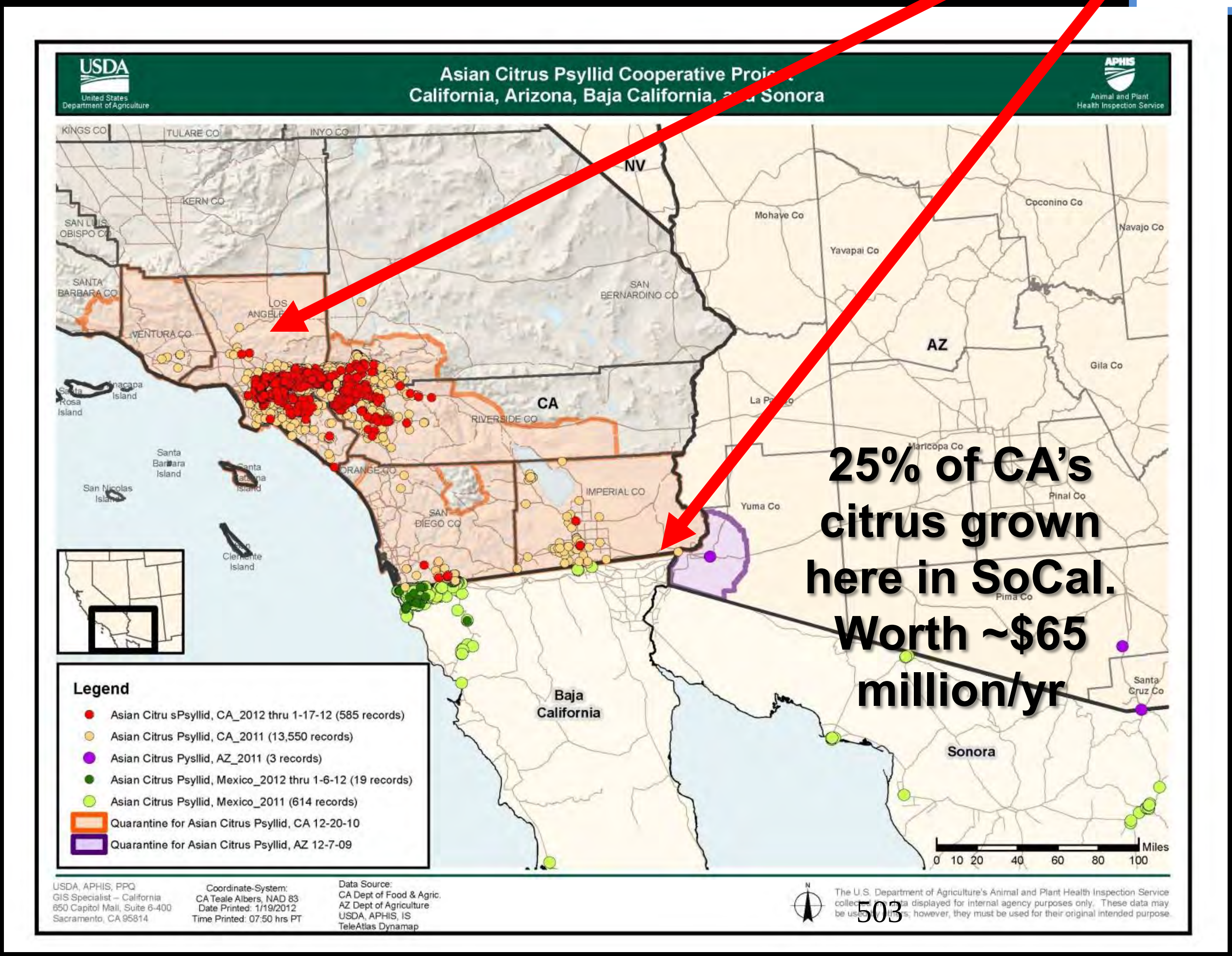
The California Citrus Industry

- CA second largest citrus producer in USA after FL
  - 66% of crop = oranges
    - 75% are navels & 25% valencias
    - 80% are for fresh consumption; 30% exported
    - Worth $580 million/yr
  - lemons = 25% of crop
    - CA grows 87% of US lemons
    - 66% for fresh market
    - Worth $295 million/yr
  - grapefruit = 6%; tangerines = 3%
  - 3.2 million tons of fruit harvested per season from ~250,000 acres
  - <u>All CA citrus is worth ~$1.2 billion/yr</u>



Distribution of ACP in California

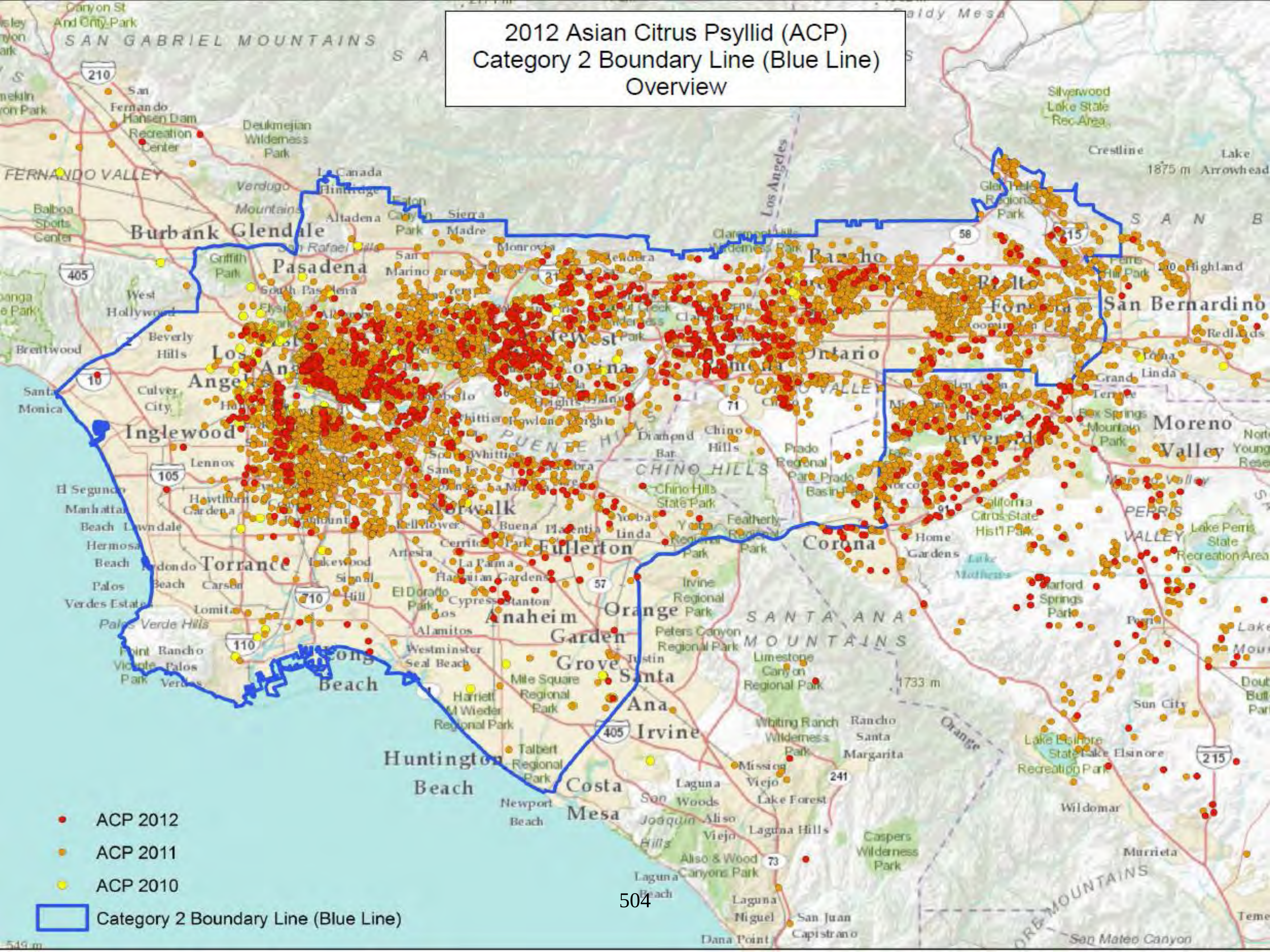




25% of CA's citrus grown here in SoCal. Worth ~$65 million/yr

ACP & HLB Found in:

1) CA (+ HLB)
2) FL (+ HLB)
3) TX (+ HLB)
4) LA (+ HLB)
5) GA (+ HLB)
6) SC (+ HLB)
7) AZ (- HLB)
8) MS (- HLB)
9) AL (- HLB)


2012 Asian Citrus Psyllid (ACP)
Category 2 Boundary Line (Blue Line)
Overview
ACP 2012
ACP 2011
ACP 2010
Category 2 Boundary Line (Blue Line)

The CDFA Spray Program

- Host plants in yard and 400 meters around the yard, are treated with a foliar and a systemic insecticide
  - Cyfluthrin a foliar pyrethroid
  - Imidacloprid a systemic neonicotinoid
    - Effective for ~3-6 months(?)
    - Problems with uptake related to soil & irrigation

CDFA Spray Program

- ACP infestations are high in LA County
- Surveys suggest that 36% of residences have 1^+ citrus in LA
  - 735,954 residences with citrus
- CDFA treated 46,941 residences by Oct 2011
  - 6% of properties with citrus treated in LA
    - Cost $4,702,435 or $100/residence
      - Resistance development documented in Florida (Tiwari et al. 2011 Pest Management Science 67: 1258-1268)
      - 35x resistance to Imidacloprid; cross resistance to thiamethoxam before it was used; Resistance building to chlorpyrifos, malathion, danitol

Is HLB in California?

- HLB was detected in Hacienda Heights, LA County in April 2012
  - Backyard pummelo with a lemon graft that may have originated from Asia & shared by a group of citrus grafting enthusiasts

The First HLB Positive Tree in CA Prior to Eradication

Is HLB in California?

- It is highly likely other HLB infestations are in CA
  - Plants smuggled into CA from Asia have been intercepted at airports
    - Some plants have been contaminated with ACP and infested with HLB
    - How many infected plants are in people’s gardens waiting for ACP to arrive?

Citrus in Nurseries in Quarantine Areas Have Tags

Don’t Move Plants out of Quarantine Areas!

Management Options

- **Biological Control**
  - Use of natural enemies, in particular parasitoids of great interest for suppressing ACP populations
    - First work on ACP parasitoids conducted by Husain & Nath (1927) in the Punjab of Pakistan
      - Study sites: Sargodha, Lyallpur, and Gujranwala
      - Trees dry up, fruit is insipid, leaves fall to ground (HLB symptoms)
    - Nine species of parasitoid associated with ACP nymphs
      - No adult or egg parasitoids recorded
      - Hyperparasitoids exist
      - 1 species named from this project, *Tamarixia radiata*

Tamarixia radiata (Waterston) (Hymenoptera: Eulophidae)

- First described from specimens collected from lemons in Lyallpur, Punjab, 2 Jan 1921
  - Solitary ecto-endoparasitoid
  - Arrhenotokous: 1.8♀: 1♂
  - At 25^{o}C egg-adult = 24 days
  - Attacks 3^{rd}, 4^{th}, & 5^{th} instar ACP
  - Females live 12-24 days
  - Females lay 166-300 eggs
  - Kills ACP via host feeding too

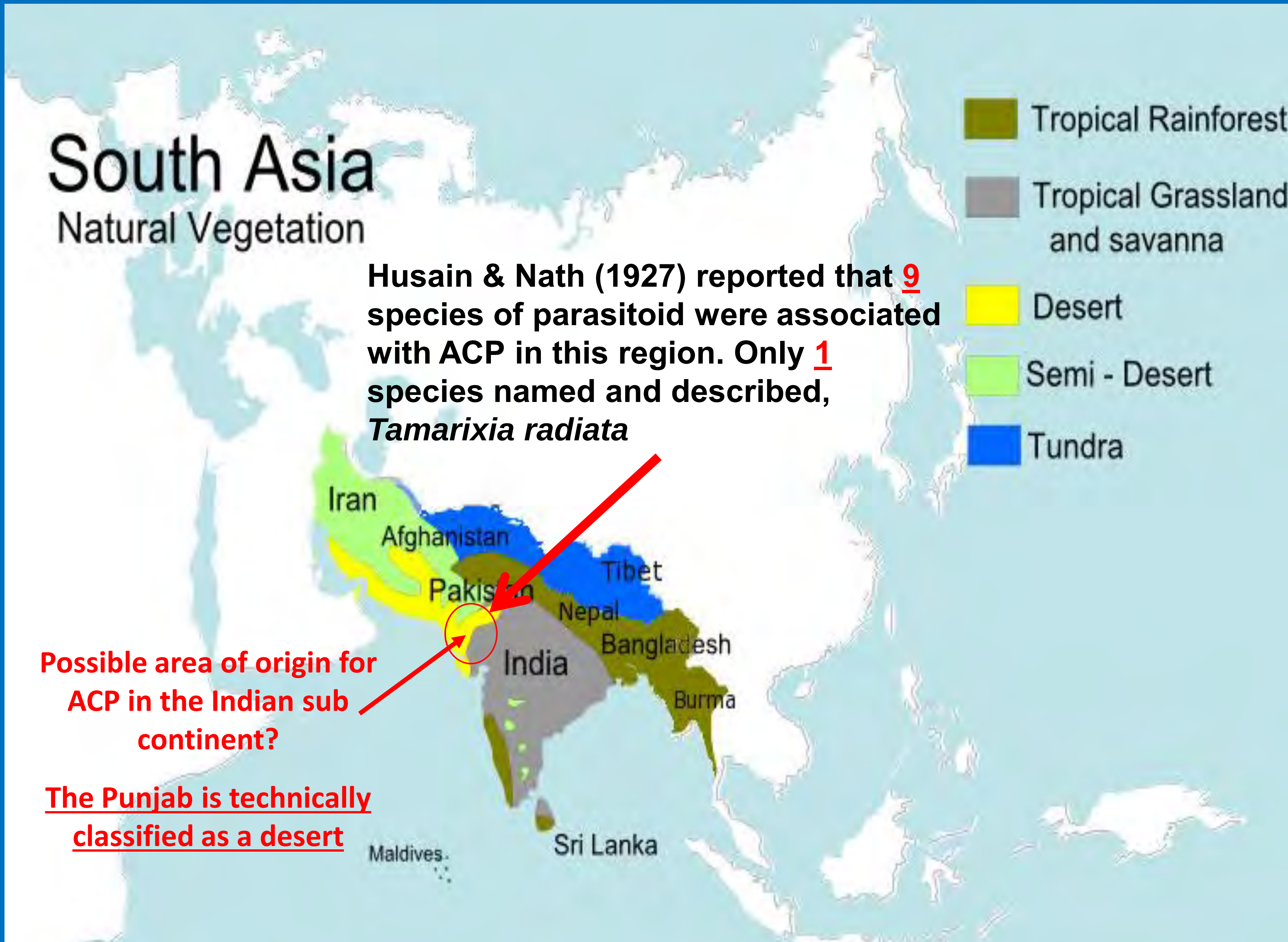
Adult Female and Male *Tamarixia*

Female *Tamarixia* have clubbed antennae

Male *Tamarixia* have setose or plumose antennae

Developing a BioControl Program in CA with *Tamarixia*

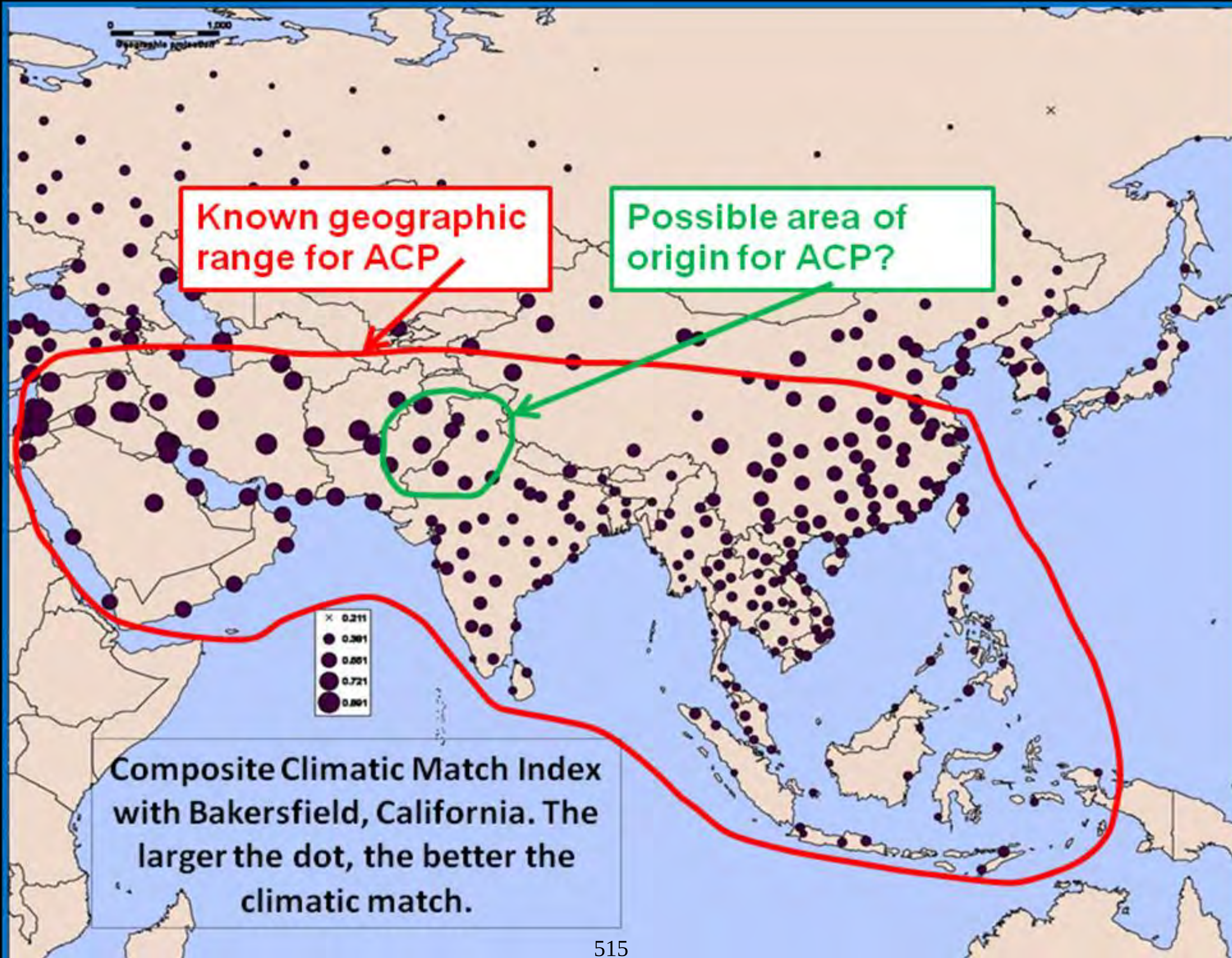
- Parasitoids from Punjab of Pakistan are of most interest for establishment in CA because of the very good climatic match to the major citrus growing regions of CA
- Punjab has a ~70% climate match with the Central Valley
  - There are three seasons in the Pakistan Punjab:
    - (1) cool (October to February [similar to Tule Fog Season in Central Valley),
    - (2) hot (March-June), and
    - (3) monsoon (July-September)



Husain & Nath (1927) reported that <u>9</u> species of parasitoid were associated with ACP in this region. Only <u>1</u> species named and described, *Tamarixia radiata*

Possible area of origin for ACP in the Indian sub continent?

<u>The Punjab is technically classified as a desert</u>


Known geographic range for ACP
Possible area of origin for ACP?
0.211
0.721
Composite Climatic Match Index with Bakersfield, California. The larger the dot, the better the climatic match.

Pakistan Collections

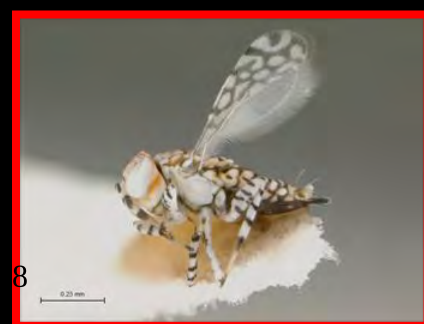
- **September 2010**
  - Reconnaissance completed in Pakistan
  - Demonstrated it was feasible to collect & rear ACP parasitoids
- **March 10 to April 10 2011**
  - Set up long-term replicated phenology studies
  - Collected ~ 200 parasitoids
- **June 4-13 2011**
  - ~400 parasitoids returned to UCR
- **Oct. 23-28 2011**
  - > 1,000 parasitoids returned to UCR
- **June 16-23 2012**
  - > 1,000 parasitoids returned to UCR
- **April 15-22 2013**
  - > 400 parasitoids returned to UCR

Tamarixia Collections in Pakistan

ACP Parasitoid Collections in Pakistan

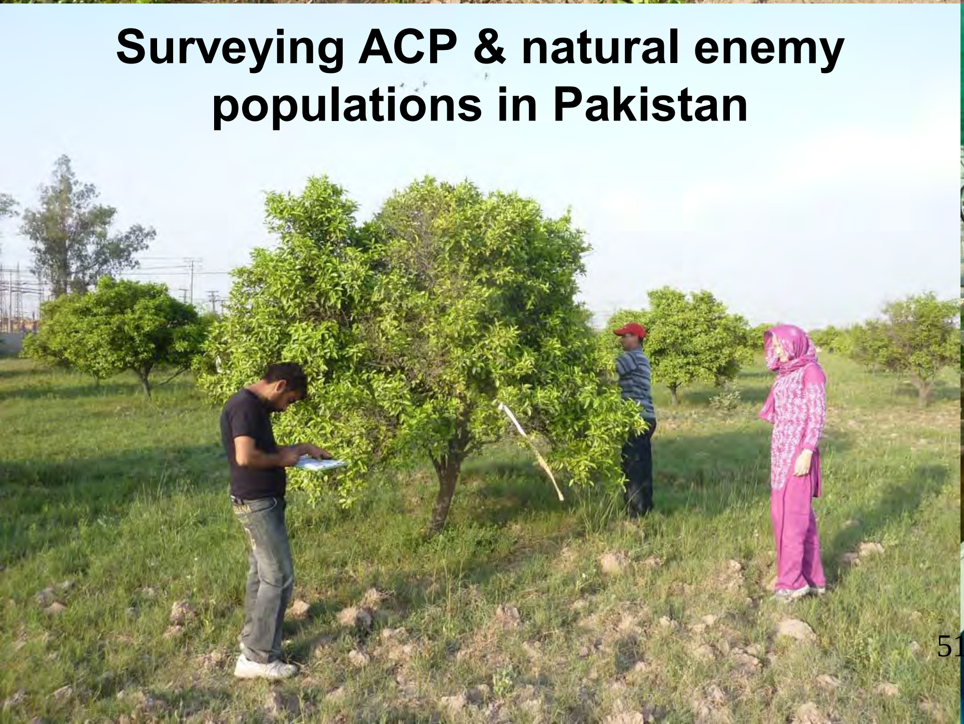
- Two species of primary parasitoid
  - *Tamarixia radiata* (Eulophidae)
  - *Diaphorencyrtus aligarhensis* (Encyrtidae)

- Five species of hyperparasitoid
  - *Psyllaphycus diaphorinae* (Encyrtidae)
  - *Marietta leopardina* (Aphelinidae)
  - *Aprostocetus* sp. (Eulophidae)
  - *Pachyneuron* sp. (Pteromelidae)
  - *Chartocera* sp. (Signaphoridae)




A malaise trap to sample for citrus pests and natural enemies


Preparing ACP nymphs collected in the field for parasitoid rearing
PEPSI


Surveying ACP & natural enemy populations in Pakistan


Rearing ACP & natural enemies in greenhouses in Pakistan



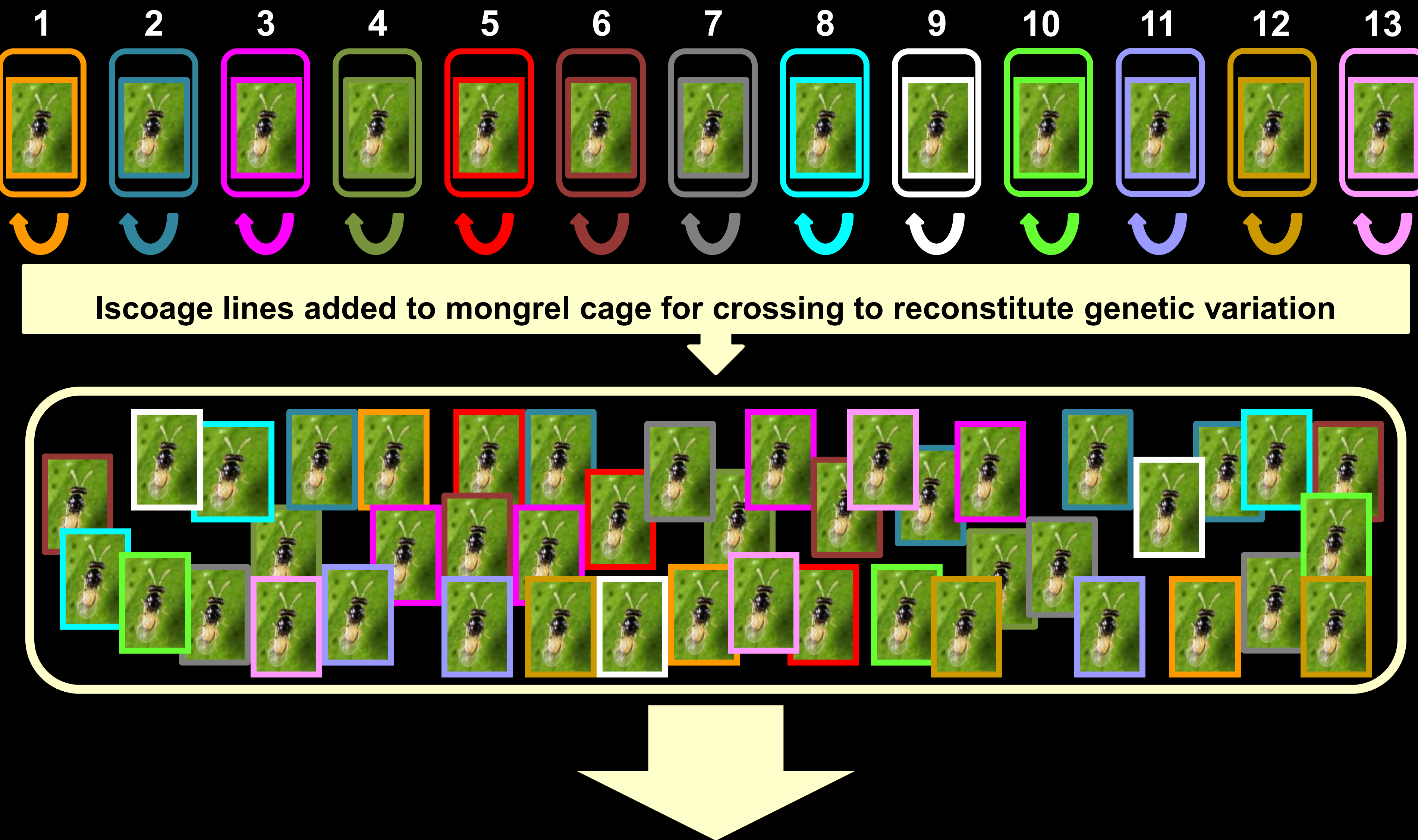

PETZL
PLUS


CLING FILM
P016(a) 4-9-11
LIVE #1 (2) 4-9-11
LIVE #1 (7) 4-9-11


mckenzie

ACP Natural Enemies Collected in Pakistan are Returned to the Insectary & Quarantine Facility at UC Riverside for Safety Testing

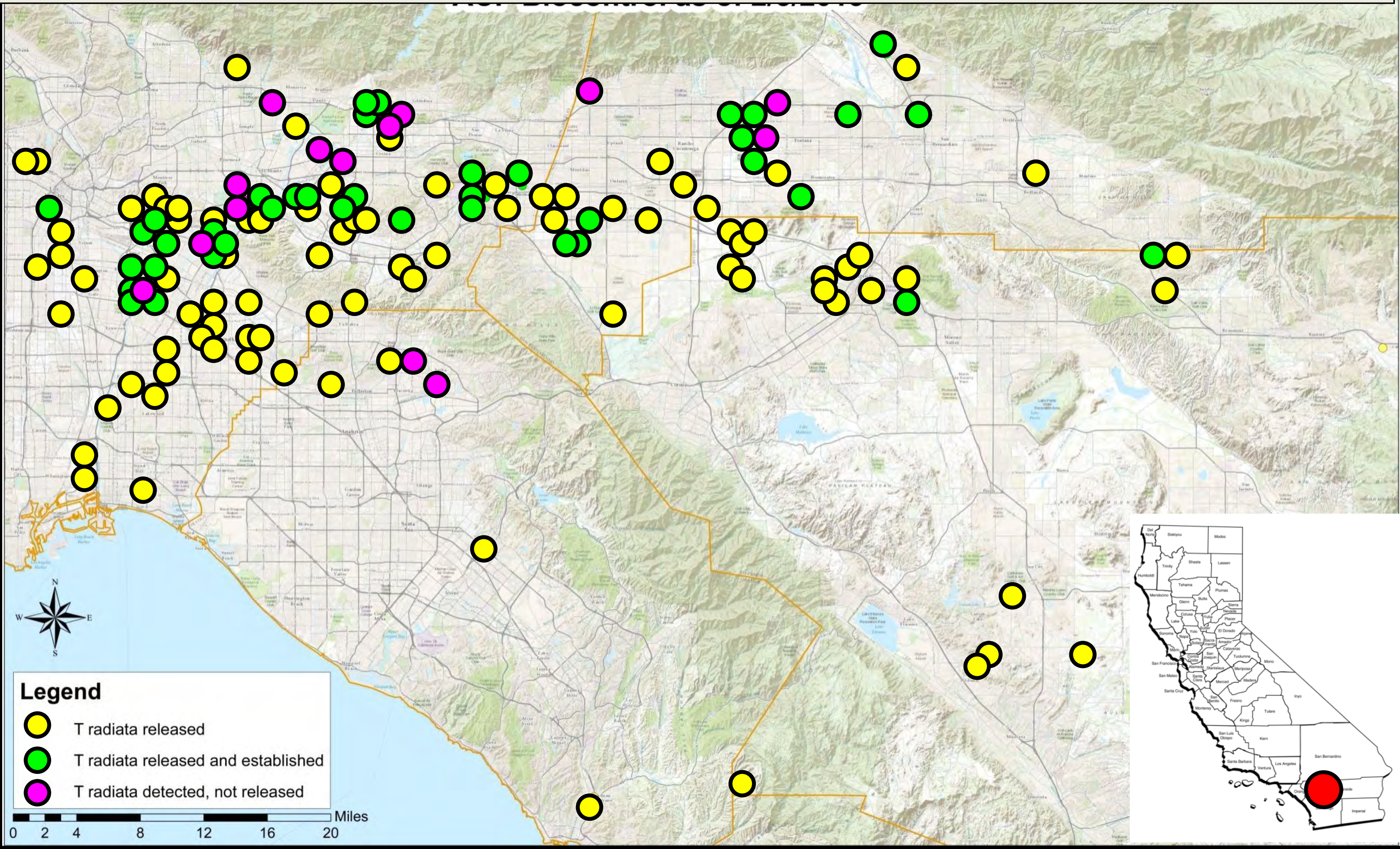
Establishment of IsoCage Lines in Quarantine



Hybrids released into field

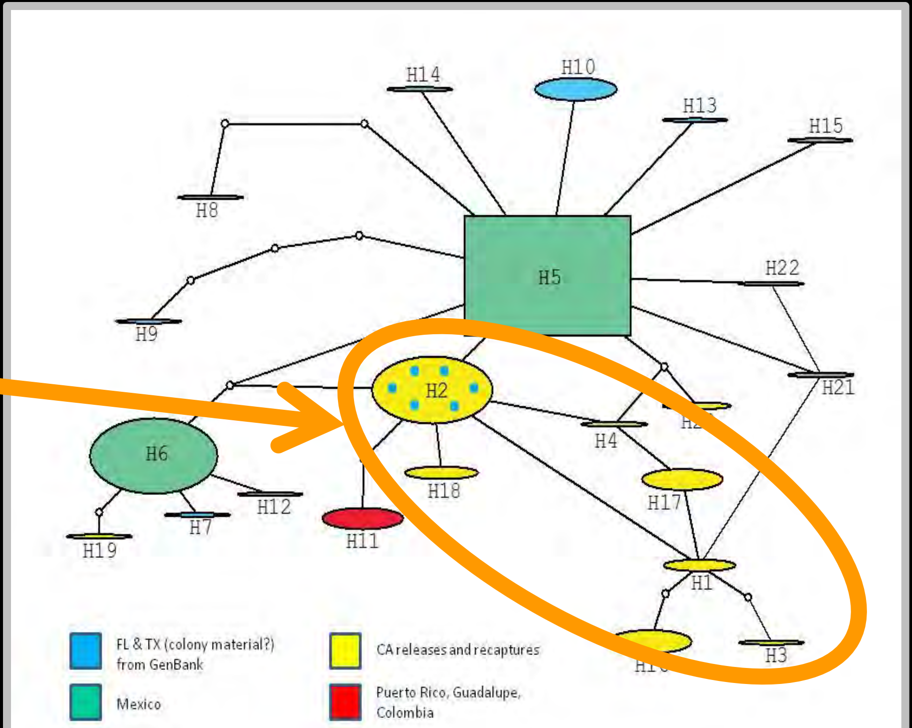



July 2013 >70,000 *Tamarixia* released >270 release sites, 250 zip codes, 55 cities, 4 Counties (LA, OC, SB, RV)



Release Survey Summary

- > 50,000 *Tamarixia* (75% ♀) released by May 2013 at > 250 sites in urban areas
  - Establishment likely in 20% of release sites
    - Parasitism found ~ 5-8 miles from some release sites
    - DNA confirms field recovered parasitoids are of Pakistani origin
      - Haplotype networks within Pakistan clade confirm high levels of diversity
    - No detection on non-Pakistani haplotypes



Rugman-Jones/Stouthamer UCR

Ants tending ACP nymphs

Tamarixia female foraging on a patch of ACP in Azusa

ACP mummies from which *Tamarixia* has emerged in Bell Gardens

Tamarixia parasitizing ACP in the field in Los Angeles

Who Pays for this Program?

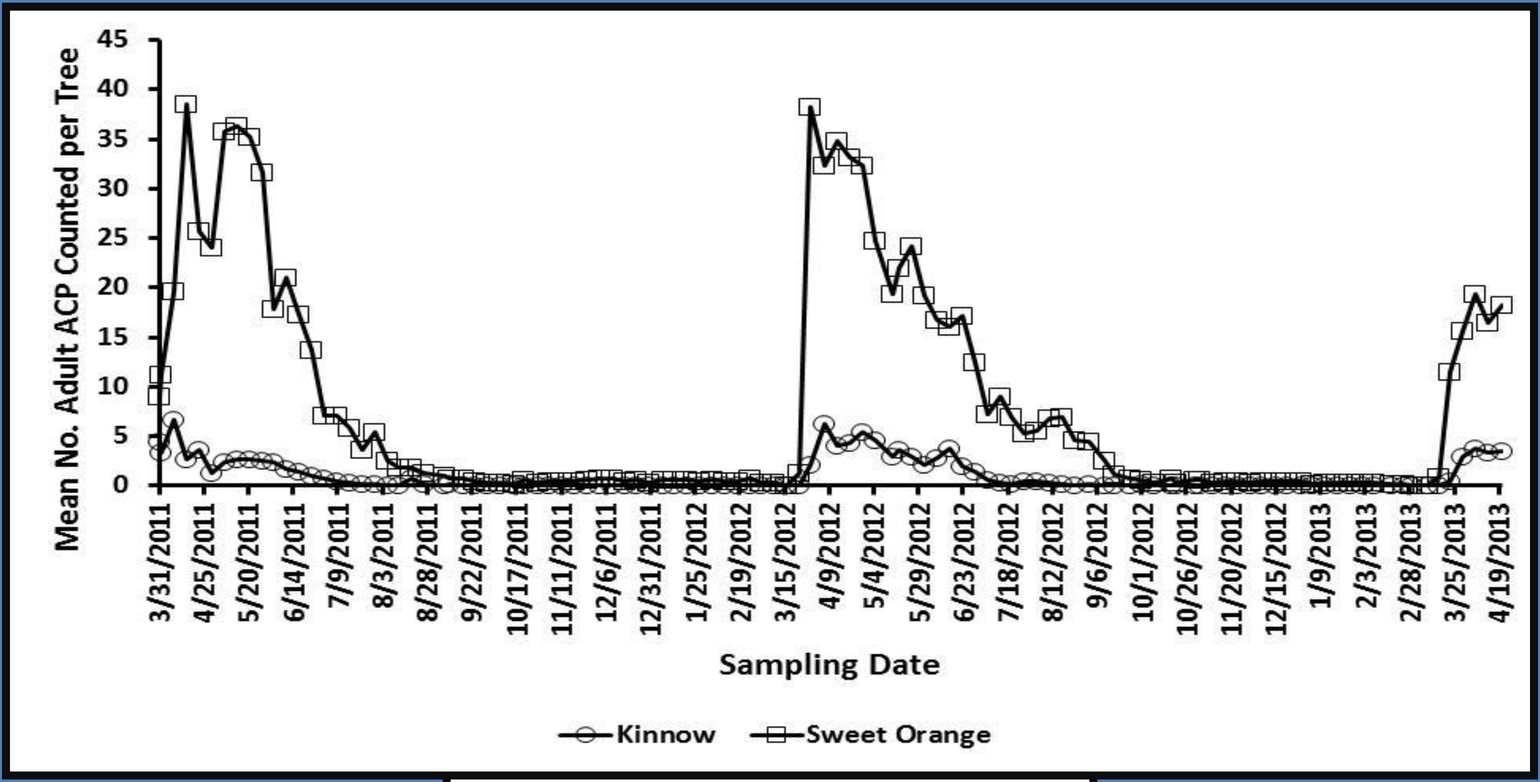
- CA growers have an organization
  - Citrus Research Board (CRB)
  - Growers tax themselves
    - $0.07 (US) per 40lb box of fruit
    - ~$3⁺ million (US) in research funds
- California Citrus Pest and Disease Prevention Committee
  - $$ from CRB for ACP control programs
- USDA (Federal) & CDFA (State) provide some $$ support
- Univ. of CA provides expertise

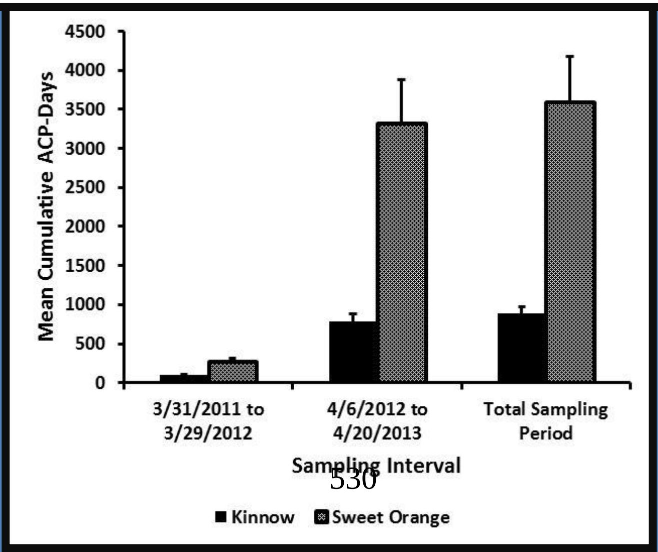



What is the Future for Citrus?

- Commercial citrus production will not go extinct
- Kinnow is still grown in Pakistan
  - 70 yrs after introduction = 80% of citrus production
    - Sweet oranges ~15% of production
    - Lemons, limes, etc. very rare
- New varieties of citrus will be developed
- Genetic engineering may be needed
- Multiple management tactics needed

ACP Population Trends on Kinnow and Sweet Orange in Pakistan





Mandarin from CA Planted in Multan, Pakistan

www.CaliforniaCitrusThreat.org

This web site, funded by the Citrus Research Board, provides users with basic information about ACP, HLB, and how to respond

Follow the action on Facebook And Twitter

¿Se quedará California sin cítricos?

Esto podría suceder si el psílido asiático de los cítricos y la enfermedad que transmite se establece en el estado.

Debemos detenerlo – antes de que sea demasiado tarde.

La peligrosa plaga: el psílido asiático de los cítricos

- Un insecto diminuto (3-4 mm), del tamaño de un áfido.
- Se alimenta de las hojas y tallos de los cítricos.
- Es portador de la enfermedad Huanglongbing (HLB) la cual mata las plantas. También se le conoce como el enverdecimiento de los cítricos.
- Este insecto ya se ha encontrado en el Sur de California.
- Representa una seria amenaza para la producción y cultivo de cítricos en California.

La enfermedad: Huanglongbing (HLB)

- Hace que las hojas se tornen de un color amarillento con moteado. (ver foto a la izquierda)
- Produce frutos amargos, incomibles y deformes.
- Daña la apariencia y reduce el valor de los árboles de cítricos.
- Es mortal para los árboles de cítricos.

La solución: todos jugamos un papel importante

- La detección y eliminación del psílido es la primera línea de defensa contra la enfermedad.
- Es ilegal traer árboles de cítricos a California provenientes de otros estados o países, porque podrían estar infectados con HLB. Asegúrese de plantar sólo árboles de cítricos cultivados en California y que hayan sido certificados como libres de enfermedades.
- Inspeccione sus árboles con frecuencia en busca de señales del insecto o de la enfermedad.
- Si sospecha que sus árboles tienen el psílido asiático de los cítricos, ¡actúe de inmediato! Llame a la línea directa de CDFA al **800.491.1899** o comuníquese con el Comisionado de Agricultura de su condado. ¡No pierda un minuto para hacerlo!

Para conocer más acerca del psílido asiático de los cítricos y el HLB, visite el sitio

PeligranCitricosEnCalifornia.org

En este sitio se pueden descargar materiales impresos en inglés, español, chino y otros idiomas.

CITRUS RESEARCH BOARD

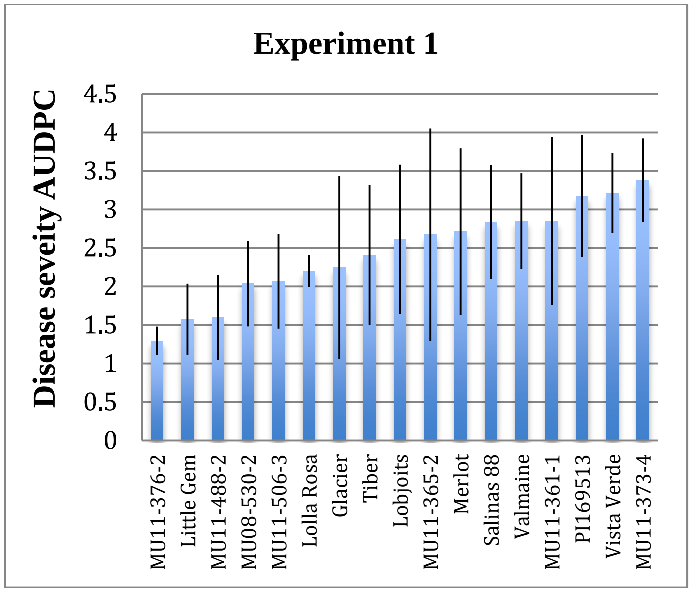
More Information on ACP and the Biocontrol Program

UNIVERSITY OF CALIFORNIA
UC RIVERSIDE | Center for Invasive Species Research

WWW.CISR.UCR.EDU

Attachment A: Figures

Figure 1. Area under disease progress curve (AUDPC) of bacterial leaf spot disease for leafminer-resistant breeding lines and cultivars evaluated in two inoculated greenhouse tests. A lower AUDPC value means less disease symptoms observed and indicates resistant response. Little Gem is the resistant control and Vista Verde is the susceptible control. Breeding lines MU06-857 (=MU08-530-2, green leaf), MU07-838 (=MU11-376-2, red leaf), and MU10-558 (=MU11-506-3, red leaf) were resistant to the disease, while MU09-462-1 (=MU11-506-3, romaine) was moderately resistant to the disease in the two tests. This result suggests that these breeding lines have resistances to both leafminers and bacterial leaf spot.



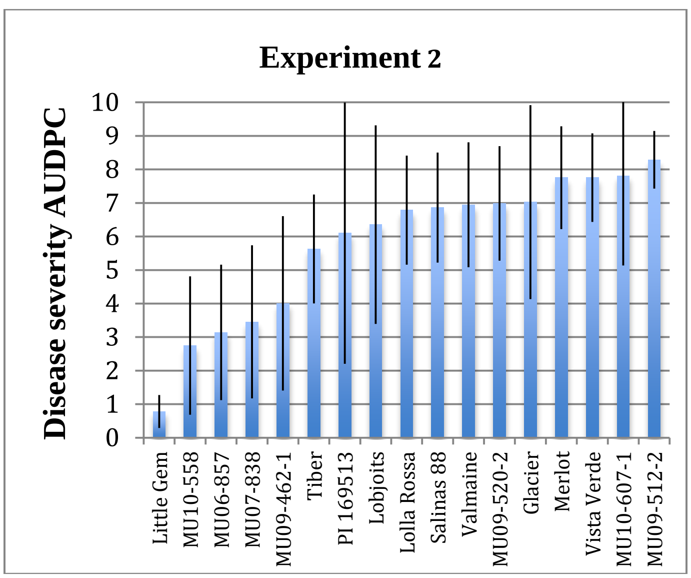
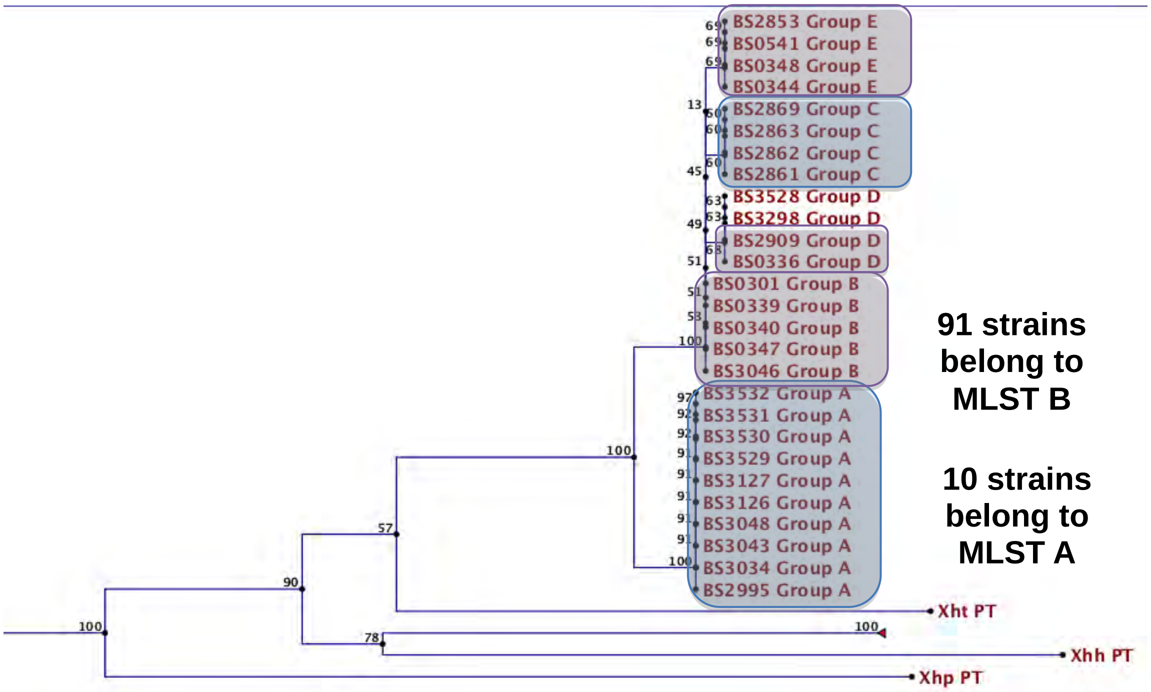


Figure 2: Dendrogram showing the relationships of different multilocus sequence type (MLST) groups of *X. hortorum* (*Xcv*) and *X. hortorum* pathotypes. Blue bubbles indicate strains in particular MLST that do not produce an HR after 30 h on Little Gem. Pink bubbles indicate strains in particular MLST that that do produce an HR after 30 h on Little Gem.



Breeding line	Previous #	DM	LD	LM	TBSV	SL	HH
SM13-A	GRxl-1018	Above average	Average	Above average	✗	Average	Among the best
SM13-B	GRxl-1046	Among the best	Above average	Above average	✓	Above average	Above average
SM13-C	GRxl-1053	Among the best	Average	Above average	✓	Above average	Average
SM13-D	GRxl-1057	Above average	Average	Above average	✓	Average	Average
SM13-E	GRxl-1078	Among the best	Below average	Above average	✓	Average	Below average
SM13-F	S1158-01	Average	Average	Above average	✓	Above average	Among the best
RH08-0464	RH08-0464	Above average	Below average	Below average	✗	Above average	Average

Legend:

DM – downy mildew resistance, LD – lettuce drop resistance, LM – leaf miner resistance, TBSV – resistance to dieback (tested with molecular markers), SL – decay after processing, HH – decay of whole heads

Relative performance to all tested accessions from multiple trials:

- Among the best
- Above average
- Average
- Below average
- Among the worst

TBSV (molecular markers):

- ✓ Resistance marker allele present
- ✗ Resistance marker allele absent

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
WASHINGTON, D.C.

NOTICE OF RELEASE OF BABY LEAF ROMAINE BREEDING LINES OF LETTUCE WITH RESISTANCE TO BACTERIAL LEAF SPOT CAUSED BY Xanthomonas campestris pv. vitians.

Executive Summary

The Agricultural Research Service, United States Department of Agriculture announces the release of two F2:4 breeding populations of lettuce (Lactuca sativa L.) with resistance to bacterial leaf spot (BLS) caused by Xanthomonas campestris pv. vitians. The breeding populations are designated RH12-3370 and RH12-3371 and were selected from the cross Batavia Reine des Glaces × Eruption. In replicated testing, the level of resistance to BLS in these lines was significantly greater than 'Eruption' and equivalent to 'Batavia Reine des Glaces'. Their shelf-life of salad-cut lettuce is commercially acceptable. In limited testing they exhibited susceptibility to leafminers and downy mildew. RH12-3370 and RH12-3371 are romaine type populations with variable leaf morphology. These should be used to select different types of lettuce cultivars possessing BLS resistance and good salad shelf-life for use in baby leaf lettuce production.

Introduction

The popularity of commercially produced and packaged spring-mix salads has increased in the US, and California is the top producer of this product. Baby leaf lettuce (Lactuca sativa L) is the primary component of spring-mix, which typically includes a mixture of a number of different leafy green vegetable species. Baby leaf lettuce is grown at extremely high densities, up to 7.4 million seeds per hectare. The crop is mechanically harvested when the first four true leaves are about 5 to 13 cm (2 to 5 in.) long, typically 20 to 30 days after planting. Approximately 15 to 20 different types of lettuce with unique combinations of leaf shape, margin serration, lobbing, undulation, pliability, savoy and color have been used for baby leaf lettuce production, although most commercially prepared salads contain less than 10 types of lettuce. The diversity of types used in baby leaf production creates a challenge for public plant breeders attempting to enhance the cultivar genepool with new traits such as disease resistance. Introgressing a new trait into a new cultivar of each type is too expensive to be feasible for public breeding programs. Surveys of existing baby leaf cultivars of each type can be executed to determine which types have the greatest need for resistance breeding. This information can be used to prioritize breeding efforts, and screening of 36 commercially used baby leaf cultivars indicated that improved resistance is needed most in red leaf and red romaine type cultivars. Additionally, breeders could select and publicly release early generation (F2 to F4) populations genetically fixed for disease resistance, but with sufficient leaf variability to encompass two or more lettuce types used in baby leaf production. Private seed companies could then select multiple lettuce types from a single resistant population.

Bacterial leaf spot (BLS) of lettuce, caused by Xanthomonas campestris pv. vitians (Xcv), is an economically damaging disease in California during spring and fall production. The pathogen causes small angular leaf spots, which are initially water-soaked, later become necrotic (brown to black) and papery, and eventually coalesce into large necrotic patches. The high planting densities of baby leaf lettuce exacerbate the severity of many lettuce pests, including BLS. Furthermore, the small size and mechanical harvest of the crop reduce the feasibility of culling infected leaves. Consequently, baby leaf crops with bacterial leaf spot disease may be abandoned, which results in a complete yield loss.

Host resistance is an efficient and cost-effective tool to manage BLS of lettuce. Diverse sources of resistance are known including the Latin type cultivar Little Gem, the Batavia type cultivars Batavia Reine des Glaces (synonym Reine des Glaces) and Iceberg, and seven resistant iceberg type breeding lines from the cross (Salad Crisp × Iceberg) × Salinas 88 that were developed by the USDA. 'Little Gem' and its numerous derivatives are used in baby leaf production, while the remaining known sources of resistance are not suitable for baby leaf production. We are reporting the release of two F2:4 (F2 derived F4) breeding populations designated RH12-3370 and RH12-3371 from the cross Batavia Reine des Glaces × Eruption. These populations are genetically uniform for BLS resistance, but genetically variable for leaf morphology. 'Batavia Reine des Glaces' (PI634668, http://www.ars-grin.gov/cgi-bin/npgs/acc/display.pl?1594749; CGN05864, http://applicaties.wageningenur.nl/applications/cgngenis/AccessionDetails.aspx?ID=uh22ve45&acnumber=CGN05864) is an heirloom cultivar with crisp, highly serrate, medium green leaves. The cultivar typically exhibits a degree of leaf cupping and head closure, and may in some cases be considered an iceberg type rather than a Batavia type. 'Batavia Reine des Glaces' has black colored seeds and is highly susceptible to lettuce drop caused by Sclerotinia minor and S. sclerotiorum. The shelf-life of packaged salad prepared from Batavia Reine des Glaces in USDA experiments is sufficient to be considered commercially acceptable, although Batavia Reine des Glaces is not widely used for commercial lettuce production. 'Eruption' (PI 613577, http://www.ars-grin.gov/cgi-bin/npgs/acc/display.pl?1600187) is a dark red colored cultivar developed by the seed company Enza Zaden B.V. for use in commercial baby leaf production. 'Eruption' carries the short leaf 1 (sl1) gene, which confers a diminutive stature to 'Eruption' that is architecturally similar to many Latin type cultivars. Progeny from intertype crosses with 'Eruption' that do not inherit sl1 can have a romaine type architecture. 'Eruption' has white colored seeds. 'Eruption' is resistant to race 1 isolates of V. dahliae and to lettuce drop caused by Sclerotinia minor and S. sclerotiorum, but is susceptible to BLS. The shelf-life of packaged salad prepared from 'Eruption' is inferior to many romaine cultivars, but the cultivar has been used in commercially prepared spring-mix salads.

Development and BLS Resistance of RH12-3370 and RH12-3371

Lettuce is a diploid (2n=2x=18), naturally self-pollinating species, and cultivars are inbred lines. Artificial cross-pollinations were made between 'Batavia Reine des Glaces' and 'Eruption' to produce the F1 generation. The F2:3 and F3:4 generation were produced by growing plants in the greenhouse and allowing each plant to naturally self-pollinate. Seed from each plant was kept separate unless otherwise noted.

Experiments to select for and to evaluate bacterial leaf spot resistance were conducted using greenhouse grown seedlings in plug trays with plant populations of approximately 2,380 plants·m-2. Three diverse Xcv strains (BS339, BS340 and BS347) isolated from diseased plants in California were used as inoculum. Suspensions of bacteria were adjusted to approximately 1 × 108 colony forming units·ml-1 and sprayed on four-week old seedlings until run-off. The seedlings were incubated at near 100 percent humidity for one week prior to disease evaluation. Previous results using this greenhouse assay with 'Batavia Reine des Glaces' and other diverse populations were highly correlated with results from field experiments. Seedlings of F2 Batavia Reine des Glaces × Eruption were grown and evaluated for BLS disease severity, leaf shape, and leaf color. Up to 486 F2 seedlings along with 18 seedlings of 'Eruption' and 'Batavia Reine des Glaces' were grown, and 38 seedlings were selected for low disease severity, romaine type leaf shape and red leaf color. These seedlings were transplanted into larger pots to produce seed. The resulting 38 F2:3 families were subsequently evaluated for BLS resistance and eight potentially resistant families and one susceptible family were selected for retesting. The remaining 29 families were discarded.

The nine selected F2:3 families, their parents and 'Vista Verde' (susceptible control) were evaluated for resistance to BLS in two experiments. 'Batavia Reine des Glaces' had significantly less disease than 'Eruption' and 'Vista Verde' in both experiments (Table 1). Among the F2:3 families, the susceptible selection RH11-1931 had the greatest amount of disease. Three F2:3 families (RH11-1906, RH11-1922 and RH11-1927) had disease levels that were significantly less than 'Eruption', and not significantly different from 'Batavia Reine des Glaces' in both experiments. In addition, the variability between seedlings in RH11-1906, RH11-1922 and RH11-1927 was similar to Batavia Reine des Glaces and not significantly different than the estimated environmental variance, indicating the potential of homozygosity and homogeneity of resistance genes in these families. Families RH11-1922 and RH11-1927 segregated for plants with dark red and green colored romaine shaped leaves. These families were selected for additional testing while the remaining F2:3 families were discarded. Every plant from RH11-1922 and RH11-1927 evaluated for BLS resistance was transplanted into larger pots to produce F3:4 seed. This resulted in 47 F3:4 families from RH11-1922 and 79 F3:4 families from RH11-1927.

Thirty-eight F3:4 families from RH11-1922 and 72 F3:4 families from RH11-1927 were randomly selected and tested for BLS resistance along with 'Batavia Reine des Glaces', 'Eruption' and 'Vista Verde'. 'Batavia Reine des Glaces' and the two populations of F3:4 families had equal amounts of disease, which were significantly less than 'Eruption' and 'Vista Verde' (Table 2). Analysis of disease levels of each F3:4 family within the RH11-1922 and RH11-1927 populations indicate that these populations do not segregate for BLS resistance. The variance between F3:4 families was not significantly different from the estimated environmental variance. Additionally, 100 percent of RH11-1922 F3:4 and 94 percent of RH11-1927 F3:4 families were significantly better than 'Eruption' for disease severity. Equal aliquots of the remaining seed of all F3:4 families from RH11-1922 and RH11-1927 were massed together to produce populations RH12-3370 and RH12-3371.

Salad Shelf-life and Susceptibility to Leafminer and Downy Mildew

Two field experiments were conducted using F2:3 RH11-1922, F2:3 RH11-1927, 'Eruption', 'Batavia Reine des Glaces', and standard check cultivars to assess salad shelf-life and susceptibility to leafminers (Liriomyza langei) and downy mildew (Bremia lactucae) due to natural infestations. These experiments indicate that the levels of susceptibility to leafminers and downy mildew in RH11-1922 and RH11-1927 are similar to their parents. Salad shelf-life was evaluated by harvesting more than 50 fully-grown mature heads of each population, parent, and the baby leaf check cultivars Annapolis (red romaine) and Parris Island Cos (green romaine) and making one bag of salad from each head. Each bag was 22.8 × 15-cm and contained 170 g of 2.5 cm2 lettuce pieces. The bags were triple flushed with N2 prior to sealing. These experiments demonstrated that RH11-1922, RH11-1927 possess shelf-life that is equivalent or improved compared to 'Eruption' and 'Annapolis', similar to 'Batavia Reine des Glaces', but inferior to 'Parris Island Cos'.

Morphological Description

RH12-3370 and RH12-3371 are romaine type populations that segregate for leaf morphology (Fig. 1). RH12-3370 segregates for black and white seed color. When grown to whole head maturity, the plants are generally romaine type with open-tops (rather than closed-top hearting type romaine). Variability for days to flower and seed set as well as resistance or susceptibility to other diseases or physiological defects not discussed in this report are unknown.

Availability and Use of RH12-3370 and RH12-3371

Limited samples of seed are available for distribution to all interested parties for the development and commercialization of new cultivars. These families are resistant to BLS and have commercially acceptable shelf-life when used in packaged salads. They should be used to select inbred lines of lettuce suitable for baby leaf lettuce production. Based on limited field tests, selection of red or green romaine type cultivars is feasible. It is requested that appropriate recognition be made if these breeding lines contribute to research or the development of new germplasm, breeding lines, or cultivars. Written requests should be sent to Dr. Ryan Hayes, USDA-ARS, 1636 E. Alisal St., Salinas, CA 93905, or Ryan.Hayes@ars.usda.gov.

Ryan J. Hayes, Mark Trent, Beiquan Mou, Ivan Simko, and Carolee T. Bull
Agricultural Research Service, United States Department of Agriculture, Salinas, CA 93905.

Signature:

K Simmons

Deputy Administrator, Crop Production and Protection
Agricultural Research Service, U.S. Department of Agriculture

Date 7/18/13

Table 1. Bacterial leaf spot (BLS) disease severity of nine $F_{2:3}$ families from the cross Batavia Reine des Glaces × Eruption, the resistant cultivar Batavia Reine des Glaces, and the susceptible cultivars Eruption and Vista Verde in two replicated greenhouse experiments inoculated with *Xanthomonas campestris* pv. *vitians* isolates BS339, BS340 and BS347.

	Experiment 1			Experiment 2		
		BLS disease severity[z]			BLS disease severity[y]	
Cultivar name or family number	Number of plants[x]	Mean	Variance between plants	Number of plants	Mean	Variance between plants
Batavia Reine des Glaces	32	1.3 fgh[w]	1.0	36	2.6 de	1.3
Eruption	31	2.9 a	1.9	36	3.7 ab	2.9
RH11-1906	35	2.0 cdef	0.3	36	2.9 cd	2.0
RH11-1907	31	2.3 abc	1.3	36	2.8 ce	2.3
RH11-1909	31	2.0 cde	1.3	36	2.9 ce	2.0
RH11-1912	36	2.6 abc	0.1	36	3.1 bcd	2.6
RH11-1922	34	1.6 def	0.6	36	2.5 def	1.6
RH11-1927	33	1.4 eg	0.6	36	2.2 ef	1.4
RH11-1931[v]	28	2.7 ab	2.3[†]	36	3.3 ac	2.7
RH11-1933	21	2.1 bd	1.5[†]	36	3.1 acd	2.1
RH11-1936	33	2.6 abc	0.8	36	3.1 acd	2.6
Vista Verde	34	2.9 a	1.1	36	3.8 a	2.9
Environmental variance[U]			1.3			2.4

[z]Disease severity was evaluated on the top three leaves of each plant where 0 = no disease to 3 = severe disease.

[y]Disease severity was evaluated on each plant as 0 = no disease to 5 = severe disease.

[x]Total number of plants tested from four reps as a randomized complete block design with up to nine plants per rep.

[w]Means with different letters are significantly different at $P < 0.05$ using the Tukey multiple comparison procedure.

[v]Susceptible $F_{2:3}$ family selected and retested as a control.

[U]The environmental variance was calculated as the variance among seedlings pooled across cultivars.

[†]/Variance of $F_{2:3}$ family significantly greater than the environmental variance at $P < 0.05$ using an F-test.

Table 2. Bacterial leaf spot disease severity of two populations of $F_{3:4}$ families from Batavia Reine des Glaces × Eruption, the resistant cultivar Batavia Reine des Glaces, and the susceptible cultivars Eruption and Vista Verde in a greenhouse experiment inoculated with *Xanthomonas campestris* pv. *vitians* isolate BS347.

			Bacterial leaf spot disease severity[z]		Percent
Cultivar name or Population number	Number of replications	Number of $F_{3:4}$ families[y]	Mean	Variance between $F_{3:4}$ families or cultivar replicates	$F_{3:4}$ families significantly better than Eruption[x]
Batavia Reine des Glaces	22		1.2 a[w]	0.08	
Eruption	22		3.0 b	0.08	
RH11-1922		38	1.2 a	0.05	100
RH11-1927		72	1.2 a	0.08	94
Vista Verde	22		3.0 b	0.06	
Environmental variance[v]				0.07	

[z]Disease severity was evaluated on each plant as 0 = no disease to 5 = severe disease.
[y]$F_{3:4}$ families derived from self-pollination of single plants randomly selected from $F_{2:3}$ families RH11-1922 and RH11-1927. $F_{3:4}$ families were assigned to nine-plant-plots using an augmented randomized complete block design with 22 blocks and eight plots per block.
[x]Mean disease severity significantly lower than Eruption at $P < 0.05$ using the Tukey multiple comparison procedure.
[w]Means with different letters are significantly different at $P < 0.05$ using the Tukey multiple comparison procedure.
[v]Environmental variance was calculated as the variance of replicated plots pooled across cultivars.

Fig. 1. Leaves of $F_{2:3}$ families RH11-1922 (A) and RH11-1927 (B) grown in a field experiment at Spence farm near Salinas, CA. RH11-1922 and RH11-1927 are from the cross Batavia Reine des Glaces × Eruption. The experiment was planted on June 26, 2012; pictures were taken when plants had four to five expanded leaves. Each leaf is from a different plant.

Attachment D: Presentations given and anticipated publications

Presentations given:

#1. Bull, C.T., Trent, M.A., Hayes, R.J. 2013. Internal colonization of lettuce leaves by *Xanthomonas campestris* pv. *vitians* is influenced by lettuce cultivar. Phytopathology 103:S2.21. (Oral presentation at the American Phytopathological Society Annual Meeting, Austin, TX, August 9-15, 2013)

#2. Hayes R.J., Trent, M.A., and Bull, C.T. 2013. A single gene confers resistance to bacterial leaf spot in the lettuce cultivar La Brillante. Oral presentation at the Americal Society of Horticultural Science, July 22 – 25, 2013, Palm Desert, CA.

Full length journal publications in preparation:

#3. Releases of green leaf, red leaf, and romaine lettuce breeding lines with resistances to leafminer and bacterial leafspot and/or good shelf-life for baby leaf and whole plant productions. (Mou et al., release notices and articles to be submitted to HortScience journal)

#4. Simko, I., Hayes, R. J., Bull, C.T, Mou, B., Trent, M.A. Release of lettuce breding lines with polygenic resistance to downy mildew (describes performance of seven breeding lines with resitance to downy mildew).

#5. Simko, I., Atallah, A. J., Ochoa, O. E., Antonise, R., Galeano, C. H., Truco, M. J., and Michelmore, R. W. Identification of QTLs conferring resistance to downy mildew in legacy cultivars of lettuce (describe genes involved in downy mildew polygenic resistance).

#6. Hayes, R.J. Trent, M.A., Mou, B., Simko, I., and Bull, C.T. Baby leaf lettuce germplasm enhancement: developing diverse populations with resistance to bacterial leaf spot caused by *Xanthomonas campestris* pv. *vitians*. (describes a new baby leaf lettuce breeding procedure)

#7. *Xanthomonas hortorum* pv. *vitians* pv. nov and *Xanthomonas hortorum* pv. *radicchio* pv. nov. new pathovars of *X. hortorum* causing bacterial leaf spots on lettuce (*Lactuca sativa*) and radiccho (*Cichorium intybus*), respectively. (Bull et al., will clarify the taxonomy of *Xcv* strains transferred to *Xanthomonas hortorum*)

#8. Hayes, R.J. Trent, M.A., Michelmore, R., Truco, M., and Antonise, R., and Bull, C.T. The inheritance of bacterial leaf spot resistance in the lettuce cultivars La Brillante, Little Gem, and Pavane. (described a new lettuce gene conferring resistance to *Xcv*)

#9. Population dynamics of *Xanthomonas campestris* pv. *vitians* is dependent on the host genotype. (Bull et al., will describe initial research on strain by cultivar interactions)

Attachment E: Citations

- Barak, J. D., Koike, S. T., Gilbertson, R. L. (2001) The role of crop debris and weeds in the epidemiology of bacterial leaf spot of lettuce in California. Plant Dis. 85:169-178.
- Hayes, R.J., and Liu Y.B. 2008. Genetic variation for shelf-life of salad-cut lettuce in modified-atmosphere environments. J Amer Soc Hort Sci. 133:228–233.
- Simko, I. and Piepho, H. P. 2011. Combining phenotypic data from ordinal rating scales in multiple plant experiments. Trends Plant Sci. 16: 235-237

Economic Impact of Removing the Maturity Standard for California Granny Smith Apples

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Introduction

The California Apple Commission (CAC) represents the state's growers and handlers of fresh apples. The Commission pursues multiple objectives, including market development, education, and research. The CAC also interacts with policymakers and regulatory agencies on issues pertaining to the California apple industry.

Acting on the request of its Board of Directors, the CAC engaged with the California Department of Food and Agriculture (CDFA) to repeal the maturity standard for California Granny Smith apples, which had been in place since 1994. The standard was repealed in time for the 2011/2012 crop year.

In November 2012, CAC retained the services of D.W. Block Associates, LLC (DWB) to estimate the economic impact of removing the maturity standard. This was part of a larger initiative that dealt with other aspects of the standard, such as its relationship with consumer taste preferences.

The study was conducted between October 2012 and July 2013 and consisted of a review of the economic literature, acquisition and processing of data, and an econometric analysis, the results of which are contained in this final report.

The principal investigators for this study were James Ahern, Ph.D., Associate Consultant, Agricultural Economic Analysis & Market Research, and Kyle Birchard, Senior Research Associate with D.W. Block Associates, LLC.

Acknowledgements

This work was funded through the USDA Specialty Crop Block Grant Program, in conjunction with the California Department of Food and Agriculture. Government agencies, industry organizations, and individual industry members provided additional assistance with data and background information. These include representatives from USDA Agricultural Marketing Service, USDA National Agricultural Statistics Service, California Department of Food and Agriculture, and the U.S Apple Association.

Executive Summary

Following are the three key findings of the study:

1. **Results of the econometric model presented in this study indicate that, for nine of 13 crop years, Granny Smith sellers would have obtained additional revenues in the absence of a maturity standard.**

   The results from the pricing model developed in this study suggest that the early-season premium obtained by California shippers would have been maintained in the absence of the maturity standard. Higher revenues would have been obtained due to a longer shipping period and an overall higher price level for Granny Smiths over the duration of the season.

2. **Model results show that, from 1998 to 2010, the California Granny Smith maturity standard could have delayed the start of shipments by up to five weeks in some years.**

   By prohibiting the shipment of *any* Granny Smiths from a county until the maturity standard was met, marketable fruit was likely kept out of the market. While this is an intuitive finding, without explicit data it is difficult to estimate the likely effect of the standard on shipment patterns, pricing, and revenues. This study appears to be the first to attempt to estimate the magnitude of the effect.

3. **The effect of the Granny Smith maturity standard on California industry revenues is estimated at a negative $18.7 million over the 13 years for which data were available.**

   The maturity standard is estimated to have reduced industry revenues in nine of 13 years and increased revenues in four years.

   With over 18.4 million boxes of Granny Smiths shipped between the 1998 and 2010 seasons, this figure corresponds to a loss of approximately $1.01 per box on average over the 13-year period.

These results are summarized in **Table ES1**, on the following page.

Table ES1: Cumulative Effect of California GS Maturity Standard on Industry Revenues, 1998-2012 (2012 Dollars).

Crop Year	Actual Revenue	Estimated Revenue w/o Maturity Std	Effect of Maturity Standard	Actual Boxes	Effect/Box
1998/99	$29,965,469	$29,678,339	$741,702	1,116,498	$0.26
1999/00	$29,379,099	$32,926,950	($3,447,322)	1,661,708	($2.14)
2000/01	$34,137,052	$33,554,262	($124,296)	1,373,057	$0.42
2001/02	$24,683,113	$28,453,905	($3,583,155)	1,226,123	($3.08)
2002/03	$54,566,273	$55,338,107	($738,573)	2,038,501	($0.38)
2003/04	$42,819,834	$43,546,009	($1,428,568)	1,917,234	($0.38)
2004/05	$25,387,337	$27,455,642	($2,478,267)	1,522,188	($1.36)
2005/06	$32,664,615	$32,011,003	$267,985	1,651,577	$0.40
2006/07	$35,345,227	$37,155,636	($2,160,492)	1,617,379	($1.12)
2007/08	$18,539,934	$20,953,566	($2,756,873)	944,772	($2.55)
2008/09	$43,732,151	$45,368,763	($2,232,801)	1,552,127	($1.05)
2009/10	$14,651,029	$14,552,716	($241,227)	839,175	$0.12
2010/11	$17,502,093	$21,059,789	($3,485,658)	948,167	($3.75)
2011/12*	$31,875,906			1,113,778	
2012/13*	$27,674,770			751,244	
Total	**403,373,226**	**422,054,688**	**($18,681,462)**	**18,408,506**	**($1.01)**

**2011/12 and 2012/13 revenues and boxes omitted from total.*

*   *   *   *   *

Profile of the U.S. Granny Smith Market

Production and Consumption Trends

California and Washington are by far the largest U.S. producers of Granny Smiths, so much so that government and industry sources do not break out Granny Smith production for other states. While imports from southern hemisphere producers are estimated to make up a larger proportion of Granny Smith supply than California production, this does not overlap much, if at all, with California. In addition, data at the level of detail considered here are scarce for imports. **Therefore**, **the analysis focuses exclusively on the U.S. domestic market supplied by Washington and California**.

A six-year history of the domestic U.S. supply of Granny Smiths is shown in **Table 1**, below. Washington and California supply were taken from industry reports from their respective states; supply from Chile and other countries were calculated by multiplying U.S. imports from each country by the share of Granny Smiths compared to all apples grown in that country.

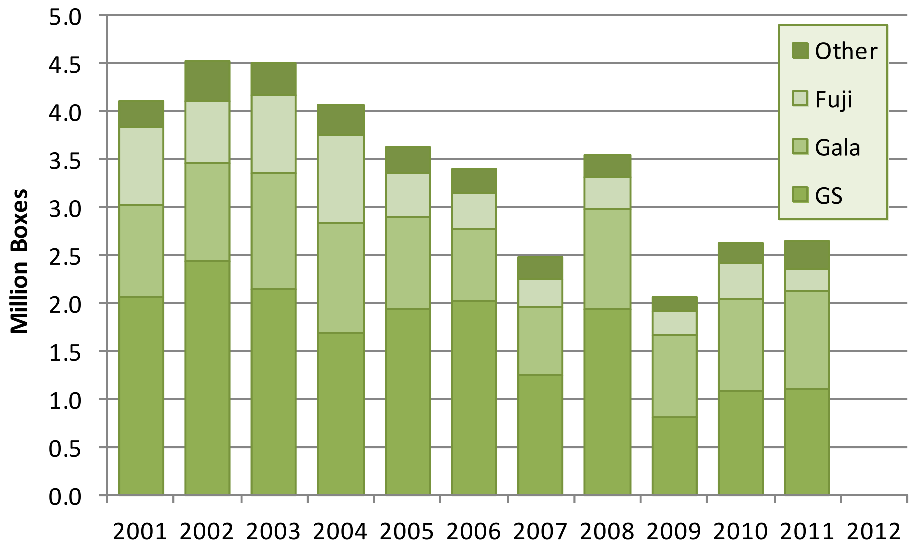
Table 1: Estimated U.S. Domestic Granny Smith Supply by Source (Thousand Boxes).

	2007	2008	2009	2010	2011	2012
Washington	12,847	14,577	12,684	13,004	12,950	n/a
California	945	1,552	839	948	989	n/a
Imports from Chile	1,627	1,222	1,145	1,521	1,103	1,480
Other imports	383	274	348	342	451	492
Total U.S. Supply	15,802	17,625	15,016	15,815	15,493	n/a
CA % of Total	*6%*	*9%*	*6%*	*6%*	*6%*	*n/a*

Sources: Yakima Valley Growers-Shippers Association, California Apple Commission, World Apple and Pear Association, U.S. International Trade Commission, DWB estimates

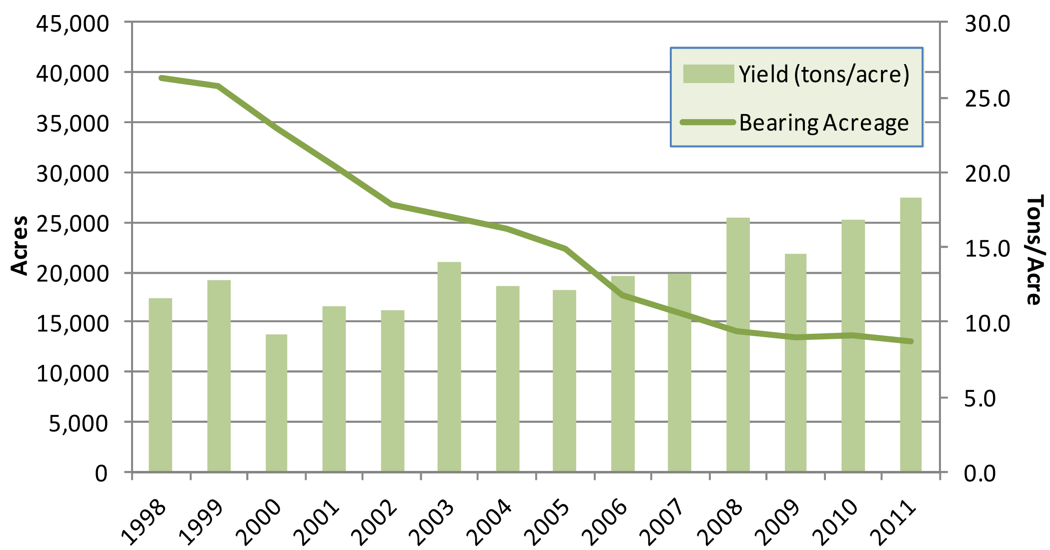
California Granny Smith production has experienced a long-term decline over the past ten years, reflecting similar trends in several other apple varieties grown in the state. California's end-of-season pack-out figures are reported in **Figure 1**, below. Since the 2001 crop year, Granny Smiths have accounted for as much as 60 percent of the state's total apple shipments (in 2006) and as little as 39 percent (in 2009). While acreage data are not reported by variety, California has also experienced a drop in bearing acreage for all apples, which declined from 40,000 acres in 1998 to 13,000 acres in 2011, a trend illustrated in **Figure 2**, below (note also the steady increase in yields over this period).

Figure 1: California Apple Pack-Out, 2001-2011.



Source: California Apple Commission

Figure 2: California Apple Bearing Acreage and Yield, 1998-2011 (All Varieties).



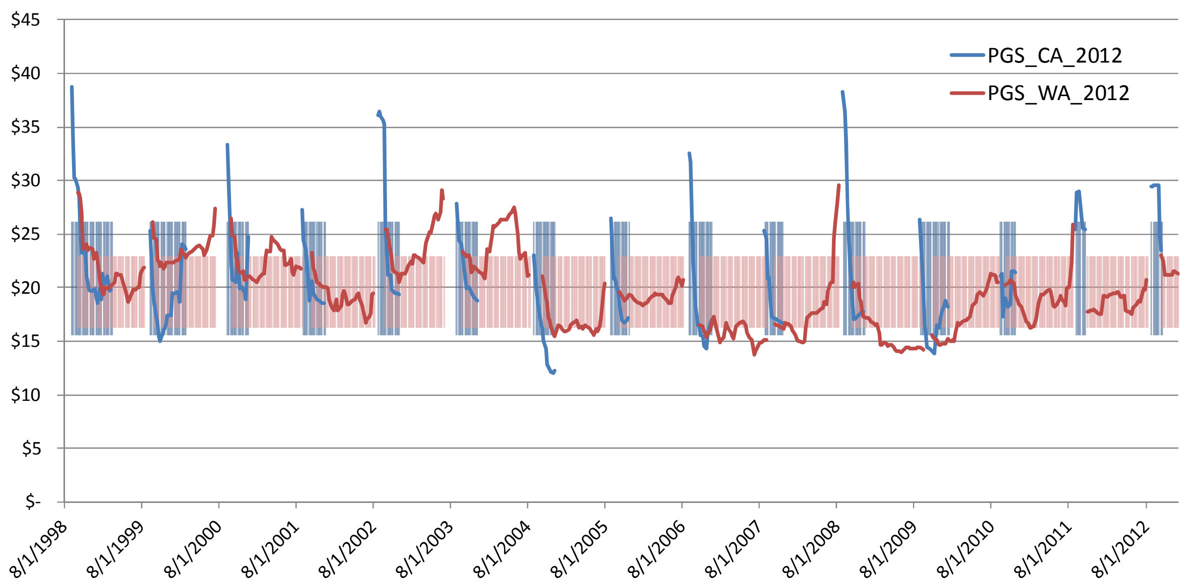
Source: California County Agricultural Commissioners/USDA-NASS

Granny Smith Pricing

Washington State produces approximately 90 percent of U.S. Granny Smiths, which makes the timing of the harvest critical to the marketing of California's crop: California has a limited time period in which to capture premium prices before the onset of the later-season Washington harvest. As shown in **Figure 3** below, California has received a premium price for new-crop Granny Smiths for most of the past 15 years. This premium typically declines rapidly as the new Washington crop approaches.

There is a negative but weak relationship between total crop size and price for Washington and California (as measured by total movement during the crop year): a linear trendline fit for crop size and pricing showed that a one-percent increase in the size of the Washington crop in a given year was associated with a California price decrease of 0.15 percent. The effect of the California crop size was even smaller, with a one-percent increase in crop size associated with a 0.01 percent decrease in price. It is important to note that these are very rough approximations, and a more thorough analysis, taking more factors into account, will be provided by this study.

Figure 3: Weekly Average Domestic Granny Smith Price per Box (2012 Dollars).

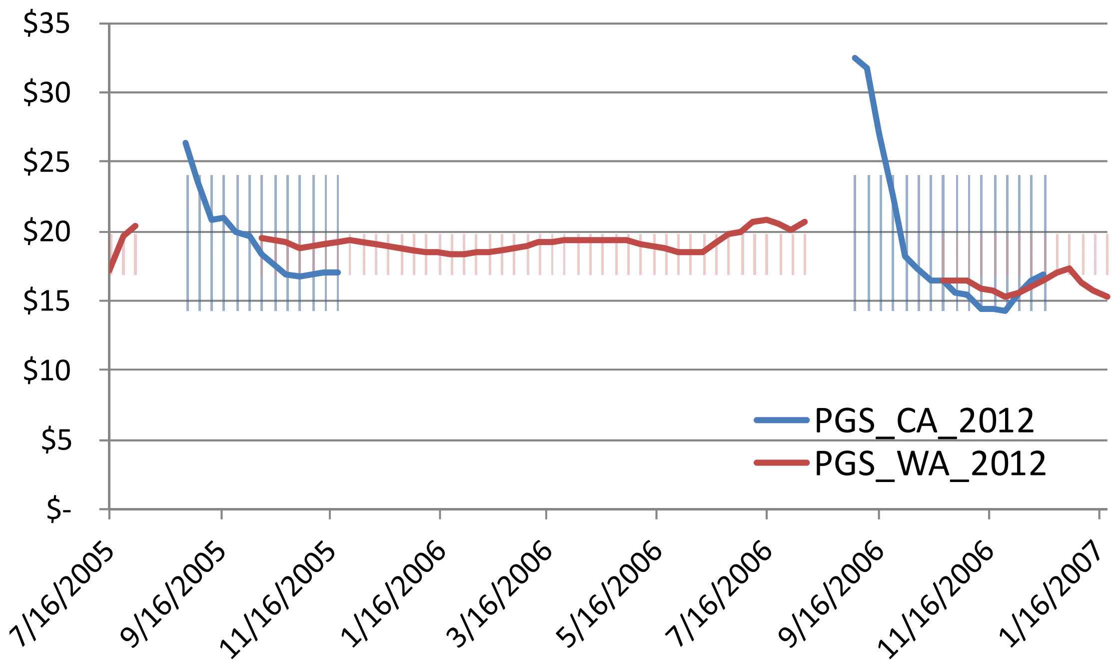


Source: USDA-AMS Fruit and Vegetable Market News

The standard deviation for each price series is shown by the shaded bars – pink for Washington, blue for California.

A closer look at the evolution of Granny Smith Pricing over time (the 2005- and 2006-crop years in this case) illustrates the relationship of California and Washington pricing, as in **Figure 4** below. For the period of time when California was the only supplier of new-crop Granny Smiths, there was often a substantial premium for California over Washington pricing. This premium typically disappeared over a three-to-six-week period, and the California price converged with the Washington price as new-crop Washington apples began to ship. California Granny Smiths typically sold at a discount after Washington entered the market, but in some cases, California pricing improved at the end of its shipping period, as can be seen in the 2005/2006 and 2006/07 crop year pricing in Figure 4.

Figure 4: Weekly Average Domestic Granny Smith Price per Box (2012 Dollars), 2005- and 2006-Crop Years.



Source: USDA-AMS Fruit and Vegetable Market News

Throughout this report, the prices reported are fresh, U.S. Extra Fancy (California) and Washington Extra Fancy grades, size 100s, aggregated on a weekly basis, for 40-pound boxes, covering crop years from 1998/99 to 2012/13. Pricing for organic product was excluded. Data collection methods are detailed in the Appendix.

The Granny Smith Maturity Standard

Origins of the Maturity Standard

In the mid-1990s, members of the California Granny Smith Association enacted a maturity standard for the state's Granny Smith production. This came about due to concerns of some in the industry that immature apples were being marketed, the logic being that these apples were of inferior quality and could negatively impact consumer demand for Granny Smiths that shipped later in the season (CAC 2010).

The maturity standard was based on the results of a testing procedure developed by researchers at University of California, Davis. The standard prohibited the shipping of Granny Smiths from any county until a sample of apples reached a reading of 2.5 on the Starch-Iodine test scale. The standard applied to all Granny Smith apples grown in a county. For example, no Granny Smiths could be shipped from anywhere in Fresno County until an official sampling of apples within the county attained a 2.5 average on the test.

Criticism and Repeal

After its adoption, complaints began to mount from growers and shippers about the idiosyncrasies of the maturity standard. The 2.5 average reading was considered by some to be arbitrary, especially in light of later research showing that many consumers preferred apples with lower SI readings. The release dates were controversial: in some years, northern counties met the standard before southern counties, and there were also reports of fruit being released in one county, while, in a nearby county, fruit was prevented from shipping because the county sample had not met the standard. Finally, some observers believed the standard sent a misleading message that once a county's apples were released, then all the apples in that county were suitable for shipping (CAC 2010).

Responding to industry requests and work by the CAC, CDFA repealed the maturity standard for Granny Smith apples in July 2011.

The issue this study addresses is whether the maturity standard caused unwarranted delays in shipping Granny Smith apples, resulting in lost early-season revenues when prices were highest.

Initial Analysis

In order to estimate the effect of the maturity standard on California Granny Smith shippers, detailed price and shipment data are needed. The approach described below used weekly market data for two reasons. First, annual and monthly-level data do not capture the important timing aspects of the market. A second reason was that daily market data can exhibit a high degree of variation ("statistical noise") that obscures the underlying market dynamics. Daily data are also problematic because they often have missing values that can complicate statistical analyses. Weekly aggregated data were therefore considered to be the most appropriate for this analysis.

Price and shipment data were obtained from USDA-AMS Fruit and Vegetable Market News reports (FVMN) dating back to 1998, the earliest time period for which these data were available. FVMN captures data on 100 percent of Washington apple shipments and approximately 95 percent of California statistics, and as such are considered a reliable indicator of the apple market for these states.

ANOVA

The initial look at the data used an analysis of variance (ANOVA) procedure. This is typically the first step in an econometric analysis, and was used here to obtain an estimate of the effect of the maturity standard on market pricing. The ANOVA grouped California Granny Smith prices into two sub-samples – years with the maturity standard (1998-2010) and years without the standard (2011-2012) – and identified whether these sub-sample means were equal. All prices are reported in real (2005) dollars.

The results of this ANOVA showed that when the maturity standard was in effect, California Granny Smith prices averaged approximately $17.55 per box. In the two years since the maturity standard was repealed, the California Granny Smith price was over $10 higher per box than when the maturity standard was in effect. The relevant statistics are shown in bold text in **Table 2** below.

In a counterintuitive result, the coefficient of variation (CV) of the ANOVA indicates pricing in the post-maturity standard period was less volatile, meaning that Granny Smith pricing was both higher and more stable after the maturity standard was repealed. Typically, one would expect a higher CV in a smaller data set (the two years after the repeal of the standard). It remains to be seen whether these results will hold in future crop years.

Table 2: ANOVA: California Granny Smith Price per Box, During/After Maturity Standard, 1998-2012.

	Sum of squares	df	Mean square	
Treatment	1491.33	1	1491.33	
Residual	3914.09	230	17.0178	
Total	5405.42	231	23.4001	
$F(1, 230) = 1491.33 / 17.0178 =$ **7.6334*** $F_{CRIT}(1, 230)$ at $\alpha = 0.05 =$ **3.8822**				
Level	# observations	**mean**	std. dev	**CV**
0 (After maturity std.)	15	**27.8405**	2.0918	**0.0751**
1 (During maturity std.)	217	**17.5531**	4.1717	**0.2377**

Notes: Grand mean = 20.944, *-significant at $\alpha = 0.05$ level.

Since pricing for all apples in 2011 and 2012 was notably higher than in previous years, a second ANOVA was run, comparing the differential between the California and Washington Granny Smith prices and the average price of all apples. This is reported in **Tables 3 and 4 below**. Note that, while California Granny Smith pricing improved notably (over $3 per box) after the repeal of the maturity standard, no such effect was found in Washington pricing. This could imply that the change in policy was indeed a driver for increased revenues for California suppliers.

Table 3: ANOVA: Price Differential for California Granny Smiths vs. All-Apple Price per Box, During/After Maturity Standard, 1998-2012.

	Sum of squares	df	Mean square	
Treatment	148.69	1	148.69	
Residual	2035.53	230	8.85012	
Total	2184.22	231	9.45549	
$F(1, 230) = 148.69 / 8.85012 =$ **16.8009*** $F_{CRIT}(1, 230)$ at $\alpha = 0.05 =$ **3.8822**				
Level	# observations	**mean**	std. dev	
0 (After maturity std.)	15	**3.0384**	2.2154	
1 (During maturity std.)	217	**-0.2171**	3.0176	

Grand mean = -0.00658. *-significant at $\alpha = 0.05$ level.

Table 4: ANOVA: Price Differential for Washington Granny Smiths vs. All-Apple Price per Box, During/After Maturity Standard, 1998-2012.

	Sum of squares	df	Mean square	
Treatment	32.0653	1	32.0653	
Residual	2044.52	634	3.22479	
Total	2076.58	635	3.27021	
$F(1, 634) = 32.0653 / 3.22479 =$ **9.94335*** $F_{CRIT}(1, 634)$ at $\alpha = 0.05$ = **3.8562**				
Level	# observations	**mean**	std. dev	
0 (After maturity std.)	53	**-0.49536**	1.5543	
1 (During maturity std.)	583	**0.31705**	1.8158	

Grand mean = 0.24935. *-significant at $\alpha = 0.05$ level.

Another way of looking at the issue is to consider the price obtained when California is the only new crop supplier in the marketplace. In this case, California Granny Smith shippers received $22.40 per box in the period between the start of the California shipping season and the start of the Washington crop, compared to $15.90 per box after Washington product began shipping. The relevant statistics are shown in bold in **Table 5** below.

Table 5: ANOVA: California Granny Smith Price per Box When CA is Sole Supplier of New Crop, 1998-2012.

	Sum of squares	df	Mean square	
Treatment	2240.57	1	2240.57	
Residual	3164.85	230	13.7602	
Total	5405.42	231	23.4001	
$F(1, 235) = 2240.57 / 13.7602 =$ **162.83*** $F_{CRIT}(1, 230)$ at $\alpha = 0.05$ = **3.8822**				
Level	n	**mean**	std. dev	**CV**
0 (CA+WA supply)	155	**15.9932**	2.1362	**0.1336**
1 (CA only supply)	82	**22.4003**	5.5598	**0.2482**

Grand mean = 18.1971. *-significant at $\alpha = 0.05$ level.

These initial results suggested that the maturity standard had a negative effect on California pricing during the years analyzed. In order to arrive at a more accurate figure, a more detailed economic model has been developed, and will be described in the next section.

Economic Model of the Granny Smith Maturity Standard

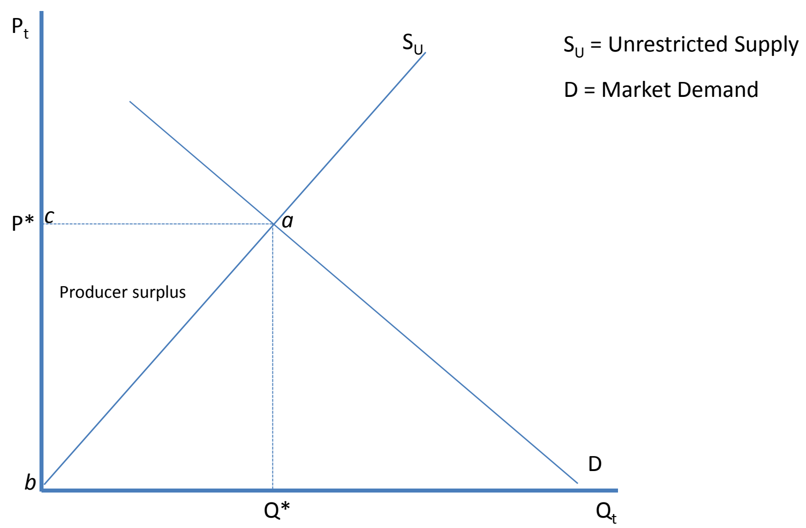
Conceptual Overview

As mentioned previously, Granny Smith pricing exhibits a strong seasonal pattern as first California and then Washington State enter the harvest season over the course of the year. The timing of the Granny Smith harvest is critical to the marketing of California's crop: suppliers have a limited time period in which to capture premium prices prior to the onset of the later-season Washington crop.

In an unrestricted market, California shippers are free to move product at any time according to market conditions and fruit quality; however, with a maturity standard in effect, movement of otherwise marketable fruit may have been artificially delayed. These two possibilities are illustrated below.

Without the maturity standard, the Granny Smith market can be represented, in the short-run, with a downward-sloping demand curve and an upward-sloping, supply curve, as in **Figure 5**. The fresh market is assumed to clear at point "*a*" on the graph, at price P* and quantity Q*. Producer surplus, the benefit producers receive above their marginal production costs (*i.e*, the supply curve), is shown by the shaded area, below.

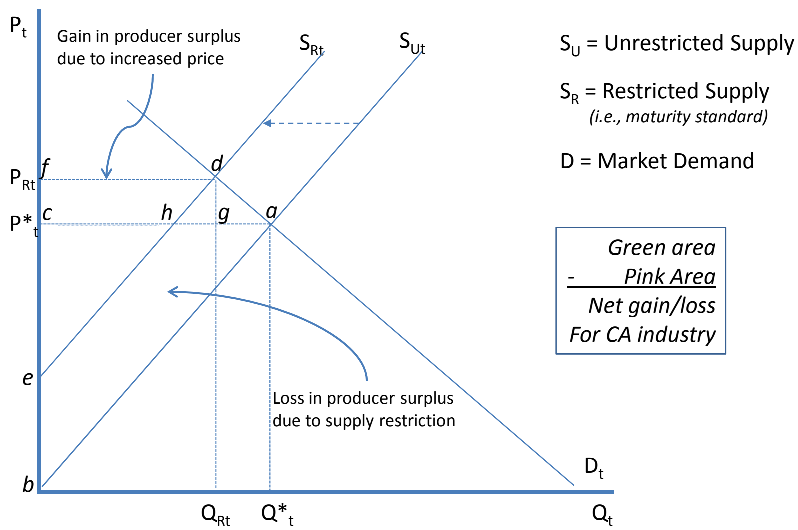
Figure 5: Unrestricted Granny Smith Market



If Granny Smith shipments are delayed due to a maturity standard, there will be a temporary drop in California supply, as localized California shippers are prevented from entering the market. This is reflected in the leftward shift of the supply curve, from S_U to S_R, as illustrated in **Figure 6** below. The expected effect is an increase in market price to P_R and a decrease in quantity sold to Q_R due to the supply restriction.

The change in producer surplus due to the decrease in quantity supplied is given by the area of the red-shaded region in the chart, denoted by the polygon *abeh*. The change in producer surplus due to the increased price caused by the restriction is shown in the green-shaded area, denoted by polygon *dhcf*. If *abeh* is larger than *dhcf*, then the maturity standard would have a negative impact on California industry revenues. This would occur if the price elasticity of Granny Smiths is relatively large (e.g., a one percent increase in price results in greater than one percent decrease in quantity demanded). A review of the literature on price elasticities suggests that this is indeed the case, so one would expect the maturity standard to negatively impact California Granny Smith producer welfare.

Figure 6: Restricted Market Due to Maturity Standard



Once the maturity standard has been met, the market reverts to the unrestricted case shown in Figure 5; however, the initial delay will cause California marketers subsequently either to sell the same amount of apples over a shorter time period, or sell product later in the season, when supplies from competing regions are more abundant. In either case, prices realized after the maturity standard has been met would likely respond somewhat negatively.

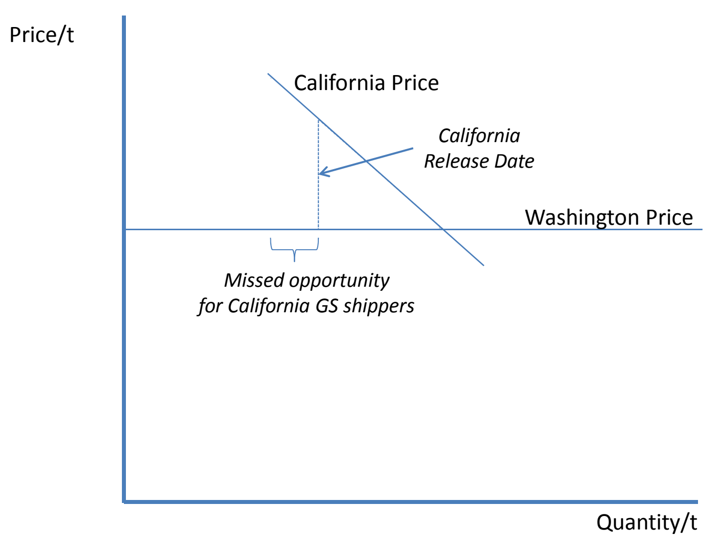
While the producer surplus concept (*i.e.*, P>Marginal Cost) described above would require data on grower production costs in order to estimate a supply function (the summation of grower incremental/marginal costs), the data that were available for this study do not allow for such an estimate, and so the benefit-cost framework is not used here. Rather, the economic impact will be conservatively defined as the net present value (NPV) of the revenues foregone or gained as a result of the maturity standard (as in Table ES1).

Price dynamics: California vs. Washington

As the above conceptual model implies, a key focus of this analysis is the evolution of California Granny Smith pricing over time. **Figure 7**, below, shows a generalized relationship between California's Granny Smith release date and market pricing, Over the 15-year history for which data are available, California prices were consistently highest at the beginning of the shipping period in each crop year. By the time Washington began shipping, the California price converged with the Washington price, after which fruit often sold at a discount. These two facts are consistent with the assumptions in the conceptual model.

Therefore, a price model must be developed that is capable of estimating what California Granny Smith pricing *would have been*, if there had been no maturity standard and suppliers were free to ship product earlier. This price model will then be coupled with estimates of shipment volume over this time period to arrive at an estimate of revenues that were foregone due to the maturity standard.

Figure 7: Price behavior of California Granny Smiths with maturity standard



Note that, if California represents a large enough portion of the supply in the early shipping period, it will affect the price as well, and the model should account for this.

Additional questions arise when taking the long run into account. For example, if Granny Smith growers were negatively impacted by the maturity standard in the early years of its use, they may have been induced to take Granny Smith acreage out of production in favor of other varieties, or, alternatively, exit the market. This would affect subsequent pricing, production volume, and profitability of other California-grown varieties. The focus of this study is specifically on the annual incidence of the maturity standard, and these long-run effects are not addressed by this model.

Literature Review

Economic impacts of commodity promotion programs

Economic evaluation of commodity commission activities often centers on the efficacy of generic promotion and advertising programs. Many of these evaluations are carried out in compliance with federal commodity research and promotion (i.e., "checkoff") programs that are funded through industry assessments. There are currently 19 federal checkoff programs ranging from beef cattle, dairy, and eggs to multiple crops and even softwood lumber (USDA-AMS 2009). The program authorities (e.g., the U.S. Highbush Blueberry Council) must periodically evaluate the economic impacts of these promotions (7 U.S.C. 7411-7425, Sec 515(h)), and the resulting literature was the first source of review for the present project.

It is important to note that the California Granny Smith maturity standard was specific to California shippers of fresh Granny Smiths. Administration of the standard was associated with state commodity commission law; however, the closest source of economic literature on the topic was found to be related to federal programs.

A common characteristic of the economic evaluation of these programs is their use of a benefit-cost framework, in which producer benefits are compared with program costs. Since the present study does not evaluate the existence of the Granny Smith maturity standard as a commodity "program," this approach is not used here; however, key elements of the economic modeling approach were adapted from these studies, most notably an evaluation of the U.S. Highbush Blueberry Council by Kaiser (2010), a paper on dynamic changes in producer surplus by Hossain and Maxwell (1986), and an extensive study of the California Table Grape Commission by Alston, et al. (1997). These include the choice of partial, rather than general equilibrium analysis, and the econometric methods for estimation of model parameters.

Market windows and hedonic price analysis

The temporal aspect of the Granny Smith standard is essential to uncovering its economic impact on the California industry. The period in which California is the only supplier of new crop apples might be thought of as a "market window," Two strains of market window analysis were reviewed. The first, dating at least as far back as the 1970s, was developed to help farmers identify the most profitable time to market their fresh produce. Tronstad, Huthoefer, and Monke (1992) merge this approach with hedonic price analysis in the U.S. apple industry, examining the role of product quality characteristics in apple pricing. These methods are used to demonstrate the role of product quality on price during such market windows. Additional background on hedonic price analysis in the apple industry was provided by Carew (2000), McCluskey, et al. (2007), and Wang and Ge (2006), and guided the econometric approach.

Impact of minimum quality standards

The Granny Smith maturity standard might be thought of as a minimum quality standard (MQS) that holds over a period of time. Saitone and Sexton (2010) introduce a model examining the effects of such standards in marketing orders and find that, in general, an MQS reduces social welfare in two ways: first, by an inefficient enhancement of product quality, and second, by the wastage of low-quality product that cannot be marketed due to the standard. This differs slightly from the California Granny Smith case, as all product (in principle) could still be marketed once the maturity standard was met; however, it does suggest the possibility of a loss of social welfare while such a standard is in place.

Technical barriers to trade

A second way of looking at the Granny Smith maturity standard is as a technical barrier to trade. This approach models the regulatory control of supply as a backward shift of the supply curve, and analyzes the effect of the regulation on producer and consumer surplus. This approach was used by Richards, Molina, and Hussein (2009) in an analysis of a quarantine on U.S. potatoes in Mexico, which found that import restrictions reduced consumer and producer welfare.

Demand elasticities of fresh fruit

Various estimates of demand elasticities of fresh fruit have been published over the years. Two papers referenced here, Price and Mittelhammer (1979) and Durham and Eales (2006) arrive at estimates that suggest a limited amount of substitution between apples and other fruit: In Durham and Eales, for example, the largest cross-price elasticity estimate for apples is with grapes at 0.18. This suggests a relatively low cross price or inelastic response between the prices of apples and other substitutes.

Methods and Data

Based on the literature review, the nature of the analysis, and the availability of data, two equations were used to model the quantity and price of California Granny Smiths over the study period. The quantity model (QGS) was used to estimate the weekly movement of California Granny Smiths into retail channels over time, allowing the effects of the maturity standard on weekly quantities to be isolated. The price model (PGS) used the output of the QGS model to estimate price as a function of the available supply of Granny Smiths, substitute goods (*i.e*., other fresh fruit), and other variables.

The key variables considered for the model include the following:

- Price of Granny Smiths by state (Source: USDA)
- Prices of all other varieties by state (Source: USDA)
- Movement by origin and (for some years) by variety (Source: USDA)
- Imports and exports (Source: U.S. International Trade Commission)
- U.S. apple holdings by variety (Source: U.S. Apple Association)
- Per capita disposable income (Source: U.S. Bureau of Economic Analysis)
- Per capita availability of fresh fruit other than apples (Source: USDA-ERS)
- A variable to distinguish when the Granny Smith maturity standard was in effect (Source: California Apple Commission)
- Variables to measure the number of days since the initial harvest of each year's crop (a proxy for product quality)
- A variable to distinguish weeks during which California was the sole supplier of new-crop apples

As will be explained in the results section, some of the above variables did not significantly explain changes in price and quantity and were excluded from the final models.

Estimating the Quantity of Granny Smiths (the QGS Model)

As the prices received by shippers of Granny Smiths are treated as a function of movement of product from packers into retail channels (*i.e*., the leftward shift in the supply curve as illustrated in Figure 6 on page 16), these data are critical to the construction of the forecasting model.

Only six years of California Granny Smith movement data are available (2005/06 through 2010/11 seasons), so the quantity of Granny Smiths entering the market were estimated for the missing movement data periods. Ordinary least squares

(OLS) regression was used to estimate missing values for the 1998/99 through 2004/05 and 2011/12 through 2012/13 crop years.

Since Granny Smiths comprise such a relatively large proportion of California apple shipments (from 40 percent to over 50 percent, depending on the year), a starting assumption is that the distribution of California apple shipments over time was dominated by Granny Smiths. Following from this assumption, the movement of California Granny Smiths during the years with a maturity standard can be regarded as a function of all California apple shipments and the county release dates.

The general form of the QGS model is depicted in the following equation:

$$QGS_t = \theta_i(\beta_0 + \beta_1 Movement\_CA_t + \beta_3 Restrictions_t + \beta_4 DCropYear_t) \qquad (1)$$

Where β are the unknown parameters on each of the predictive variables , β_0 is a constant, and θ_i is a factor that scales the output of the equation so that the sum of QGS over all time periods equals the total (known) domestic shipments of California Granny Smiths in a given crop year. Total actual shipments are taken from the California Apple Commission's annual reports.

The dependent variable, *QGS*, is the weekly quantity of California Granny Smiths moving into <u>domestic</u> retail channels. While California does export between 10% and 20% of its Granny Smiths, imports and exports are not included, largely because weekly statistics are not readily available by variety for imports, while they <u>are</u> available for six years of domestic movement.

Movement_CA represents the movement of <u>all</u> California apples into domestic retail channels. Unlike *Movement_CA_GS*, these data are available for all years considered in this study.

Restrictions are dummy variables for apple-shipping counties that take the value 1 if that county has met the maturity standard for Granny Smiths and zero otherwise. San Joaquin and Santa Cruz counties were the only two that had a statistically significant effect on Granny Smith movement, and were the only ones used in the model.

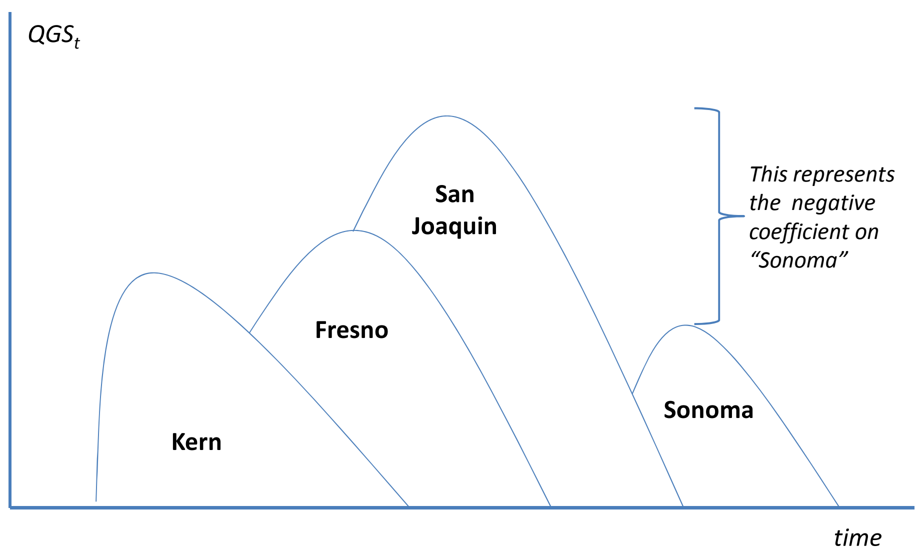
*DcropYear_* is a dummy variable denoting the crop year in which Granny Smith movement was observed. For example, California Granny Smith prices were recorded from September through December 1998. These are classified in the 1998-crop year. These variables are used to account for unobserved factors that may influence the timing of movement, such as weather conditions during crop development, cultural practices, and the movement of other apple varieties. Dummy variables for the 2005/06 through 2009/10 season were included in the model, while 2010/11 was excluded to avoid collinearity.

Three model variants were estimated using Ordinary Least Squares (OLS) and appear in the Appendix. The model chosen for further analysis (QGS3) was then used to estimate the weekly movement of Granny Smiths if the maturity standard did not apply. This resulted in two data series for movement: the *actual* movement (with the maturity standard intact) and the "unrestricted" movement.

For the six years in which Granny Smith movement data are available, QGS3 fits the data with an adjusted R-squared value of 0.89, meaning the model can explain 89 percent of the variation in prices over the six-year period.

One note on interpreting the coefficients of the model is necessary. When the coefficients on the county release date are negative (Sonoma, in this case), this does not imply that *movement from that county* is negative; rather, it is the marginal change in *movement for the entire market* at that point in time. As illustrated in **Figure 8** below, Sonoma County was typically released well after statewide Granny Smith shipments had peaked:

Figure 8: Interpreting the Negative Coefficient in the QGS Model.



Results of the OLS regression for the QGS 2 model are shown in **Table 6**, below.

Table 6: QGS3: OLS, using observations 1998-08-01:2012-12-29 (T = 149)
Missing or incomplete observations dropped: 604
Dependent variable: Movement_CA_GS

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	-262.282	31.9428	-8.2110	<0.00001	***
Movement_CA	0.507192	0.0258597	19.6133	<0.00001	***
San_Joaq	323.468	24.5127	13.1959	<0.00001	***
Sta_Cruz	-84.6795	20.6199	-4.1067	0.00007	***
DCropYear_9	59.9376	18.1174	3.3083	0.00119	***
DCropYear_10	85.5483	17.2726	4.9528	<0.00001	***
DCropYear_11	40.9442	19.8024	2.0676	0.04052	**
DCropYear_12	56.0655	16.639	3.3695	0.00097	***
DCropYear_13	36.9634	18.2671	2.0235	0.04492	**

Mean dependent var	219.6443	S.D. dependent var	193.1735
Sum squared resid	552968.6	S.E. of regression	62.84724
R-squared	0.899875	Adjusted R-squared	0.894153
F(8, 140)	157.2811	P-value(F)	4.97e-66
Log-likelihood	-823.7456	Akaike criterion	1665.491
Schwarz criterion	1692.527	Hannan-Quinn	1676.475

Estimating the Price of Granny Smiths (the PGS Model)

The Granny Smith pricing model is based on variables describing the supply of apples at a given week *t*. The PQS model is depicted in the following equation:

$$PGS_t = \rho_0 + \rho_1 GS\ Stocks_t + \rho_2 QGS_t \quad + \rho_2 DCropYear_t + \rho_3 P\_All_t + \rho_4 CA\_Only\_GS_t \qquad (2)$$

Where ρ are the unknown parameters on each of the predictive variables and ρ_0 is a constant.

The dependent variable, *PGS*, is the average real weekly price per 40-lb carton of California Granny Smith apples (in 2012 dollars). These are reported for the 1998 to 2012 crop years.

The independent variables include the following:

GS_Stocks represents the weekly holdings of Granny Smiths in the U.S, in millions of pounds. This term is expected to be negatively related to price, as higher inventories imply a higher level of supply relative to demand, or conversely, a lower rate of disappearance, which indicates lower demand. A one-week lag of *GS_Stocks* was tested but did not improve the explanatory power of the model.

QGS is the movement of California Granny Smiths at week *t*, taken from the fitted values of the QGS model described in the previous section.

*DcropYear_* is a dummy variable denoting the crop year in which Granny Smith prices were observed. In this case, it is used to account for unobserved variables that may have impacted pricing. These could include the market concentration of shippers and wholesale buyers, promotional efforts by industry organizations, favorable or unfavorable events reported in the news media, and changes in consumer preferences.

P_All is the average price of all Washington and California apples in week *t*. This was included to account for changes in the price level, which was expected to influence the price of all apple varieties. It was also included to avoid large over- and under-estimation of prices when the hypothetical, "unrestricted" prices were estimated.

CA_Only_GS represents the period during which California is the sole supplier of new-crop Granny Smiths in the market. This coefficient is expected to be positive, as it represents the period of time in which California Granny Smith shippers have the greatest market power, and may also be a proxy for product quality, as California is the only source of new-crop apples at this time (less than six months vintage).

Some of the variables for available market supply, such as net exports and the availability of substitutes were tested; however, none were significant, and their inclusion did not improve the results. A key reason for this is that a large number of observations needed to be dropped because of missing data points.

The PGS3 model is summarized in **Table 7**, below.

Table 7: PGS3: OLS, using observations 1998-08-01:2012-12-29 (T = 206)

Missing or incomplete observations dropped: 547
Dependent variable: PGS_CA_2012

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	12.3368	1.76668	6.9831	<0.00001	***
GS_Stocks	-0.037244	0.00199307	-18.6867	<0.00001	***
CA_Only_GS	1.8271	0.375048	4.8717	<0.00001	***
DCropYear_2	3.34091	0.590181	5.6608	<0.00001	***
DCropYear_3	-5.28267	0.519398	-10.1708	<0.00001	***
DCropYear_8	-1.39017	0.58633	-2.3710	0.01872	**
DCropYear_9	3.42047	0.652764	5.2400	<0.00001	***
DCropYear_12	3.19059	0.774266	4.1208	0.00006	***
P_All_Deflated	1.25522	0.0949735	13.2165	<0.00001	***
QGS	4.06724e-06	3.65638e-06	1.1124	0.26736	

Mean dependent var	20.51653	S.D. dependent var	5.262486
Sum squared resid	788.5180	S.E. of regression	2.016067
R-squared	0.859740	Adjusted R-squared	0.853233
F(9, 194)	132.1274	P-value(F)	8.88e-78
Log-likelihood	-427.3711	Akaike criterion	874.7421
Schwarz criterion	907.9233	Hannan-Quinn	888.1645

Results and Discussion

Using the QGS and PGS models, price and movement estimates were made for the periods when California Granny Smiths *could have shipped had there been no maturity standard.* **Model results show that, from 1998 to 2010, the California Granny Smith maturity standard could have delayed the start of shipments by up to 5 weeks in some years.** Graphical results of this effect can be found in Figures 9 (A-E) below.

The Weekly GS Movement charts show the estimated movement of Granny Smiths with the maturity standard in place (in blue) and an alternate scenario in which Granny Smith movement was not restricted by the standard (in green). As can be seen, additional early-season movement was seen in the alternate scenario. This effect ranged in size, and was barely noticeable in one season (2000/01).

Similarly, the Weekly GS Price charts show the actual Granny Smith Price in blue, with the alternate scenario prices from the PGS model in red. In general, the early-season premium is slightly lower with the maturity standard removed, which suggests that the overall revenue increases were driven by the additional movement early in the season.

Figure 9A: Estimated Weekly GS Movement and Pricing: With and Without Maturity Standard

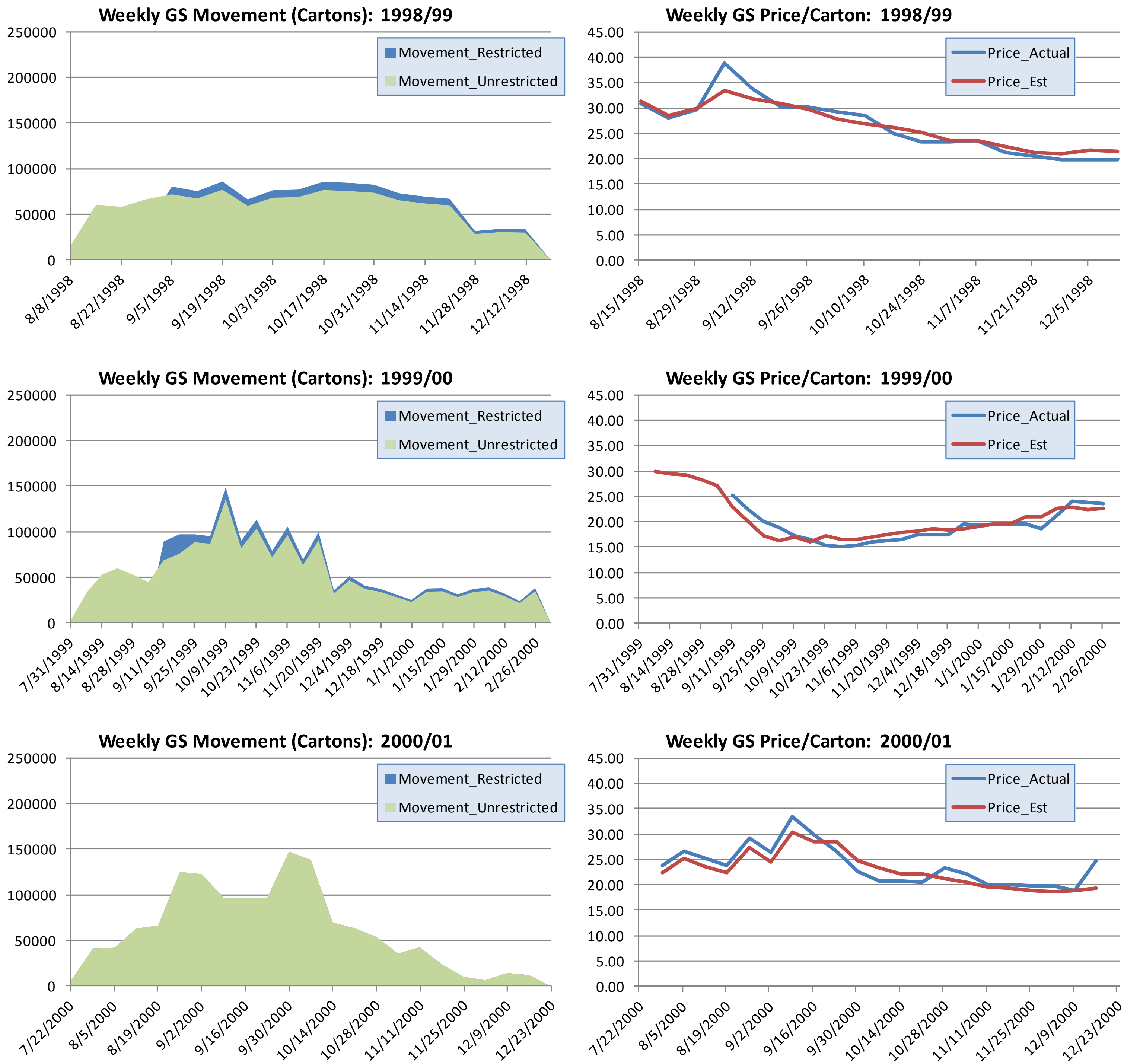


Figure 9B: Estimated Weekly GS Movement and Pricing: With and Without Maturity Standard

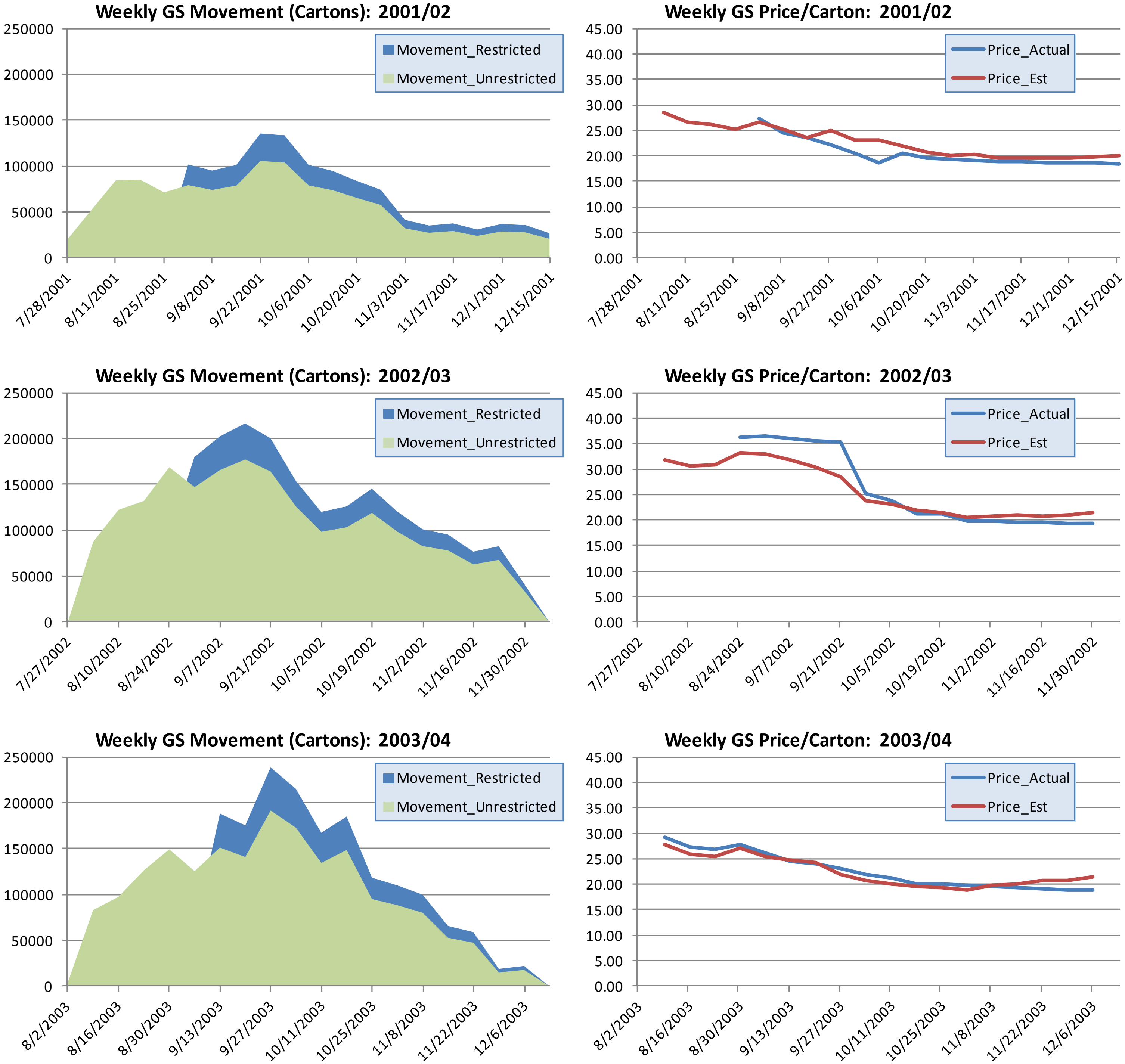


Figure 9C: Estimated Weekly GS Movement and Pricing: With and Without Maturity Standard

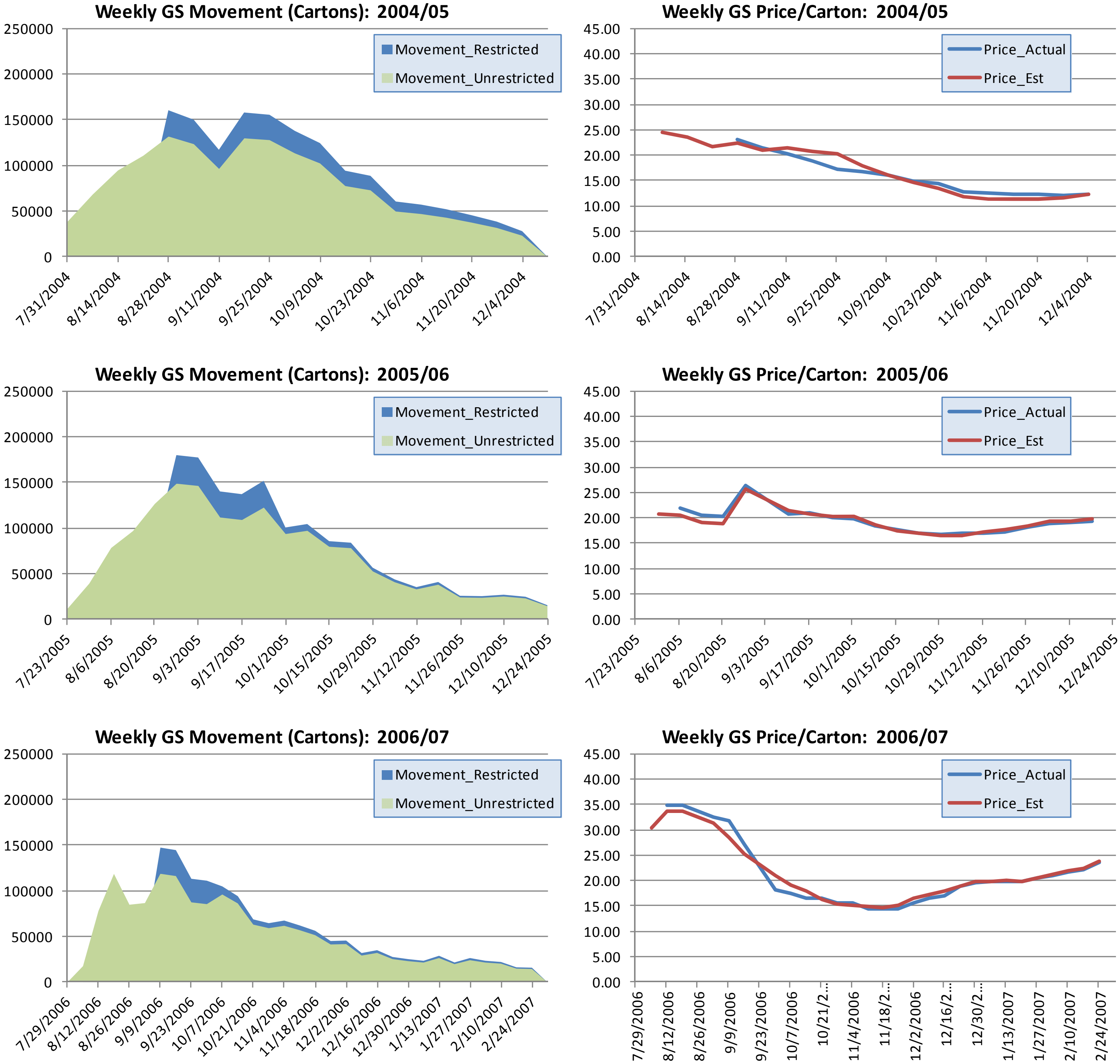


Figure 9D: Estimated Weekly GS Movement and Pricing: With and Without Maturity Standard

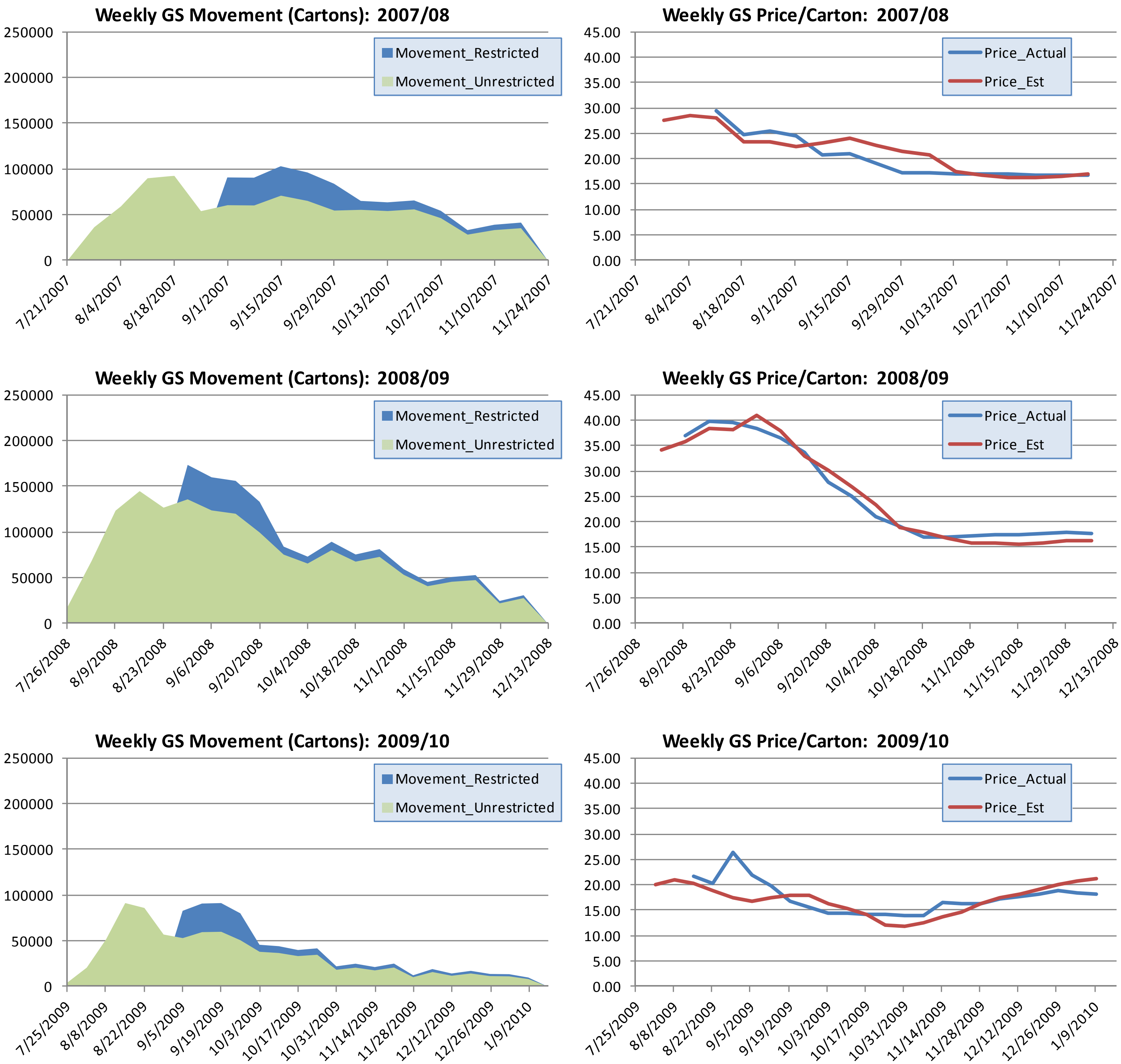
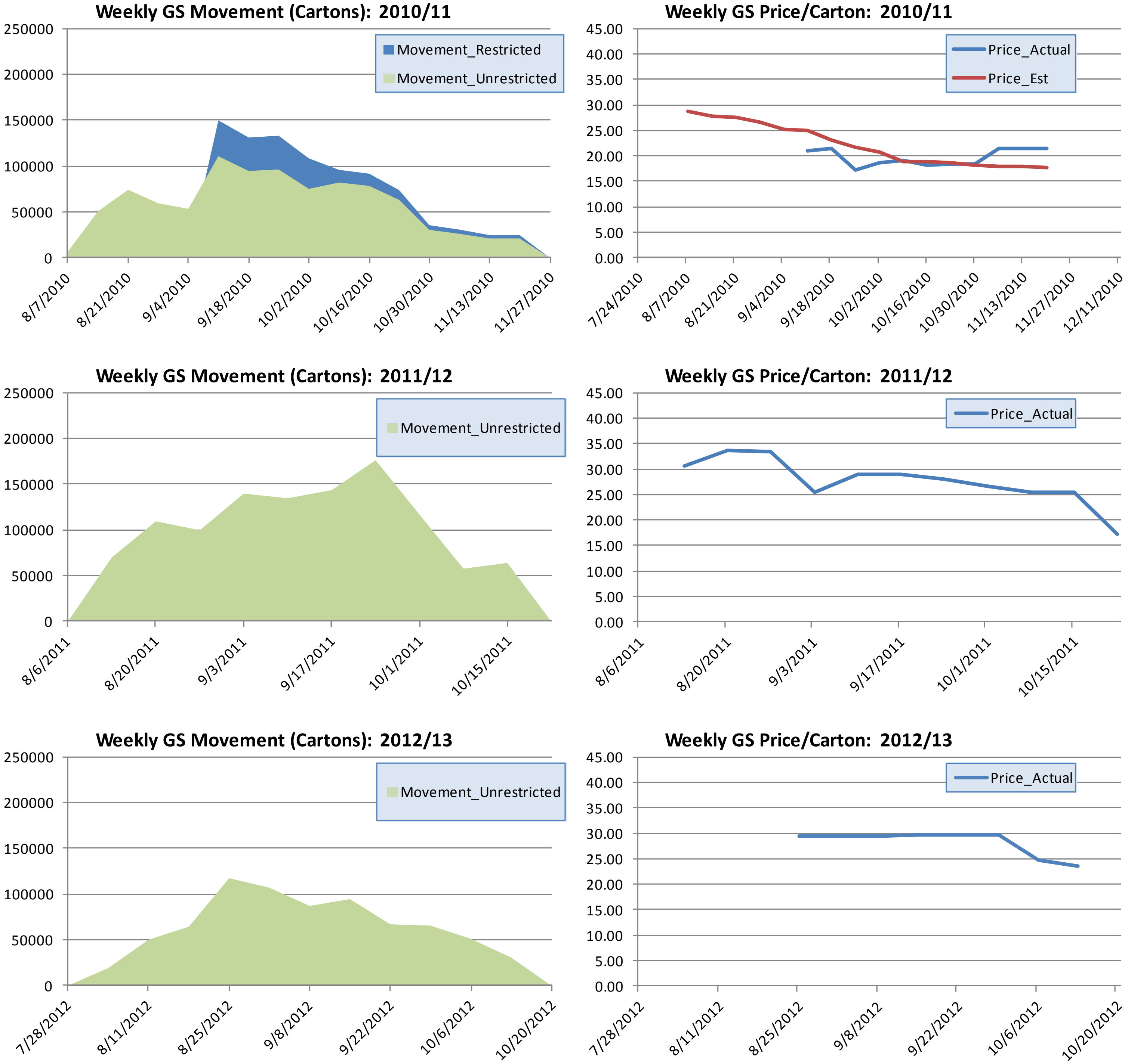


Figure 9E: Estimated Weekly GS Movement and Pricing: With and Without Maturity Standard



Results of the econometric model indicate that, for nine of 13 crop years, Granny Smith sellers would have obtained additional revenues in the absence of a maturity standard.

The results from the pricing model developed in this study suggest that the early-season premium obtained by California shippers would have been maintained in the absence of the maturity standard. Higher revenues would have been obtained due to a longer shipping period and an overall higher price level for Granny Smiths over the duration of the season.

Model results show that, from 1998 to 2010, the California Granny Smith maturity standard could have delayed the start of shipments by up to five weeks in some years.

By prohibiting the shipment of *any* Granny Smiths from a county until the maturity standard was met, marketable fruit was likely kept out of the market. While this is an intuitive finding, without explicit data it is difficult to estimate the likely effect of the standard on shipment patterns, pricing, and revenues. This study appears to be the first to attempt to estimate the magnitude of the effect.

The effect of the Granny Smith maturity standard on California industry revenues is estimated at a negative $18.7 million over the 13 years for which data were available.

The maturity standard is estimated to have reduced industry revenues in nine of 13 years and increased revenues in four years.

With over 18.4 million boxes of Granny Smiths shipped between the 1998 and 2010 seasons, this figure corresponds to a loss of approximately $1.01 per box on average over the 13-year period.

Table 8 presents the difference in revenues for California Granny Smiths in the actual vs. alternate scenarios in 2012 dollars.

Table 8: California Granny Smith Revenues vs. Alternate Scenario, 1998-2012.

Crop Year	Actual Revenue	Estimated Revenue w/o Maturity Std	Effect of Maturity Standard	Actual Boxes	Effect/Box
1998/99	$29,965,469	$29,678,339	$741,702	1,116,498	$0.26
1999/00	$29,379,099	$32,926,950	($3,447,322)	1,661,708	($2.14)
2000/01	$34,137,052	$33,554,262	($124,296)	1,373,057	$0.42
2001/02	$24,683,113	$28,453,905	($3,583,155)	1,226,123	($3.08)
2002/03	$54,566,273	$55,338,107	($738,573)	2,038,501	($0.38)
2003/04	$42,819,834	$43,546,009	($1,428,568)	1,917,234	($0.38)
2004/05	$25,387,337	$27,455,642	($2,478,267)	1,522,188	($1.36)
2005/06	$32,664,615	$32,011,003	$267,985	1,651,577	$0.40
2006/07	$35,345,227	$37,155,636	($2,160,492)	1,617,379	($1.12)
2007/08	$18,539,934	$20,953,566	($2,756,873)	944,772	($2.55)
2008/09	$43,732,151	$45,368,763	($2,232,801)	1,552,127	($1.05)
2009/10	$14,651,029	$14,552,716	($241,227)	839,175	$0.12
2010/11	$17,502,093	$21,059,789	($3,485,658)	948,167	($3.75)
2011/12	$31,875,906			1,113,778	
2012/13	$27,674,770			751,244	
Total	**403,373,226**	**422,054,688**	**($18,681,462)**	**18,408,506**	**($1.01)**

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Appendix

1. Detailed Data Collection Methods

Price and movement data were obtained from the USDA-Agricultural Marketing Service's Fruit and Vegetable Market News Portal (http://www.marketnews.usda.gov/portal/fv). The following two reports were used:

- Shipping Point Reports – By Commodity (State)
- Movement Reports – By Commodity (State)

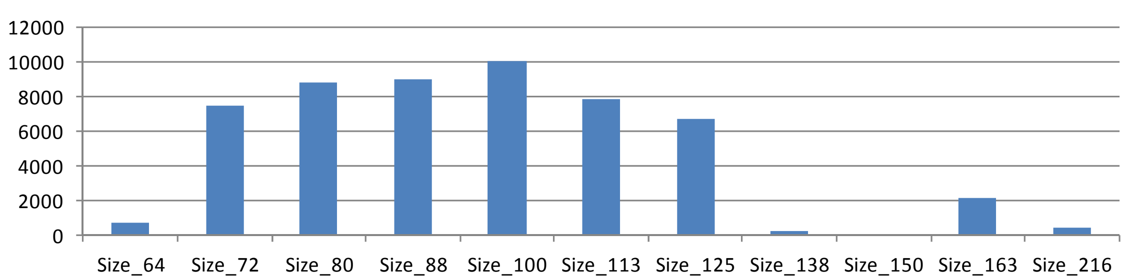
Both reports were run for weekly aggregated data for apples from the top six producing states: Washington, New York, Michigan, Pennsylvania, California, and Oregon. These six states have accounted for approximately 90 percent of all U.S. fresh apple production since 1994.

After running these reports and reviewing industry data as reported by the U.S. Apple Association and USDA-NASS, it became clear that Granny Smith production in states other than California and Washington was minimal, with no shipping point data reported for New York, Michigan, and Oregon. Prices were reported for Pennsylvania; however, as they were all reported in the December-March time period, and knowing that so little of the U.S. Granny Smith supply is grown outside California and Washington, these data were omitted (see Table 1, page 6).

As a result of the above findings, the other states were dropped from the analysis, leaving only Washington and California.

Prices for size = 100s were used in the analysis, as there were more observations for this size than for any other, as shown in **Figure A1**, below.

Figure A1: Distribution of Granny Smith Price Observations by Size, 1998-2012.



2. Technical Notes

Table A1: Summary Statistics of Model Variables

Variable	Mean	Median	Minimum	Maximum	Std. Dev.	C.V.
GS_Stocks	282.944	272.298	43.4298	654.528	135.257	0.478034
Movement_CA	426.264	263.500	1.00000	2181.00	415.635	0.975063
Movement_CA_GS	219.644	153.000	3.00000	881.000	193.173	0.879483
PGS_CA_2012	20.9440	19.7081	11.9915	38.7657	5.27027	0.251636
PGS_Wa_2012	19.6053	19.3651	13.7796	29.5461	3.31335	0.169003
PGS_WA_Diff	0.249350	0.200771	-6.43985	6.64096	1.80837	
PGS_CA_Diff	-0.00658017	-0.506220	-6.07681	9.18031	3.07498	
QGS	69479.2	59260.5	1935.46	238673.	48356.7	0.695989
Yield	13.3508	12.8000	9.15866	18.3000	2.47354	0.185272

Table A2: Summaries for QGS Model Variants

OLS estimates
Dependent variable: Movement_CA_GS

	QGS1	QGS2	**QGS3**
const	-211.5**	-645.3**	-262.3**
	(69.83)	(84.46)	(31.94)
Movement_CA	0.4893**	0.5081**	0.5072**
	(0.03743)	(0.02284)	(0.02586)
San_Joaq	109.9**	187.4**	323.5**
	(52.41)	(31.33)	(24.51)
Sta_Cruz	-92.38**	-111.6**	-84.68**
	(27.65)	(19.25)	(20.62)
Sonoma	13.35		
	(24.42)		
Stanislaus	128.5**	114.0**	
	(34.02)	(26.55)	
Kern		259.8**	
		(60.51)	
Fresno		170.5**	
		(60.38)	
DCropYear_9		60.36**	59.94**
		(16.12)	(18.12)
DCropYear_10		79.28**	85.55**
		(15.42)	(17.27)
DCropYear_11		35.29**	40.94**
		(17.70)	(19.80)
DCropYear_12		64.26**	56.07**
		(14.99)	(16.64)
DCropYear_13		44.13**	36.96**
		(16.63)	(18.27)
n	88	149	149
Adj. R^2	0.8753	0.9175	0.8942
	F(6, 81) 102.7642**	F(11, 137) 150.6471**	F(8, 140) 157.2811**

Standard errors in parentheses
* indicates significance at the 10 percent level
** indicates significance at the 5 percent level

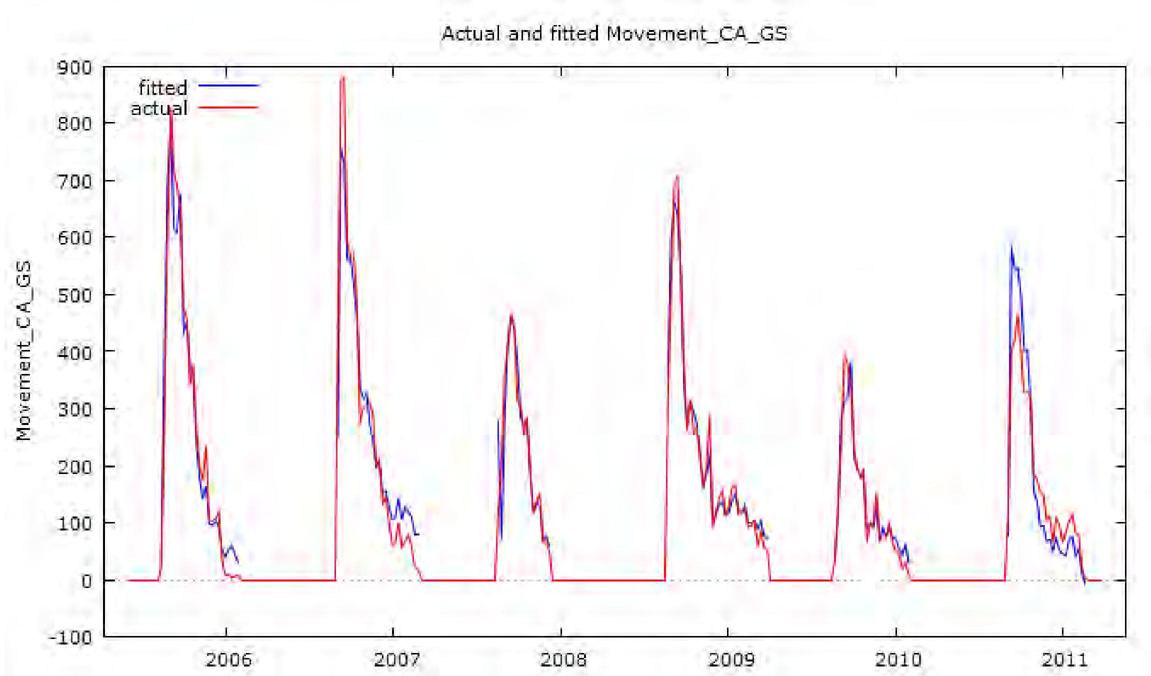
Table A3: Summaries for PGS Model Variants

OLS estimates
Dependent variable: PGS_CA_2012

	PGS1	PGS2	**PGS3**
const	193.8**	13.08**	12.34**
	(43.65)	(2.949)	(1.767)
GS_Stocks	-0.04605**	-0.03623**	-0.03724**
	(0.003868)	(0.003048)	(0.001993)
CA_Only_GS	2.114**	1.916**	1.827**
	(0.5865)	(0.4748)	(0.3750)
Net_Exports_Boxes	-2.222e-06**	-2.240e-07	
	(1.061e-06)	(8.866e-07)	
PerCap_Other	-1.360**		
	(0.3822)		
DCropYear_2	-4.482**	3.080**	3.341**
	(1.524)	(0.9854)	(0.5902)
DCropYear_3	-9.739**	-5.022**	-5.283**
	(1.313)	(0.9617)	(0.5194)
DCropYear_4	-6.002**	0.6569	
	(1.390)	(1.013)	
DCropYear_5	-9.281**	-1.221	
	(1.531)	(0.9769)	
DCropYear_6	-3.149**	1.241	
	(1.373)	(0.9126)	
DCropYear_7	-5.626**	0.01147	
	(1.261)	(0.9298)	
DCropYear_8	-9.858**	-1.461*	-1.390**
	(1.750)	(0.8526)	(0.5863)
DCropYear_9	-6.580**	3.231**	3.420**
	(1.857)	(0.9119)	(0.6528)
DCropYear_10	-4.050**	-0.07068	
	(1.336)	(0.7800)	
DCropYear_11	-9.519**	-0.7996	
	(2.351)	(0.8421)	
DCropYear_12	5.448**	3.410**	3.191**
	(1.224)	(0.9602)	(0.7743)
DCropYear_13	-6.949**	0.6588	
	(1.836)	(0.7956)	
P_All_Deflated		1.183**	1.255**
		(0.1116)	(0.09497)
QGS			4.067e-06
			(3.656e-06)
n	206	206	204
Adj. R^2	0.7862	0.8571	0.8532
	F(17, 188)	F(17, 188)	F(9, 194)
	45.33433**	73.32567**	132.1274**

Standard errors in parentheses
* indicates significance at the 10 percent level
** indicates significance at the 5 percent level

Figure A2: QGS3: Actual and Fitted Values, Residual Plots



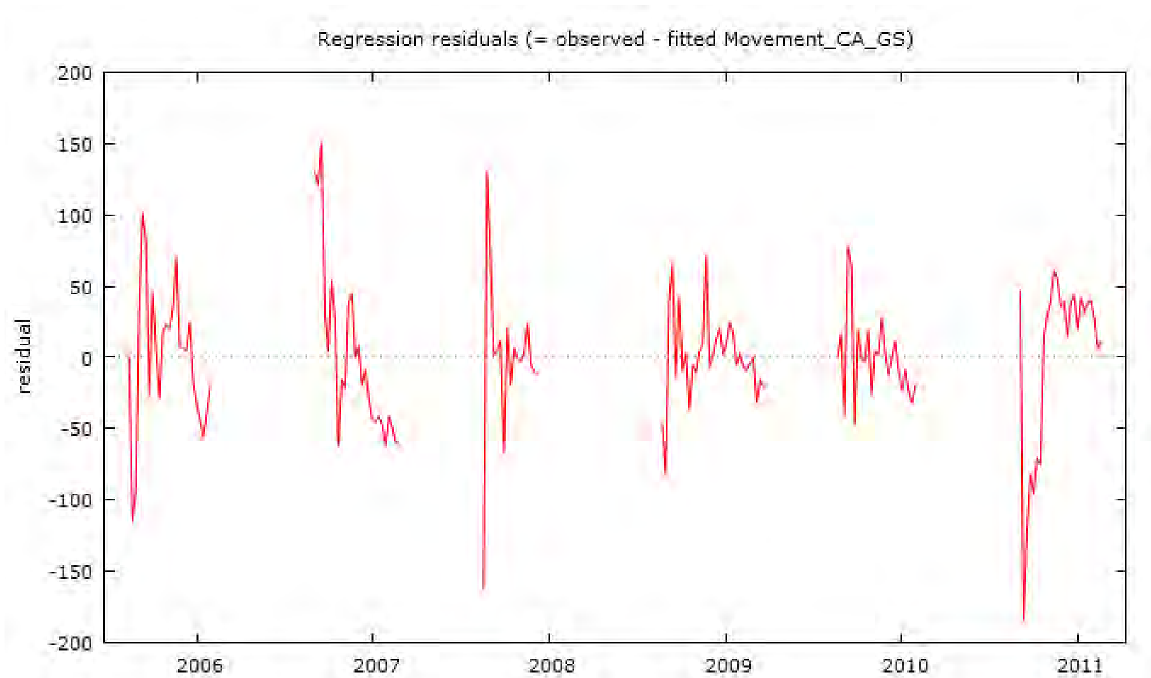
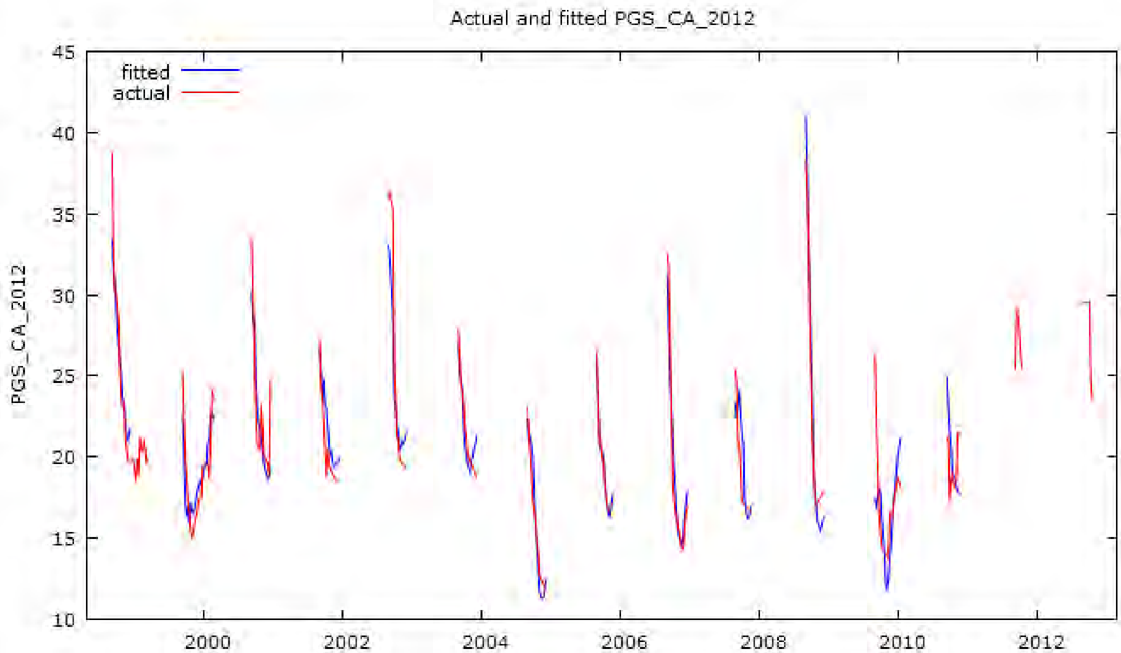


Figure A3: PGS3: Actual and Fitted Values, Residual Plots



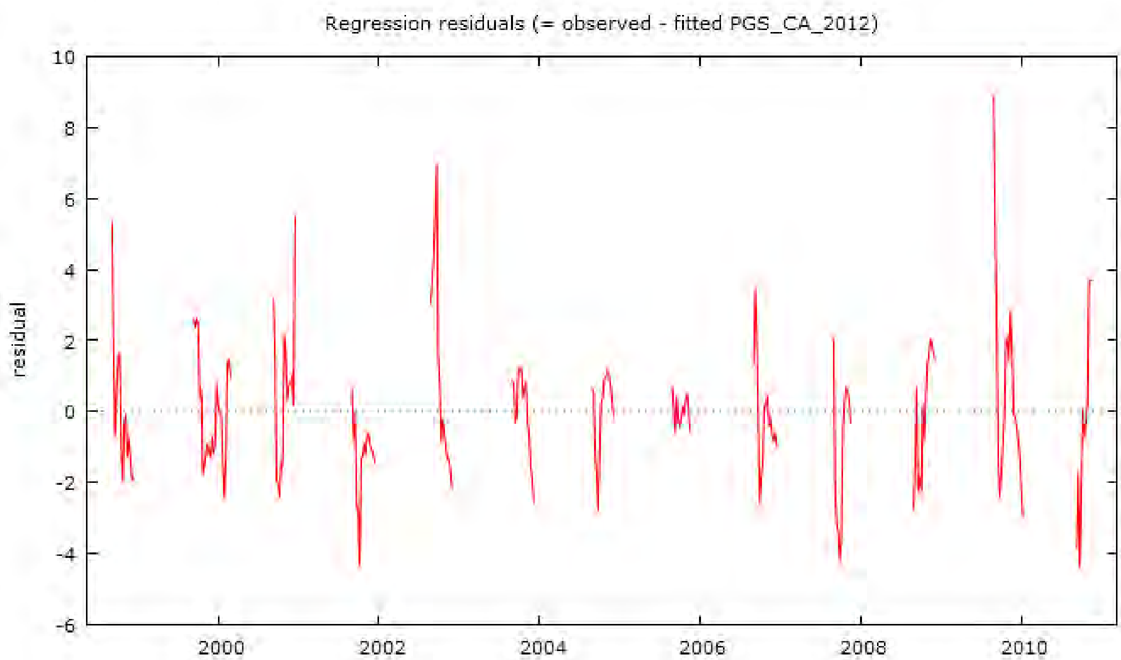


Table A3: Collinearity Tests

Variance Inflation Factors for **QGS3**
Minimum possible value = 1.0
Values > 10.0 may indicate a collinearity problem

Movement_CA	1.182	DCropYear_10	1.049
San_Joaq	2.618	DCropYear_11	1.043
Sta_Cruz	2.350	DCropYear_12	1.070
DCropYear_9	1.030	DCropYear_13	1.058

VIF(j) = 1/(1 - R(j)^2), where R(j) is the multiple correlation coefficient between variable j and the other independent variables

Properties of matrix X'X:
1-norm = 37670382
Determinant = 2.1340513e+017
Reciprocal condition number = 4.0322379e-008

Variance Inflation Factors for **PGS3**
Minimum possible value = 1.0
Values > 10.0 may indicate a collinearity problem

GS_Stocks 1.676
CA_Only_GS 1.462
DCropYear_2 1.144
DCropYear_3 1.286
DCropYear_8 1.120
DCropYear_9 1.108
DCropYear_12 1.458
P_All_Deflated 1.341
Movement_R_Alt 1.496

VIF(j) = 1/(1 - R(j)^2), where R(j) is the multiple correlation coefficient between variable j and the other independent variables

Properties of matrix X'X:
1-norm = 1.782421e+012
Determinant = 9.5606269e+029
Reciprocal condition number = 4.4901156e-013

Thank you for participating in our survey!
The following questions about your experience at this farmers' market help us improve our services. Responses are anonymous. We appreciate your input.

Tell us about yourself

1. Your gender ☐ Male ☐ Female
2. Your age group ☐ 18- 25 ☐ 26 – 35 ☐ 36 - 45 ☐ 46 – 55 ☐ 56- 65 ☐ Over 66
3. Number of persons in your household _________
4. Your zip code _________________
5. Your benefits program (check all that apply)

   ☐ Food Stamps/ CalFresh (EBT) ☐ Senior Farmers Market Nutrition Program (Senior FMNP)

   ☐ WIC FMNP ☐ WIC ☐ Supplemental Security Income (SSI)

Tell us about your experience at the farmers' market

6. Why did you come today to the farmers' market? (Check all that apply)

   ☐ Eat a snack ☐ Shop for produce ☐ Enjoy atmosphere ☐ Find deals ☐ Meet friends

   ☐ Receive Market Match ☐ Learn how to shop cheaply ☐ Watch cooking demo

   ☐ Learn about community services Other _________________________

7. Have you been to this farmers' market before? ☐ Yes ☐ No (then go to 10.)
8. When were you here last time? ☐ A week ago or less ☐ Within the month ☐ A month ago or more
9. Why do you come here? (Please write down the two most important reasons in a and b below – e.g. quality of produce, great deals, special events, atmosphere, the people, etc.)

   a) ________________________________ b) ________________________________

10. Do you live close to a store that has fresh produce? ☐ Yes ☐ No
11. What would make you come more often to this farmers market?

    ☐ Better transportation ☐ Greater selection of produce ☐ Info how to find good deals

    ☐ More Parking ☐ Food Sampling ☐ Places to sit

    Other __________________________________

Tell us about your experience with the Market Match Program

12. Have you ever received it? ☐ Yes ☐ No
13. Where did you find out about the Market Match program? (Check all that apply)

    ☐ Family or friend ☐ Social Service Office ☐ Community Center ☐ Mail

    ☐ Farmers' Market ☐ Public advertisement ☐ Website ☐ Food bank

    Other _____________________

14. Do you know when it is available at this Farmers Market? ☐ Yes ☐ No
15. How important is the Market Match Benefit for your coming here today?

    ☐ Very much ☐ Somewhat ☐ A little ☐ Not at all

16. What difference has the Market Match Program made in your life?

____

Surveyor:
Market name and location:
Farmers Market ID:

Date:
Number:

Project 14 – Attachment

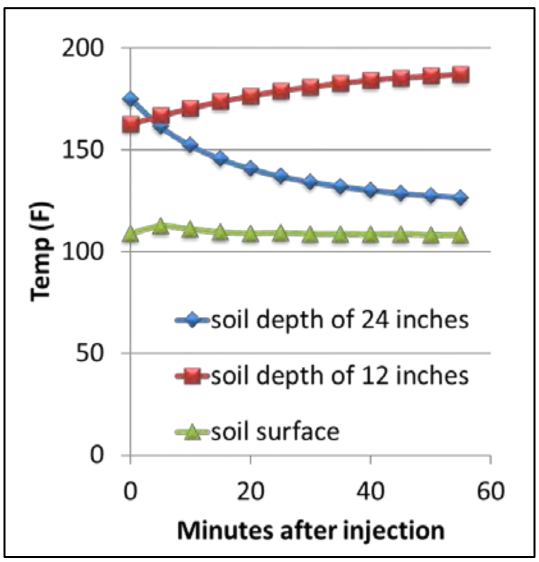
Table 1. Location and details of steam injection system trials in California almond orchards from 2010-13.

Trial location	Cooperator	Soil type	Treatments initiated	Orchard planted
Delhi, CA	Littlejohn Farms	Delhi sand	Nov-10	Jan-11
Wasco, CA	Paramount Farms	Wasco sandy loam	May-11	June-11
Atwater, CA	Taylor Farms	Atwater loamy sand	Dec-11	Feb-12
Livingston, CA	Chad Farms	Delhi loamy fine sand	Feb-12	Mar-12

Table 2. Soil temperature (averaged over depth) for 45 minutes following steam auger treatments in field trials near Arbuckle and Delhi, CA during summer 2012 for injection site over 45 minutes following steam injection.

Steam injection time	24- inch auger		36- inch auger	
	dry	wet	dry	wet
min	------------------------------- °F		-------------------------------	
Arbuckle-fine sandy loam				
1	118.6	139.2	106.8	121.3
2	140.6	175.8	108.8	139.5
4	134.7	171.2	145.3	132.9
Delhi-sand				
1	137.7	143.5	116.9	90.6
2	181.7	179.2	153.4	125.9
4	195.9	194.0	181.7	162.9
6	--	--	199.5	180.3

At each site, half of the plots were pre-irrigated to raise soil moisture above natural conditions.



Figures. Steam application at the Delhi trial (top left) and closeup of the modified 36-inch steam injection auger at the Wasco site (top right). Representative soil temperature curves following steam injection (lower left).

Table 3. Effects of pre-plant soil treatments on nonpareil almond growth and disease severity in a 2010-13 orchard replant trial near Delhi, CA.

Treatment	Increase in trunk diameter 2011-12	Increase in trunk diameter 2011-13	Disease rating 2011	Disease rating 2012
	---------- mm ----------		--------- 0-5 scale[2] ---------	
Untreated	14.4 b	31.5 b	0.9	1.6
24 inch auger	16.4 ab	34.9 ab[1]	0.6	1.2
24 inch auger + steam	20.3 a	38.9 ab	0.5	0.9
36 inch auger	18.3 ab	35.1 ab	0.9	1.2
36 inch auger + steam	19.7 a	37.3 ab	0.6	1.4
Backhoe	19.2 ab	41 a	1	1
P value	0.0267	0.0251	0.5031	0.0653

[1]Letters indicate statistical difference at the alpha = 0.05 level according to Tukey's HSD.
[2]Disease ratings made on a 0-5 scale where zero is healthy and 5 is dead.

Table 4. Effects of pre-plant soil treatments on nonpareil almond growth and disease severity at orchard replant sites near Wasco, Atwater, and Livingston, CA from 2011 to 2013.

	---------------Wasco---------------			----------Atwater----------		-------Livingston-------	
Treatment	**Increase in trunk diameter 2011-12**	**Disease rating 2011**	**Disease rating 2012**	**Increase in trunk diameter 2012-13**	**Disease rating 2012**	**Increase in trunk diameter 2012-13**	**Disease rating 2012**
	mm	--- 0-5 scale[1] ---		mm	0-5 scale	mm	0-5 scale
Untreated	10.1	0.4	1.1	30.2	1.3	22.2	1.2
24 inch auger	7.8	0.7	1.3	26.2	1.5	24.7	1.0
24 inch auger + steam	8.9	0.6	1.1	34.3	0.8	27.6	0.7
36 inch auger	9.3	0.2	1.4	35.1	1.2	24.4	1.2
36 inch auger + steam	9.5	0.8	1.5	41.0	0.3	28.5	0.8
Backhoe	--	--	-	34.5	1.0	25.2	1.0
P value	0.5582	0.2353	0.6497	0.2763	0.1155	0.1176	0.7852

[1]Disease ratings made on a 0-5 scale where zero is healthy and 5 is dead.

Table 5. Pre-plant soil treatment effects on nonpareil variety tree growth and disease severity in a 2010-13 almond replant trial near Delhi, CA comparing steam and chemical fumigants.

Treatment		**Increase in trunk diameter**	**Increase in trunk diameter**	**Disease rating**	**Disease rating**
Treatment	Rate	**2011-13**	**2011-12**	**2011**	**2012**
	lb/A	--------- mm ----------		----- 0-5 scale[3] -----	
Untreated	--	41.2 d[2]	20.8 b	0.3	1.1 a
Steam	--	42.1 d	20.7 b	0.3	1.2 a
Telone II broadcast[1]	340	59.7 a	26.0 a	0.1	0.1 b
Telone II strip	340	55.7 ab	25.7 a	0.4	0.2 b
Telone C35 strip	540	54.1 bc	26.1 a	0.3	0.2 b
MB	400	50.0 c	24.8 a	0.1	0.2 b
P value		<0.0001	<0.0001	0.0011	<0.0001

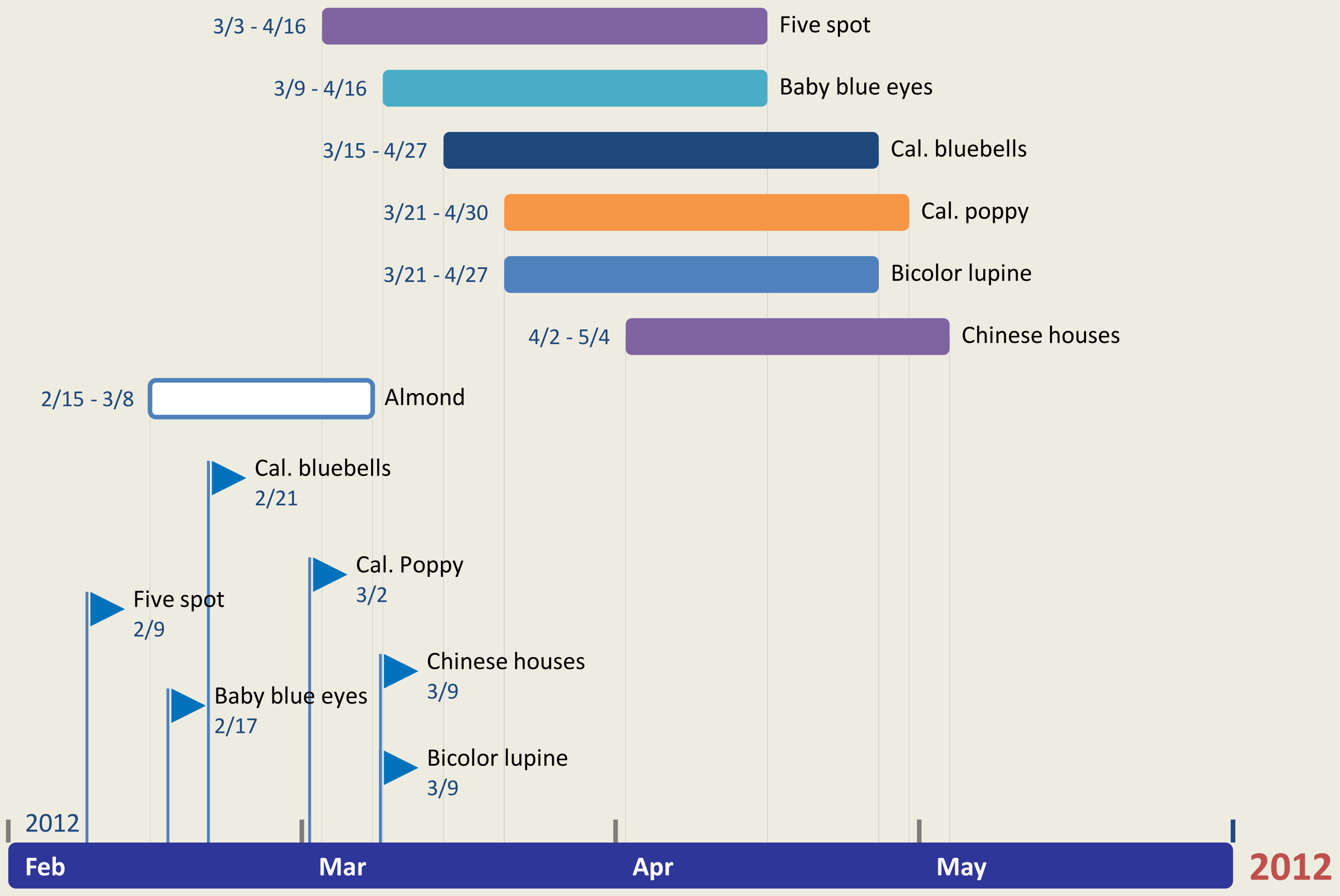
[1] Strip and broadcast applications were 11- and 22- feet wide and the length of the plot.
[2]Different letters indicate statistical difference at the alpha = 0.05 level according to Tukey's HSD.

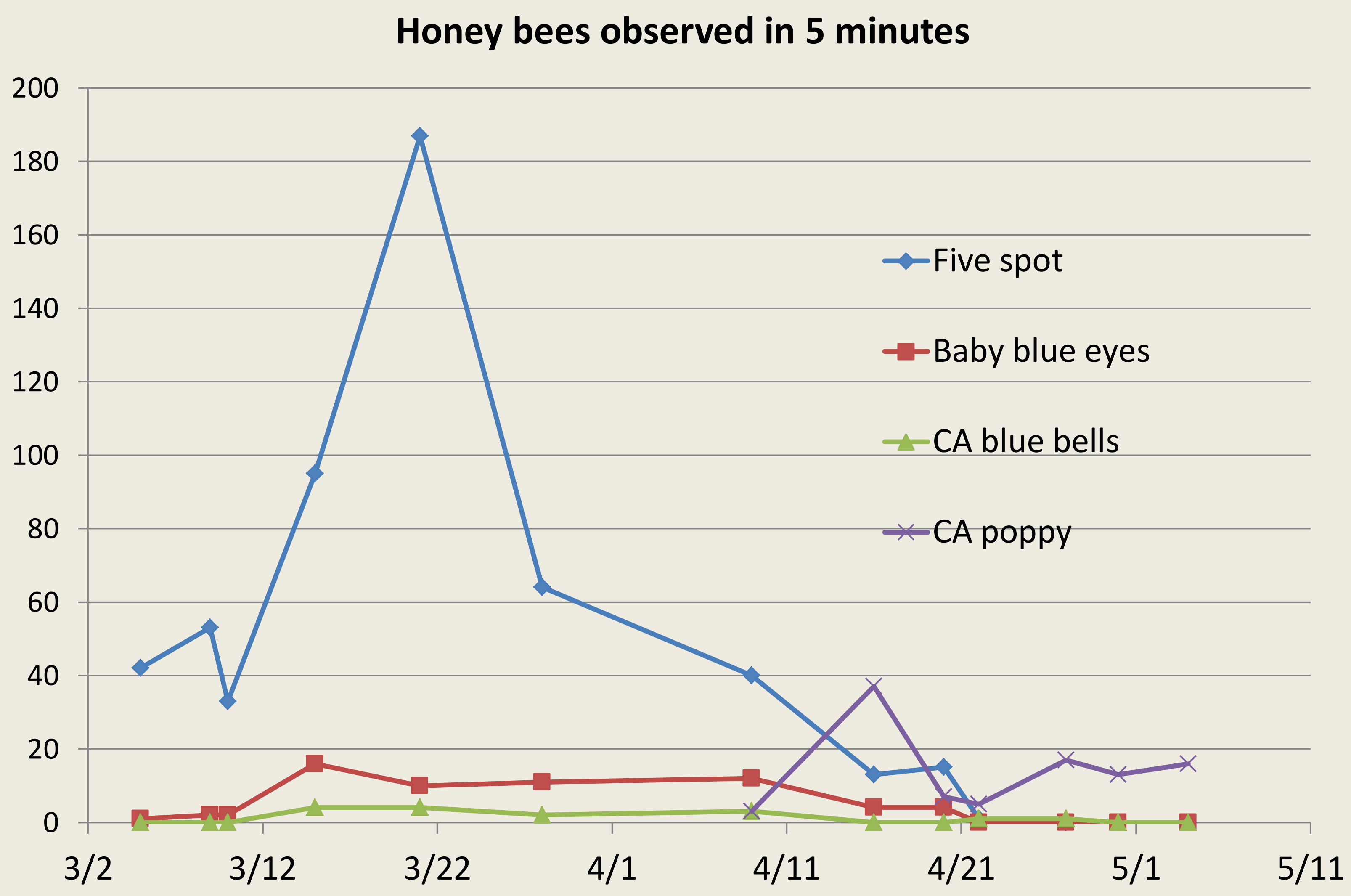
Table 6. Pre-plant soil treatment effects on nonpareil almond tree growth and disease severity in a 2011-13 orchard replant trial near Atwater, CA comparing steam and chemical fumigants.

Treatment		**Increase in trunk diameter**	**Disease rating**
Fumigant	**Rate**	**2012-13**	**2012**
	lb/A	mm	0-5 scale[3]
Untreated	--	28.5 c[2]	0.9 b
Steam	--	29.6 bc	1.0 b
Telone C35 strip[1]	540	37.5 a	0.6 a
Telone C35 tree spot	340	36.2 ab	0.4 a
Chloropicrin tree spot	340	34.8 ab	0.4 a
Telone C35 tree spot	540	34.2 ab	0.3 a
Telone II strip	340	33.1 abc	0.6 a
Telone II broadcast	340	30.9 bc	0.6 a
P value		<0.0001	<0.0001

[1] Strip and broadcast applications were 11- and 22- feet wide and length of plot, tree spots applications were 11-feet wide and 8 feet long centered on the tree spot.
[2]Letters indicate statistical difference at the alpha = 0.05 level according to Tukey's HSD.
[3]Disease ratings made on a 0-5 scale where zero is healthy and 5 is dead.

Planting Native Wildflowers to Extend Bloom in Almonds


3/3 - 4/16
Five spot
3/9 - 4/16
Baby blue eyes
3/15 - 4/27
Cal. bluebells
3/21 - 4/30
Cal. poppy
3/21 - 4/27
Bicolor lupine
4/2 - 5/4
Chinese houses
2/15 - 3/8
Almond
Cal. bluebells
2/21
Cal. Poppy
3/2
Five spot
2/9
Chinese houses
3/9
Baby blue eyes
2/17
Bicolor lupine
3/9
2012
Feb
Mar
Apr
May
2012


Honey bees observed in 5 minutes
200
180
160
140
120
100
80
60
40
20
0
3/2
3/12
3/22
4/1
4/11
4/21
5/1
5/11
Five spot
Baby blue eyes
CA blue bells
CA poppy

Lessons learned

- Plant early (September or October)
- Irrigate for best results
- Control weeds (Poast works well post-emergence on grasses)

***Brassica* Cover Crops for Honey Bees**

Project Apis m

Stephen Peterson

Brassica is a genus in the plant family Brassicaceae (mustards). Some important food crops in the genus include broccoli, cabbage, Brussels sprouts, cauliflower, turnip, collard greens, rapini and mustard seed. This genus originates in Western Europe, the Mediterranean region and temperate regions of Asia (Wikipedia, 2013). Most *Brassica* grow well in cool climates or in the cooler part of the year in warm climates. Little auto-pollination occurs in most species and cultivars, and insect pollination is essential to produce good crops of seed (Free, 1993). The flowers of most *Brassica* plants are attractive to honey bees.

Several *Brassica* species can be used for cover crops because they grow rapidly, provide erosion control, produce large amounts of biomass (up to 8,000 lb./A) and are excellent at scavenging nutrients (up to 140 lb. of nitrogen/A) (Cavanaugh, 2013). *Brassica* plants produce glucosinolates (GSLs) which the plants produce as a chemical defense against herbivores, plant pathogens and weeds. GSLs are hydrolyzed in the soil to form isothiocyanates (ITCs). These ITCs can inhibit weed seed germination and microorganisms in the soil.

Canola

Canola is rapeseed that has been bred for low levels of GSLs and erucic acid. The name "canola" was derived from the words "Canadian oil, low acid." Canola may be *B. napus* or *campestris* and both are herbaceaous annuals. Oil from the seeds of canola is used for cooking oils and biodiesel. If weed and pathogen suppression is desired from the cover crop, then rapeseed should be used instead of canola (Cavanaugh, 2013). Rapeseed can tolerate a wide range of soil conditions (pH from3.8 to 7.8) and can tolerate moderate salinity (Chapman and Carter, 1976). Canola should be planted at 5-10 lb./A no deeper than ¾ inch or broadcast at 8-14 lb/A (Cavanaugh, 2013).

Mustards

Mustards are a group of species that include white or yellow mustard, *B. hirta* or *Sinapis alba*, brown or Indian mustard *B. juncea*, and black mustard *B. nigra*. All of these have high levels of GSLs. White mustard is commonly grown in vineyards in Napa and Sonoma counties and blooms from February to March there. A comparison of various *Brassicas* showed that *B. juncea* var. Pacific Gold coupled high biomass yield with above-average GSL production (Antonious et al., 2009).

Black mustard can grow up to 8 feet tall, has indeterminate growth and with adequate moisture can bloom for several weeks. Mustards should be planted at 5-12 lb./A, ¼ to ¾ inch deep or broadcast at 12-20 lb./A (Cavanaugh, 2013).

Rapini

Rapini (*B. rapa*, the same species as turnip) is grown for its for its edible leaves (like turnip greens) and buds. It grows to about 2 feet tall with abundant yellow flowers and is very attractive to honey bees. It should be planted in the fall in California at 4-7 lb./A about ½ inch deep or broadcast at 10-12 lb./A (Cavanaugh, 2013). When planted in late October in the central valley of California it will bloom for 5 to 6 weeks, from late February to late March without irrigation.

Benefits to the Soil and Subsequent Crops

Fertility: *Brassica* cover crops grow rapidly in the fall and are excellent at scavenging nitrogen and other nutrients remaining in the soil after harvest. The crop can then be mowed and the residue can provide nutrient-rich mulch or disked in as green manure. Some microorganisms nitrify fertilizers, and the presence of *Brassica* crop residue can suppress these microorganisms, making subsequent nitrogen applications more available to plants (Brown and Morra, 2009). Even when no additional nitrogen is added to soils with *Brassica* crop residues, more nitrogen was available for plants compared with a grass cover crop.

Soil compaction: Some *Brassica* species (forage radish, rapeseed, turnip) have a taproot that can penetrate up to 6 feet and can help alleviate soil compaction. As the roots decompose, they leave channels that can improve water infiltration (Cavanaugh, 2013).

Weeds: ITCs can reduce weed seed germination. In a study with winter rape, *B. napus*, weed biomass was reduced 96% when the cover crop was cut and allowed to decompose in the soil (Masiunas and Eastman, 2012).

Plant Pathogens: ITCs are also toxic to some plant pathogens. Larkin and Griffin (2003) showed that *Brassica* cover crops grown as green manure reduced inoculums levels of *Rhizoctonia,* and the incidence of powdery scab and black scurf in potatoes. Some *Brassica* species can reduce populations of parasitic nematodes such as the root-knot nematode, as well (Monfort et al., 2007).

Benefits for Honey Bees

Brassica pollen is sticky, unlikely to be windborne and the flowers are highly attractive to honey bees. Honey bees readily collect nectar and pollen from two species of canola (Mohr and Jay, 1988) and spend 4.6 to 7.0 seconds per flower. The sugars in canola nectar do not contain sucrose, but have large amounts of glucose compared to fructose, indicating that the resulting honey will tend to granulate (Kevan et al., 1991). Canola produces abundant nectar, and can be more attractive than red or white clover (Hammer, 1966). Mustard flowers are also highly attractive to honey bees (McGregor, 1976). Because many *Brassica* species grow and bloom in the cool climates or seasons, the plants may come into bloom at temperatures below 55°F, making them unavailable to honey bees at those temperatures (McGregor, 1976).

Canola, *B. campestris*, produces an average of 0.16 µl (0.28 mg) of nectar with 40% sugar concentration per flower per day which equates to 8.6 lb. of sugar per acre, whereas *B. napa*, Swede rape, produces 0.45 mg per flower per day or 87-207 lb. per acre. (Szabo, 1982, 1985). Cabbage nectar produces 12.6-15.5 lb. of sugar per acre and kohlrabi produces 33-47 lb. per acre (Free, 1993). A study on Canola showed that flowers were visited on average 26 times per day, with visits beginning at 10 am. Visits reached a peak between noon and 2 pm, with no pollen in the flowers by 3 pm (Mohammed, 1935).

Honey bees foraging on *B. nigra* and *B. rapa*, spent an average of 175-200 seconds per trip, with 4.2-4.6 seconds per flower (Collins et al., 1997). The flowers contained 0.15-0.23 mg/pollen and the pollen loads collected by the bees varied from 4-5 mg. Extrapolating from this data, assuming a forager takes 7 minutes per round trip (200 seconds foraging and 240 seconds in the hive), and foraging lasts from 10 am to 2 pm, or 4 hours, a forager could make 34 trips in a day. If a hive had 5,000 foragers and each trip brought in 4 mg of pollen, this would amount to 1.5 pounds of pollen per day.

Brassica pollen is an excellent source of protein and contains all essential amino acids (Szcz sna, 2006). In a study of pollens from 16 different plant genera, crude protein in *Brassica* pollen averaged 24% (range in study: 13 to 25%), and total amino acids averaged 229 mg/g (range in study: 109 to 241 mg/g) (Szcz sna, 2006).

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Grower Benefits

In addition to providing needed food resources for honey bees, you may also profit from cover crop planting. There are a large number of benefits to planting forage for pollinators. Planting a bee forage cover crop will:

- **Improve soil fertility**
- **Increase organic material**
- **Fix nitrogen**
- **Improve water infiltration**
- **Suppress noxious weeds**
- **Conserve soil moisture**
- **Increase beneficial insects by providing pollen and nectar**
- **Increase pollination diversity by attracting native pollinators**
- **Reduce soil erosion**
- **Attractive visual appeal**

Be part of the solution!

To enroll in the pollinator forage project, contact us at ProjectApis@gmail.com

PAm Forage Mixes

Low rainfall plants of both legumes and non-legumes. All are an excellent source of nectar and pollen for bees.

Capay Ranch Mix

Clovers, Lana Vetch & Allysum

PAm Wildflower Mix

Native Wildflowers, Clovers & Allysum

Rapini Mustard

Brassica rapa

'Seeds for Bees'

Growers Guide for Planting Forage for Honey Bees

PAm is committed to enhancing the health of honey bees while improving crop production.

Growers Goal

Help build strong, 8-frame+ honey bee colonies by February 1st to meet your almond pollination needs.

Did you know that almond growers are a part of the largest pollination event in the world?

It requires 1.6 million honey bee colonies to pollinate 800,000 almond acres. Prior to and after almond bloom, forage can provide necessary nutrition to build honey bees that are healthy and vigorous to pollinate your crop.

Suggested Areas to Plant Bee Forage

- **When trees are being taken out of production**
- **Best is between young, non-bearing trees**
- **As a cover crop between rows**
- **Orchard margins or borders**
- **Along access rows**
- **Along waterways**
- **Fallow or unused land**

Cover Crop Guide

Prepping, Planting, and Timing

Choose the Proper Seed

Plant ***Rapini Mustard*** in areas where trees are being taken out of production, or between young, non-bearing trees. Plant either ***Capay Ranch Mix*** or the ***PAm Wildflower Mix*** between bearing or newly established orchard trees, on orchard margins and waterways.

Ground Preparation

A good, fine seed bed is desirable since most of the seeds are very small like alfalfa. The soil should be disked, cultipacked with a ring roller, planted and rolled a second time. If using a no-till drill the only preparation may be the application of an herbicide to control unwanted weeds.

Planting Methods

Use a grain drill, no till drill, broadcaster, or even a hand held broadcaster on small areas to evenly distribute the seed on the planting areas. In large fallow areas that have been prepared, aerial application followed by cultipacking is fine. Planting depth should be 1/4 inch.

Establishment Timing

In order to provide early winter bloom for honey bees, plant as early as possible in mid-to-late September. Planning, seed and equipment needs should be done before almond harvest starts. On unirrigated ground, the seed should be applied before the 1st rain so that weeds do not get a head start.

Cover Crop Guide

Weed Control and Management

Weed Control

In fallow areas, the weeds should be controlled the previous spring to prevent weed seed establishment. Between young trees and as a cover crop in mature orchards it may benefit the small flowering plants to have an application of 'grass killing' herbicide that will release the clovers and small flowers from shading and moisture stress. Caution: 'Grass killing' herbicides will cause phytotoxcity in the Rapini Mustard.

Management

If the bee forage mixtures do not cause cultural problems, they should be allowed to grow into May and June so that they both set seeds and provide the longest bloom possible. Thereafter, or at anytime they cause a problem, they can be mowed, disked and killed.

All Photos Below by Christi Heintz

Landowner Dan Cummings, rapini

Capay Ranch Clover-Vetch Mix

Lana Vetch


Honey Bee on Lana Vetch


Fred Thomas


Honey bee and Yellow Sweet Clover

Enhancing Honey Bee Health

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www.twitter.com/projectapis

About us

Project Apis m. is one of the largest non-profit honey bee research funding organizations in the United States. Since its inception in 2006, PAm has infused over $1.5 million into bee research.

Founded by beekeepers and orchardists, the mission of PAm is to enhance the health of honey bee colonies while improving crop production.

PAm is working to improve bee nutrition by encouraging land owners to plant forage resources for honey bees. To be a participant in the *'Seeds for Bees'* forage project, contact us at ProjectApis@gmail.com. To learn more, go to www.ProjectApism.org.

PAm Wildflower Mix

Common Name	Scientific Name	%
Five Spot	Nemophila maculata	26.41
Baby Blue Eyes	Nemophila menziesii	19.93
California Poppy	Eschscholzia californica	19.84
California Bluebells	Phacelia campanularia	13.42
Crimson Clover	Trifolium incarnatum	8.88
Alyssum	Lobularia maritima	2.99
Persian Clover	Trifolium resupinatum	1.98
Inert	Inert	6.51
Weed Seed	Weed Seed	0.04

Planting Instructions: Sow in Fall to take advantage of rains. In many areas, the mix should germinate with adequate natural rainfall. Planting depth is 1/8"- 1/4". Seed rate is 15 lbs/acre. No fertilizer necessary. If you are able to irrigate, ensure the root zone has available water until the roots reach 6" depth. To encourage reseeding, do not chip or disk but roll. Push seeds into the ground. Grower benefits include adding organic matter to the soil, decreasing soil compaction, and improving water penetration.

Write a contribution for honey bee research and send your donation to Project Apis m., P.O. Box 3157, Chico, CA 95927.
PAm is a 501 (c)(5) non-profit organization. Donations can also be made securely online at www.ProjectApism.org. Thank you!

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Capay Ranch Mix

Common Name	Scientific Name	%
Lana Vetch	Vicia villosa	67.36
Crimson Clover	Trifolium incarnatum	6.58
Hykon Rose Clover	Trifolium hirtum	6.57
Persian Clover	Trifolium resupinatum	3.30
Balansa Clover	Trifolium michelianum	3.29
Alyssum	Lobularia maritima	2.49
Inert	Inert	10.36
Other Crop	Other Crop	0.02
Weed Seed	Weed Seed	0.03

Planting Instructions: Sow in Fall to take advantage of rains. In many areas, the mix should germinate with adequate natural rainfall. Planting depth is 1/8"- 1/4". Seed rate is 20 lbs/acre. No fertilizer necessary. If you are able to irrigate, ensure the root zone has available water until the roots reach 6" depth. To encourage reseeding, do not chip or disk but roll. Push seeds into the ground. Grower benefits include adding organic matter to the soil, decreasing soil compaction, and improving water penetration.

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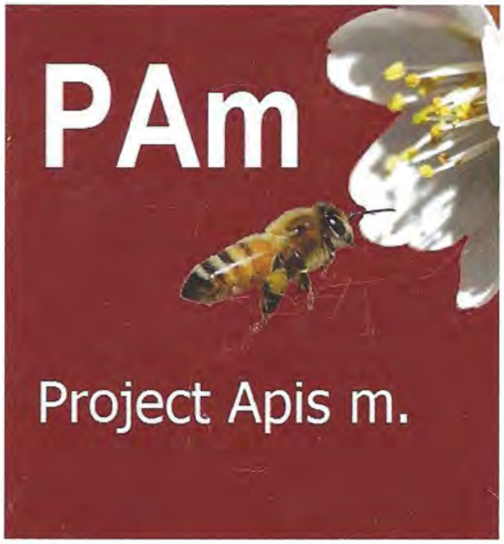

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Rapini Mustard

Common Name	Scientific Name	%
Rapini	Brassica rapa	99.93
Inert	Inert	0.07

Planting Instructions: Sow in Fall before first rains to target augmenting bee nutrition before almond bloom. For queen-rearing, also try a January planting for a post-almond bloom pollen source. Rapini is a low-moisture requiring plant. Keep moist for the first 2 weeks. Thereafter, if leaves curl, may require more water. In Arizona, rapini has done well with just 12 - 18" of water total. In many areas, the mix should germinate with adequate natural rainfall.

Planting depth is 1/8"- 1/4". Seed rate is 4 lbs/acre. Fertilizer: 50 - 50 blend of nitrogen and phosphate at 100 lbs/acre. Fertilize up front in the growing cycle. No need for fertilizer after bloom.

Bloom depends on your area. May bloom as soon as 45 days. Depending on temperatures, bloom duration may be 60 - 90 days. Post-bloom, disk under.

Grower benefits include adding organic matter to the soil, decreasing soil compaction, and improving water penetration. *Brassicas* have been shown to reduce soil-borne pathogens.

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Sowing Seeds for Honeybees

Project Apis m. is a non-profit organization committed to improving the health of honeybee colonies while enhancing crop production. You can help honeybees by sowing seeds that diversify their food supply, complement crop bloom, and provide essential nutritional sources of pollen and nectar.

"Sustainability through Floral Diversity"

Five Spot
(Nemophila maculata)


Photo by Meg Ribotto

Project Apis m.

Flower Color:	Five petals with a deep bluish-purple spot at tip.
Plant Type:	Annual. Grows quickly and blooms heavily.
Bloom Time:	Early Season
Indigenous To:	California
Height:	Low-growing, under 1 ft.
Soil Preference:	Adaptable
Exposure:	Full sun to partial shade
Soil Moisture:	Average, well-drained

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"Sustainability through Floral Diversity"

Baby Blue Eyes
(Nemophila menzeisii)


Photo by Christi Heintz

Project Apis m.

Flower Color:	True baby blue
Plant Type:	Annual. Grows quickly, blooms heavily.
Bloom Time:	Early season
Indigenous To:	California
Height:	Under 1 ft.
Soil Preference:	Prefers light, dry soils
Exposure:	Prefers some shade to filtered sun.
Soil Moisture:	Average moisture

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"Sustainability through Floral Diversity"

California Poppy
(Eschscholzia californica)


Photo by Christi Heintz

Project Apis m.

Flower Color:	Shiny petals in orange to gold.
Plant Type:	Perennial in warm areas. Annual in colder regions.
Bloom Time:	Mid and late season
Indigenous To:	California
Height:	Under 2 ft.
Soil Preference:	Adaptable
Exposure:	Full sun .
Soil Moisture:	Drought tolerant

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"Sustainability through Floral Diversity"

California Bluebells
(Phacelia campanularia)


Photo by Meg Ribotto

Project Apis m.

Flower Color:	5 blue bell-like petals with stamens resembling a clapper.
Plant Type:	Annual
Bloom Time:	Early season
Indigenous To:	California
Height:	8"
Soil Preference:	Dry, sandy
Exposure:	Full sun
Soil Moisture:	Tolerant

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"Sustainability through Floral Diversity"

Bicolor Lupine
(Lupinus bicolor)

Project Apis m.

Flower Color:	Two colors, deep blue with either white or purple.
Plant Type:	Annual
Bloom Time:	Early season
Indigenous To:	California
Height:	Miniature species, under 8"
Soil Preference:	Adaptable
Exposure:	Full sun to partial shade
Soil Moisture:	Average

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Changing the Landscape with Bee Pastures

Honeybees are required to pollinate one-third of our food supply, or about $15 billion in crops. Bees pollinate more than 90 different fruit, nut, and vegetable crops and most herbs and spices. Yet, the important role of the honeybee in the pollination of crops is often undervalued. Bees need a diversity of food resources to maintain health. Bee pastures of bee-friendly plants provide the necessary nectar and pollen sources required by honeybees.

Project Apis m. has identified plants that are recommended to support pollinators. We encourage land owners and land managers to sow seeds in suggested areas such as:

- **The interior of orchards**
- **Between young non-bearing trees**
- **As trees are taken out of production**
- **Cover crop between rows**
- **Orchard margins or on the perimeter**
- **Along access roads and waterways**

Contact Project Apis m. to learn more or to become a land cooperator.

Sowing Seeds for Honeybees

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"Sustainability through Floral Diversity"

Chinese Houses
(Collinsia heterophylla)

Project Apis m.

Flower Color:	Light purple and white pagoda-shape flowers
Plant Type:	Annual. Grows quickly, blooms heavily.
Bloom Time:	Mid-season
Indigenous To:	California
Height:	1 to 2 ft.
Soil Preference:	Adaptable but prefers rich soil
Exposure:	Full sun to light shade
Soil Moisture:	Above average

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Project *Apis mellifera*:

Field Nutrition Research Final Report

Prepared by:
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AgScience Consulting, LLC
2102 E. Blacklidge Dr
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Fall- Winter 2012

Spring 2013

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I. INTRODUCTION:

Honeybees play a very important role pollinating many crops across the US territory. The beekeeping community had been experiencing colony losses for the past 7 years and the numbers are increasing. There are many factors that can contribute to colony collapse and nutrition is considered to be one of them. The main objective of this research project was to conduct a comparative field study on honeybee nutrition to determine the impact of two different feeding sources before and after almond pollination. Rapini was used as a Fall/Winter crop and a wildflower mixture as a Spring crop. Sets of colonies were placed in the field crops for foraging as well as in desert locations without foraging sources and fed nutritional supplements. Colony strength was monitored throughout the study in both crops.

II. MATERIALS AND METHODS:

1. Fall-Winter Rapini Study 2012:

The trial was set up in Coolidge, AZ and Allen Clark provided the honeybee colonies, the Rapini field and the desert location. The Rapini field was planted on September 6, 2012, watered on September 7, 2012 and the first bloom was observed on October 27, 2012.

A set of 24-12 frames double deep colonies were set aside for the study. On December 10, 2012, 12 colonies were placed on the blooming Rapini field and 12 colonies on a desert area away from any foraging source. Sugar syrup was fed to all 24 colonies throughout the duration of the study. Pollen substitute was fed on December 29, 2012 to all colonies. Colony strength data was collected three times (initial, mid-term and final)

Initial frames of bees and brood were recorded in all 24 colonies on December 8, 2012. A second set of data (frames of bees and brood) was recorded 4 weeks after on January 4, 2013 and a third set of data 3 weeks after on January 25, 2013. In the middle of January the Rapini field suffered a hard frost that damaged most of the crop. Nutritional supplement was fed to both Rapini and control colonies to help maintain the bee population and keep the colonies strong prior to be moved to California.

The field study run from December 4, 2012 through January 25, 2012. The first week of February 2013 the colonies were moved to CA for almond pollination.

Desert Colonies

Rapini Field Colonies

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Yellow Rapini Pollen in Comb

Bee foraging on Rapini Flower

2. <u>Spring Wildflower Study 2013</u>:

The trial was set up at Paramount Farming Company in Lost Hills, CA. Two plots were planted for the study: wildflower mixture and rapini-yellow mustard.
The wildflower test plot was planted on October 11, 2012, watered on October 15, 2012 and two weeks later. Heavy rain in November precluded any need for watering for the next couple of months. The first to bloom was *Phacelia ciliata* on February 5, 2013; Black mustard, California Blue Bells and Five Spot started blooming by February 18, 2013. *Collinsia heterophylla* first bloom was March 15, 2013 and *Phacelia tanacetifolia* started blooming at the end of March.

The Rapini and yellow mustard test plot was planted in early December 2012 and no irrigation was needed until January 2013. The first bloom was observed at the end of March 2013. It was noticed that Rapini showed allelopathic tendencies around fiddleneck plants in the same field.

At the end of the almond pollination, 24-8-frames triple deep colonies were set aside for the study. On March 28, 2013, 12 colonies were placed on the blooming wildflower plot and 12 colonies in a desert area away from any foraging source. Colony strength data was collected three times (initial, mid-term and final).

Initial frames of bees and frames of brood were recorded in all 24 colonies on March 30, 2013. A second set of data (frames of bees and brood) was recorded 3 weeks after on April 19, 2013 and one (1Lb) MegaBee patty was fed to each of the control colonies. All 24 colonies were fed sugar syrup in black top bucket feeders. Desert colonies were fed another one (1Lb) MegaBee patty on May 10, 2013. The third set of data was recorded 4 weeks after on May 17, 2013.

Wildflowers at Paramount Farm 3/30/13

Rapini-yellow mustard field 3/30/13

Desert Colonies 3/30/13

Dry Rapini-yellow mustard field 5/17/13

III. RESULTS:

1. Fall-Winter Rapini Study 2012:

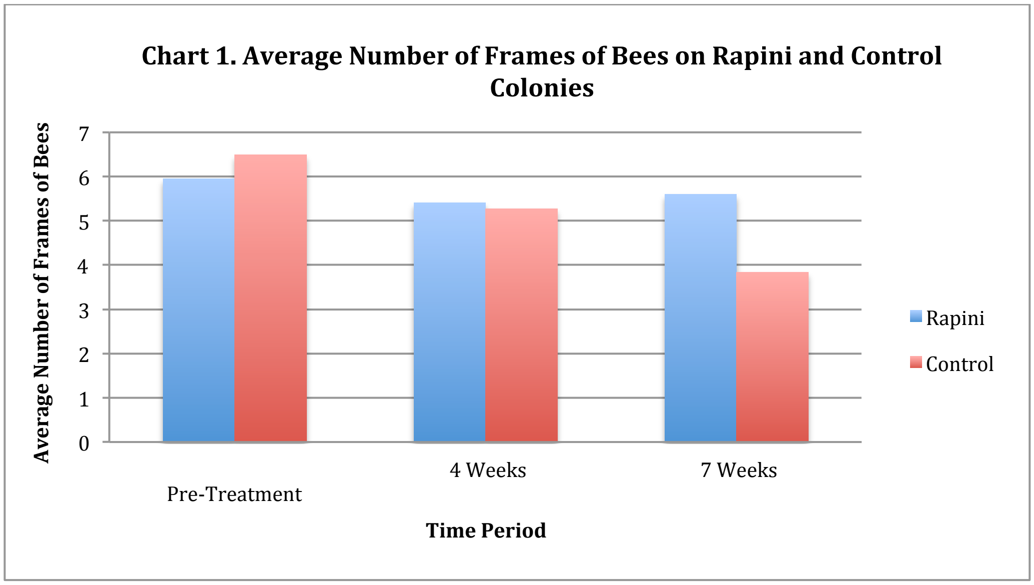
Colony strength was monitored three times throughout the duration of the study in all 24 colonies. Frames of bees, frames of brood and the queen presence were recorded and the data analyzed. The initial colony strength for all 24 colonies showed an average of 6.5 frames of bees and 0.5 frames of brood.

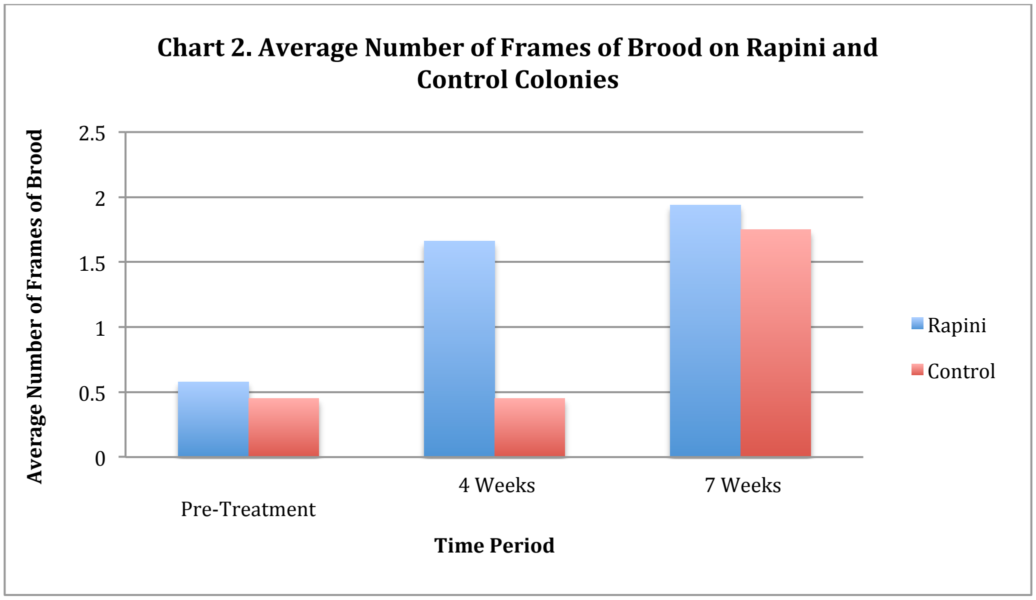
Rapini field colonies:

All 12 colonies located in the Rapini field started with an average of 5.95 frames of bees and 0.58 frames of brood. Four weeks after the initial measurement, the average number of frames of bees decreased to 5.41 and the frames of brood doubled in size from 0.58 to 1.66. After 7 weeks from the initial measurement, the average number of frames of bees increased slightly from 5.41 to 5.6. The same was observed for the average number of frames of brood with a slight increase from 1.6 to 1.94. Throughout the study it was observed that bees were foraging on Rapini flowers and bringing bright yellow pollen back to the hives. Colonies received a boost of pollen substitute in early January after the frost to supplement their needs and keep them alive.

Desert location diet control colonies:

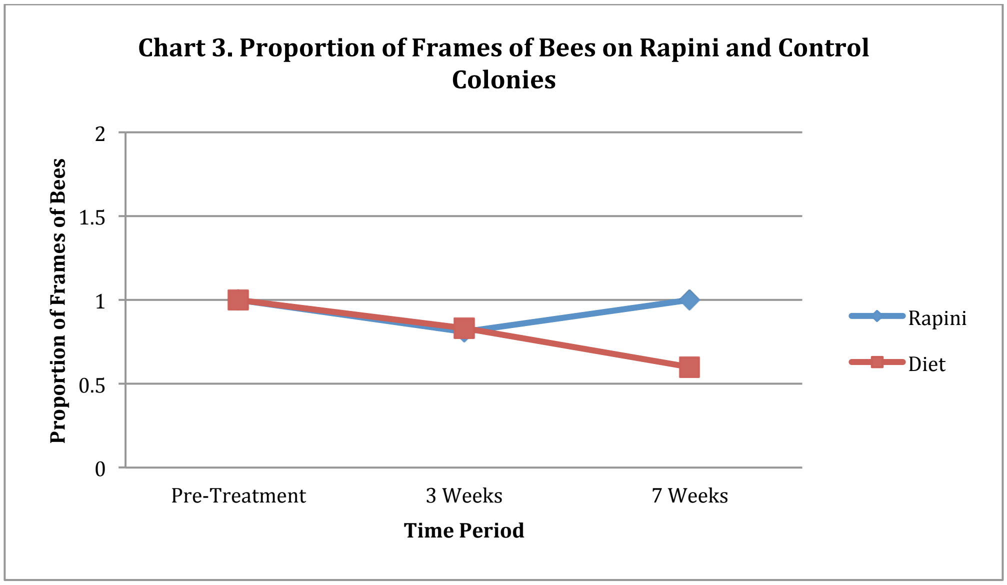
All 12 colonies located at the desert lot started with an average of 6.45 frames of bees and 0.45 frames of brood. Four weeks after the initial measurement, the average number of frames of bees decreased slightly from 6.45 to 5.27. The number of frames of brood remained the same at 0.45. After 7 weeks from the initial measurement, the average number of frames of bees decreased considerably from 5.27 to 3.84. The average number of frames of brood doubled in size from the initial average of 0.45 to 1.75 but it was below the Rapini colonies. The results from Rapini and control colonies are shown in charts 1 and 2.

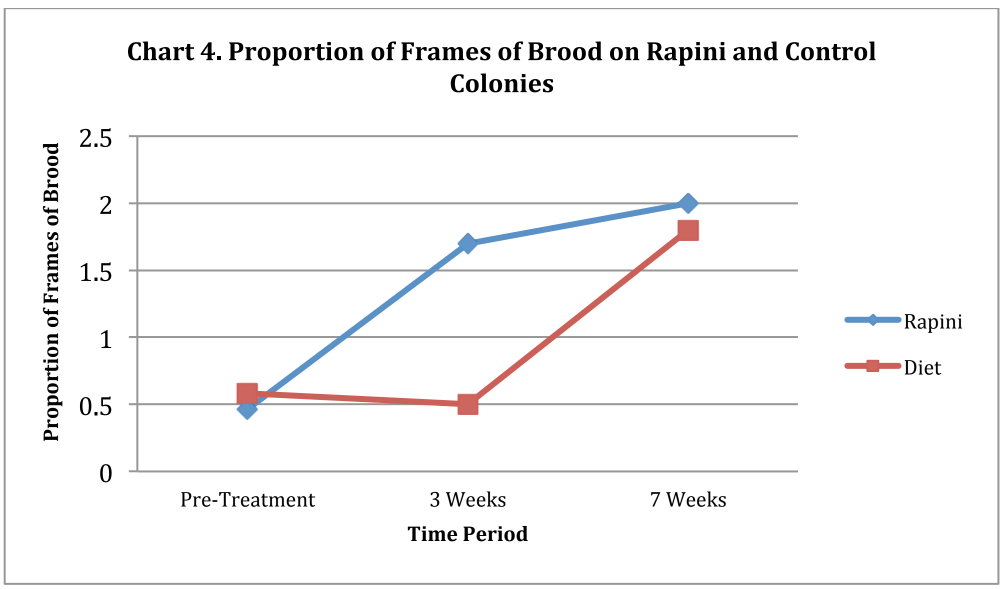




Statistical Analysis:

The statistical analyses of the data from the Fall Rapini Study have shown that all colonies started at the same strength. Rapini colonies were able to maintain the number of frames of bees over time while diet control colonies experienced a decrease. The proportion of frames of bees between Rapini and control colonies was not significantly different. On the other hand, both Rapini and control colonies were able to increase the number of frames of brood. After three weeks of treatment there was a significant difference in frames of brood between the two but at the end of the study both treatments were the same. The results are shown on charts 3 and 4.





2. Spring Wildflower Study 2013:

Colony strength was monitored three times throughout the duration of the study in all 24 colonies. Frames of bees, frames of brood and the queen presence were recorded and the data analyzed. The field study run from March 30, 2012 through May 17, 2012.

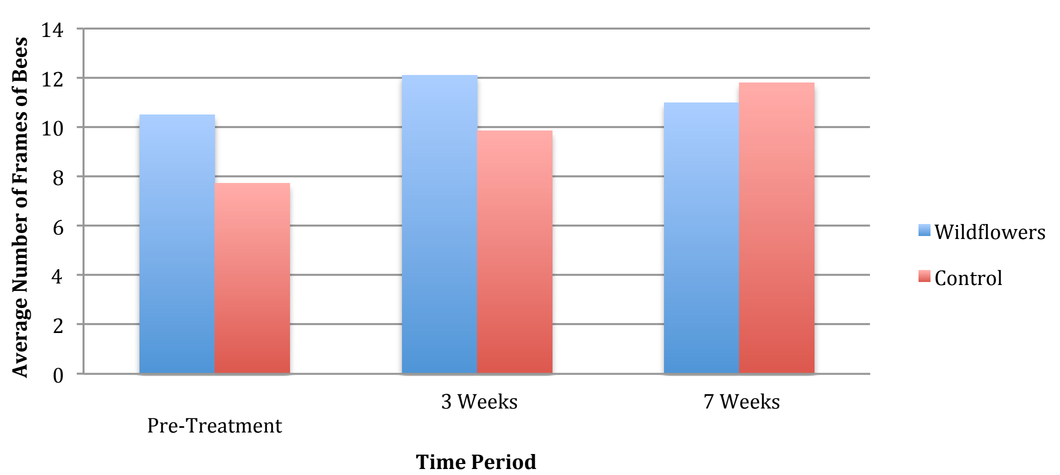
Wildflower field colonies:

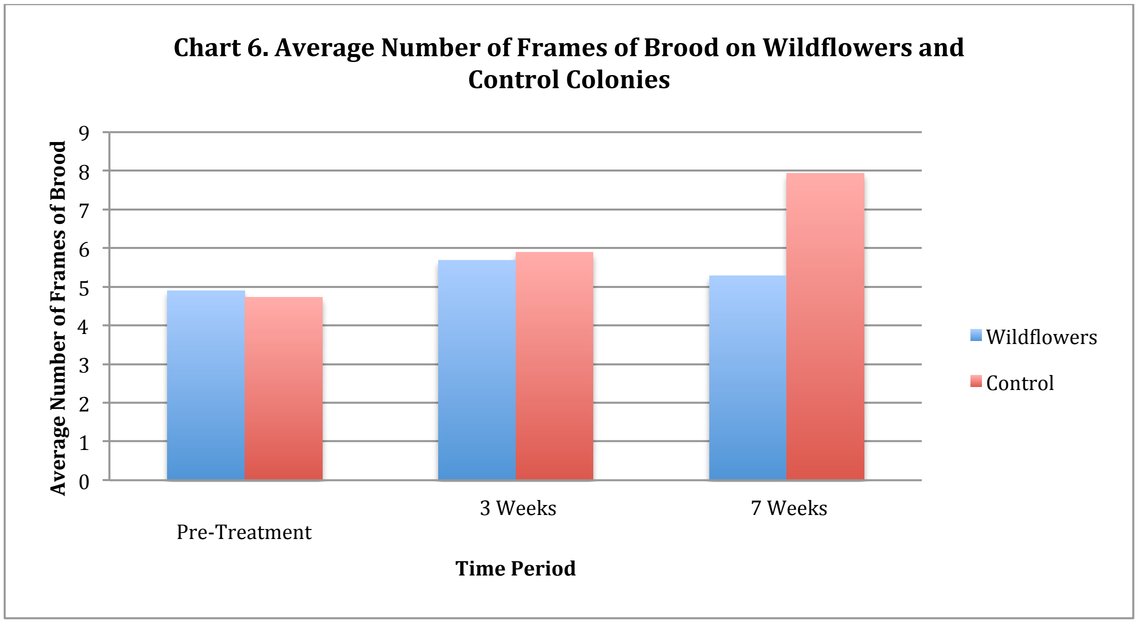
All 12 colonies located in the wildflower field started with an average of 10.5 frames of bees and 4.9 frames of brood. Three weeks after the initial measurement, the average number of frames of bees was 12.1 and 5.7 frames of brood. It was observed that the bees were foraging on the wildflower and Rapini-yellow mustard plots bringing an assortment of colored pollen back to the hives. After 7 weeks from the initial measurement, the average number of frames of bees decreased slightly from 12.1 to 11. The average number of frames of brood remained almost the same. At this time, the rapini-yellow mustard plot was no longer in bloom and almost dry. The wildflower mixture still had some flowers in bloom.

Desert location diet control colonies:

All 12 colonies located at the desert lot started with an average of 7.73 frames of bees and 4.73 frames of brood. Three weeks after the initial measurement, the average number of frames of bees was 9.85 and 5.9 frames of brood. After 7 weeks from the initial measurement, the average number of frames of bees increased from 9.85 to 11.8. The average number of frames of brood also increased from 5.9 to 7.94. The results from wildflower and control colonies are shown in charts 5 and 6.

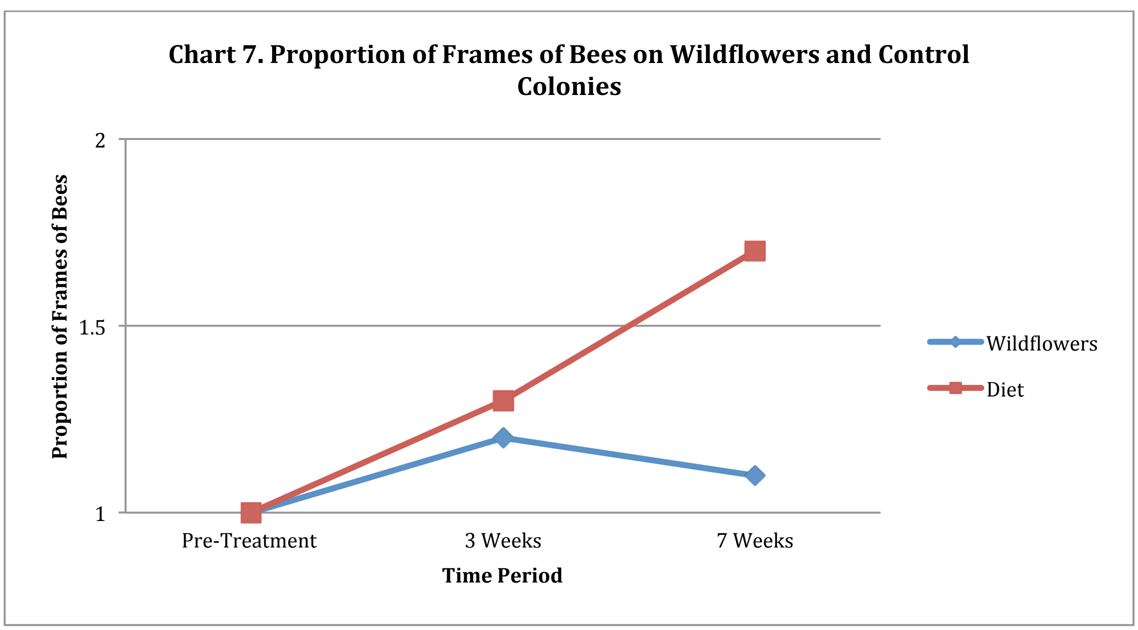
Chart 5. Average Number of Frames of Bees on Wildflowers and Control Colonies





Statistical Analysis:

The statistical analyses of the data from the Spring Wildflower Study have shown that all colonies started with similar strength. Diet control colonies were able to increase the number of frames of bees over time while wildflower colonies experienced a slight decrease at the end of the study. The proportion of frames of bees between wildflowers and control colonies was significantly different. Diet control colonies had more frames of bees. Even though diet control colonies were able to increase the number of frames of brood, at the end of the study the difference between both treatments was not significant. The results are shown on charts 7 and 8.



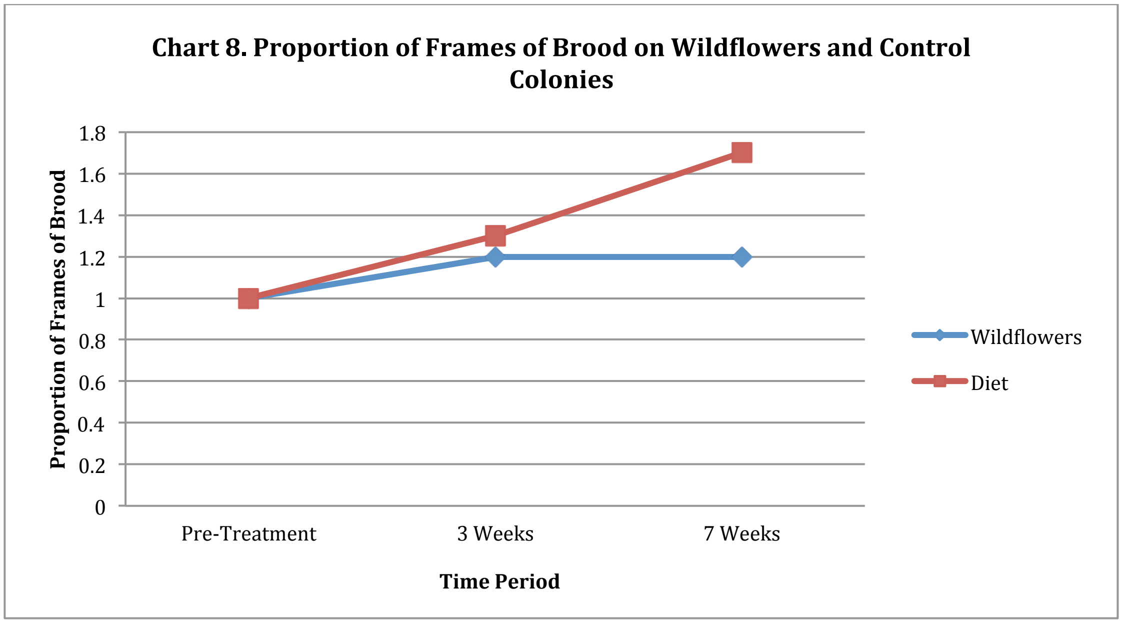


Chart 8. Proportion of Frames of Brood on Wildflowers and Control Colonies

IV. DISCUSSION:

The main focus of this study was to demonstrate if there is a benefit on having colonies forage on natural sources before and after almond pollination. A common practice on commercial beekeeping is to keep colonies in holding yards, feed them nutritional supplements and sugar syrup until they are moved to California for almond pollination. Colonies should be fairly strong to be able to successfully pollinate almonds.

The Fall-Winter study in Arizona started in early December 2012 and the colonies were not very strong. Rapini and diet control colonies started with similar numbers of frames of bees. After 7 weeks, Rapini colonies were able to maintain the number of frames of bees but the diet control colonies lost almost half of them. During the study it was observed that Rapini and diet control colonies increased the number of frames of brood after 3 weeks and there was a significant difference between treatments at this point. At the end of study, both treatments had the same number of frames of brood. Little is known about the nutritional content of Rapini and more research needs to be performed to know if it has all the necessary nutrients to over-winter colonies.

The Spring study in California started at the end of March 2013 with colonies that have finished pollinating almonds. Diet control colonies started with small number of frames of bees than the wildflower colonies. After 3 weeks, both treatments had increased the number of frames of bees and at the end of the study the proportion of frames of bees between wildflowers and control colonies was significantly different. Diet control colonies had more frames of bees than the wildflower ones. Both sets of colonies started with similar numbers of frames of brood and even though diet controlcolonies were able to increase the number of frames of brood the difference was not significant. When the study was set up, the colonies were already strong after pollinating the almonds and had good amounts of beebread and honey stored. This factor played a very important role because bees were feeding on it. It is difficult to know if their growth during the study was due to their own sources, natural foraging, supplemental feeding or a combination of food sources.

Little is known about the nutritional content of Rapini and wildflowers and more research needs to be performed to determine if they have all the necessary nutrients the colonies need before and after pollination.

In order to have a better understanding of the benefits of natural foraging, the study will have to be performed for a longer period of time to collect enough data and with appropriate colony management.
Fall-Winter colonies will have to be treated for mites before the study. This is a critical time for the colonies because the brood is very low and is important to keep the winter bees alive to be able to rear brood and increase the adult population before pollination.
Spring colonies will have to be split, equalized with similar bee and brood population, food storage and receive a mite treatment before the study. These colony management practices will be representative of commercial beekeeping activities.

What's Growin' On? Student Newspaper Evaluation

A California Foundation for Agriculture in the Classroom project funded by the California Department of Food and Agriculture's Specialty Crop Block Grant Program

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Introduction

The purpose of this study was to examine the impact of articles and activities from California Foundation for Agriculture in the Classroom's *What's Grown' On? CA Crop Talk – Specialty Crop Edition* (WGO). Specifically of interest was learning whether the articles and activities would add to teachers' and students' knowledge of specialty crops in California. WGO is a 16-page student newspaper distributed at no-cost to teachers and other educators throughout California. It contains informative articles and activities about California agriculture commodities and products. Developed for students in grades three through eight, the 10th edition focused solely on specialty crops grown in California.

Methods

Data Collection

Surveys were developed to collect data from teachers and students in the fall of 2012. Three teachers and their classrooms participated in a pilot study that was conducted in the summer of 2012. The teachers provided feedback about the procedures, and the surveys were adjusted based on teacher comments about students' level of understanding. The students who participated in the pilot of the study are not included in the data included in this report. All teachers who participated in the pilot and the intervention received a $150 material stipend for their participation and a class set of WGO newspapers for their students.

The teacher survey, attached as Appendix A, was developed to learn whether the information and activities in WGO would increase teacher knowledge about specialty crops, and if they would be willing to use the information and activities as part of their everyday curriculum.

The student survey, attached as Appendix B, was developed to learn whether participating in the activities and reading the information on specialty crops would increase student knowledge about specialty crops, and whether their likelihood to consume specialty crops would increase.

Subjects and Procedures

Teachers and students from 25 schools in 16 different counties participated in the study. There were 27 classrooms, averaging 23 students per classroom. There were 31 teachers who completed the web-based survey. The schools were in the following counties: Alameda, Del Norte, El Dorado, Fresno, Los Angeles, Nevada, Orange, Placer, Sacramento, San Bernardino, San Joaquin, San Luis Obispo, Solano, Sonoma, Tulare, and Yuba.

Teachers were directed to administer the student survey prior to letting students look at WGO or become familiar with any content included in the newspaper. Teachers read each question aloud to students, and allow time for students to respond to the questions. Teachers collected the completed surveys and returned them to the evaluator. Following the first administration of the survey, teachers and students were asked to complete pre-selected articles and activities from WGO, over a period of approximately four weeks. After completing all of the pre-selected activities, teachers were asked to re-administer the survey, following the same procedure. Teachers once again collected the completed surveys and returned them to the evaluator. All student names on the surveys were replaced with anonymous student ID codes, in order to maintain student confidentiality. Teachers were asked to complete a web-based survey at the completion of the project.

Data Analysis

Data from student surveys were entered into Survey Monkey for analysis purposes. Survey Monkey is an online survey software and questionnaire tool. Analysis can provide information about the number of students who answered each question, the number of students who skipped a question, and the number and percentage of students that selected each response option. Data from the pre-intervention survey were compared to data from the post-intervention survey.

Teacher surveys were completed and analyzed using Survey Monkey.

Results

Teacher Survey

A total of 31 teachers completed the survey following their participation in the project. The results from this survey indicate that most teachers found the experience of using WGO to be very rewarding and engaging, and that the specialty crops edition provided them and their students with a lot of new information about specialty crops. They almost unanimously indicated a desire to receive additional editions and information about these types of activities and lessons. The teacher survey is located in Appendix A. The results from this survey are summarized, by question, in Appendix C.

Student Survey

There were 663 students who took the pre-survey and 668 students who took the post-survey. Not every student answered every question on either the pre- or post-survey. The number of respondents to each question varies depending on the number of students who answered that particular question. The data are not matched by student.

The student survey is located in Appendix A. Responses to both student surveys are provided in the tables in Appendix D. The percentages of responses are provided for pre- and post-surveys.

There were 22 questions on the student survey. The questions were developed from information provided in the specialty crops edition of WGO. Most of the questions (15/22) were designed to learn about knowledge gained about specialty crops from the newspaper and after completing the pre-selected activities. The following questions sought to learn about an increase in knowledge regarding specialty crops:

Q5. Fruit and tree nuts are specialty crops.
Q7. Pistachios grow in wet climates.
Q8. Pistachios are a good source of fiber and protein.
Q9. A pistachio tree, if well-cared for, can produce nuts for more than a century.
Q10. The honeydew melon is related to cucumbers, pumpkins and squash.

Q12. Watermelons are 90% water.
Q14. Herbs provide no health benefits.
Q15. When cooking, fresh herbs are used in the same amounts as dried herbs.
Q16. Cilantro (leaves) and coriander (seeds) are from the same plant.
Q17. Wormwood, licorice, witchhazel and foxglove are all herbs.
Q18. Name one of the top three commodities produced in your county.
Q19. Specialty crops grow best in cold weather.
Q20. California is the leading agricultural state in the nation.
Q21. California does not have micro-climates that allow farmers to grow many different crops.
Q22. Name one place where you can buy specialty crops.

A comparison of the pre- and post-responses to these questions indicates that for every question, with the exception of one (Q10), there were changes in the expected direction. That is, student responses indicated an increase in knowledge about the topic on the post-survey. As evident on the tables, there were noticeably large differences in the responses for Question 9, 16, and 17.

There were several questions that reflected a positive change in direction (i.e., more knowledgeable about the topic), but the change was slight, indicating perhaps that students were already somewhat familiar with these particular topics. This is the case for Questions 12, 14, 19, 20, and 21.

There were also three questions included to learn about taste preferences. Questions 6, 11, and 13 asked students about whether they liked a particular specialty crop food item. As noted on the tables, the responses in the post-survey indicated that students' preference for these items increased following the articles and activities.

Two of the questions were open-ended (Question 18 and 22). Summaries of the responses to these questions are provided in Appendix E and Appendix F.

Appendix A

What's Growin' On? Survey for Teachers

Thank you very much for participating in this California Foundation for Agriculture in the Classroom study. Your feedback lets us know how What's Growin' On? contributes to classroom curriculum, and helps understand how What's Growin' On? can be more useful for teachers.

1. Teacher's name:

2. School:

3. Do you find the newspaper format of What's Growin' On?

	Definitely disagree	Disagree	Agree	Definitely agree
Engaging?				
Educational?				
Easy to understand?				
Age appropriate?				

Comments:

4. Does What's Growin' On?

	Definitely disagree	Disagree	Agree	Definitely agree
Support your normal classroom curriculum?				
Reinforce the California Content Standards?				

Comments:

5. Did the special edition focusing on specialty crops increase your likelihood to consume specialty crops?

___ yes ___ no
Why or why not?

6. Did the special edition focusing on specialty crops increase your likelihood to include them in your classroom curricula?

___ yes ___ no
Why or why not?

7. Did the special edition focusing on specialty crops increase your knowledge about California agriculture?

___ yes ___ no
Why or why not?

8. Do you think information and activities from What's Growin' On? increases students' awareness of agriculture in their lives?

___ yes ___ no

If YES, how?

9. Do you think you will use California Foundation for Agriculture in the Classroom materials in the future?

___ yes ___ no

Why or why not?

10. Please use the space below for any comments or questions you may have regarding the survey or the content of the survey:

Thank you very much!

Appendix B

What's Growin' On? Youth Survey

Please read each question carefully and check the box with the correct answer.

1. I am a ______ Boy ______ Girl (check one)
2. Please write in your grade: ________
3. Do you live on a farm? ______ Yes ______ No
4. Do you have friends or relatives who live on a farm? ______ Yes ______ No

The following questions are either True or False. Place an 'x' next to the correct answer.

5. Fruit and tree nuts are specialty crops.
   _____ True _____ False
6. I like to eat pistachios.
   _____ True _____ False ___ I don't know
7. Pistachios grow in wet climates.
   _____ True _____ False
8. Pistachios are a good source of fiber and protein.
   _____ True _____ False
9. A pistachio tree, if well-cared for, can produce nuts for more than a century.
   _____ True _____ False
10. The honeydew melon is related to cucumbers, pumpkins and squash.
    _____ True _____ False
11. I like to eat cantaloupe.
    _____ True _____ False _____ I don't know
12. Watermelons are 90% water.
    _____ True _____ False
13. I like watermelon lemonade.
    _____ True _____ False ___ I don't know
14. Herbs provide no health benefits.
    _____ True _____ False
15. When cooking, fresh herbs are used in the same amounts as dried herbs.
    _____ True _____ False
16. Cilantro (leaves) and coriander (seeds) are from the same plant.
    _____ True _____ False
17. Wormwood, licorice, witchhazel and foxglove are all herbs.
    _____ True _____ False

18. Name one of the top three commodities produced in your county:

____

19. Specialty crops grow best in cold weather.

____ True ____ False

20. California is the leading agricultural state in the nation.

____ True ____ False

21. California does not have micro-climates that allow farmers to grow many different crops.

____ True ____ False

22. Name one place where you can buy specialty crops:

____

Thank you!

Appendix C

Teacher Survey Results

Q3. Do you find the newspaper format of What's Growin' On? Engaging? Educational? Easy to understand? Age appropriate?

There were 31 teachers who answered the survey question. Of these, 18 teachers provided comments about the newspaper. The numbers of responses do not add up to 18 because teachers made comments regarding several aspects of the newspapers. The positive comments are summarized below:

Student Response	Students were excited about the activities (1/14); they liked having their own newspaper (1/14).
Format	Teachers found the format easy to follow (5/14), colorful (3/14), engaging and informative (3/14), the experiential aspect of the activities made the material meaningful (1/14).

Several teachers commented that they felt the *material was too difficult* for their fourth or fifth grade students (5/18). These comments included the following:

Reading level	Too difficult (1/18).
Math level	Too difficult (4/18). Of the teachers who commented that the math level was too difficult, two teachers specifically mentioned that they had not yet covered fractions. The teachers stated that they addressed this by doing the activities together.
Genetics	Two teachers mentioned that the genetics section was too difficult for 5^{th} graders. They did the activity as a class.

A general comment by one teacher regarding the newspaper is that some of the print was too small for students. This was addressed by enlarging the print when necessary.

Q4. Does What Growin' On? Support your normal classroom curriculum? Reinforce the California Content Standards?

There were 14 teachers who provided comments to this question. Of these, 9/14 said the newspaper supported their curriculum. One comment stated, generally, that it was applicable to the curriculum, without specifying. Eight of 14 comments referred to specific ways that the newspaper supported their curriculum. These included:

- The hands-on component (2/14), provided information about California agriculture that many children did not have; provided a demonstration of mastery in note taking, data collection and organizing.
- Providing information about agricultural economy.
- Leading into ESL lessons; nutrition, geography, writing, math.
- Science, math, social studies, language arts, community agriculture.
- Introducing the garden.
- The newspaper fit in with the CA Regions curriculum.

Four of the 14 comments included references to the CA Standards:

- WGO provides a nice supplement to CA History.
- WGO integrates well with Social Studies and Science.

Two of the comments regarding the CA Standards indicated that while the CA Standards are addressed, the timing of the newspaper does not fit in with their curriculum:

- Because of the timing of the newspaper, the activities were used as enrichment with some students; apparently these subjects are covered at another time of the school year and the 'push' currently is for math and language arts.
- One teacher indicated that botany and zoology are studied in fourth grade and requested that more Science and Social Studies standards be addressed.

Q5. Did the special edition focusing on specialty crops increase your likelihood to consume specialty crops? Why or why not?

There were 31 teachers who answered the question; of these, 27 responded that their likelihood to consume specialty crops was increased by the specialty crops edition of WGO. Four of the 31 respondents did not think the special edition of WGO increased their likelihood to consume specialty crops. There were 29 teachers who responded to the question 'Why or Why not?' Of the 29 who responded, their answers reflected several categories of responses:

Already consume these	Would continue to do so (4/29).
Increased knowledge	Several teachers indicated that students were excited to try new things (7/29); teachers also said they were excited to try new things (2/29); the edition provided information about nutrition and amounts of crops grown (2/29); this was a good reminder about different uses for crops (herbs, pistachios) (8/29); several teachers indicated that either they or their students didn't know these crops were called specialty crops (3/29).
Local produce	One teacher was very happy to learn about and support local CA produce; Two teachers indicated that now students are aware of supporting local produce.
Increased willingness to eat new produce	One teacher specifically said that a student was now requesting that his mother buy pistachios.

Of the two respondents who said they would not increase their consumption of specialty crops, one said because they already consume them; one said the specialty crops edition would not change what they eat.

Q6. Did the special edition focusing on specialty crops increase your likelihood to increase them in your classroom curricula? Why or why not?

There were 31 respondents to this question. Of these, 29 responded 'Yes' and 2 responded 'No'. Of the 31 respondents, 28 answered 'Why or Why not?' The responses reflected the following categories:

Supportive curriculum	Several comments reflected that the curriculum worked well with other curricula, that the extensions made it long-lasting, that it worked well with exciting garden projects; and that it worked well or

	tied in with local activities in the community (11/28).
Increased student knowledge and exposure	Teachers mentioned that the specialty crops edition provided information about California history, crops, tied into units about Life Sciences and Social Studies; Also, teachers mentioned that students were exposed to new tastes and to information about local produce (10/28).
Increased student excitement and interest	Teachers are more likely to include specialty crops in their curricula because students were excited about what they were trying (9/28).
Teacher enjoyment	One teacher specifically stated that because the activities were so enjoyable, they would be included in future curricula.

Q7. Did the special edition focusing on specialty crops increase your knowledge about California agriculture?

There were 29 respondents to this question. All 29 responded 'Yes'. Of the respondents, 24 responded to 'Why or why not?' The responses reflected the following about how knowledge was increased:

Learned new information	Of the 24 respondents, 13 indicated they learned new information. This was true for one teacher self-described as a third generation Californian, and for one teacher self-described as having a strong agriculture base. Another respondent specifically mentioned not knowing that flowers and plants are specialty crops. Four respondents specifically mentioned that they learned information about pistachios, and two mentioned melons.
California's agriculture abundance	Five teachers mentioned learning about how many crops and commodities are produced in California.
County information	Three teachers mentioned that information about the counties was very informative and that students enjoyed making a connection to their county and learning about the primary produce grown there.
California map	Two teachers found the map very informative and easy for students to understand.
Historical perspective	Two teachers commented on learning about the historical perspective of crops.

Other individual comments made by teachers about what they learned from the specialty crops edition included: proper nomenclature, the location of crops, and the contribution crops make to the economy. Two teachers also commented on sharing the material with friends and family and enjoying the Sutton Farms video.

Q8. Do you think information and activities from What's Grown' On? increases students' awareness of agriculture in their lives?

All 31 respondents to this question said 'Yes.' Of these, 27 answered 'If Yes, how?' Their responses were in the following categories:

Learning where food comes from	Teachers indicated that the information and activities led to discussions about where food comes from, and the importance of local resources (8/27). Comments included references to students being urban dwellers and not having been exposed to agriculture;

	knowing what was available regionally, and that food doesn't just come from the grocery stores.
Hands-on activities	Several teachers stated that the activities in the special edition definitely increased their students' awareness of agriculture (7/27). Specific activities mentioned included the gardens, and the recipes.
Facts	The interesting facts in the newspaper (5/27).
Increased interest	The specialty crops edition increased students' interest in crops, and in new foods (3/27).
Increased awareness	California's role in specialty crop production was new information to students (3/27). It brought awareness to students of the importance of agriculture in their lives.
Tasting new food	The students were willing to try new foods (2/27).

Other examples of how students' awareness of agriculture was increased included:

- The vocabulary tied in with Spanish spoken in the home.
- An increased interest in what families grow in other countries, as well as locally.
- The historical information tied in with other current class subjects.
- Students are paying attention to grocery ads.
- Gave them new things to think about.

Q9. Do you think you will use California Foundation for Agriculture in the Classroom materials in the future?

There were 31 respondents to this question. Of these, 29 answered 'Yes' and 2 answered 'No.' Of those who said they would *not* use the material in the future, one teacher indicated that they already have a huge nutrition program in their school, and one indicated that it would be hard to fit in additional curriculum.

Of the teachers who *do* think they will use CFAITC materials in the future, their comments reflected the following reasons:

- Great educational activities and lesson plans (10/29).
- Augments their curriculum (Social Science and Science) (5/29).
- Interactive, engaging and fun (3/29).
- Excellent resources (2/29).
- The extension activities (2/29).

Two teachers stated that they would use the materials in the future; however, using them towards the end of the school year would fit better with their curriculum.

Q10. Please use the space below for any comments or questions you may have regarding the survey or the content of the survey.

There were 20 teachers who responded to this question. The following comments and suggestions were regarding the *survey* or *content* of the survey:

- Helped understand students' level of exposure to agriculture.
- Study/survey was impetus for doing the activities (not previously done).
- Question to ask next time: Which activities were most fun? What activities were done?
- Made students think about agriculture.

- Great education for students and teacher.
- Survey/Study was impetus for starting their garden.
- Suggestion: Include math work space for student's work.
- Good questions.
- Study was fun, educational and thought provoking.
- Easy to complete.
- The program/study was well thought out.

There were also comments about the *newspaper*:

- Students really enjoyed the word search and other activities.
- Have used the newspaper in many different grades for different reasons. Enjoy using the paper with the students.
- Students asked to do the newspaper every month; it's a little long.
- Great connection to the new Common Core Standards; would like to use it every year.
- Some activities were too hard for students (particularly math ones).
- Had fun adapting ideas from the materials.
- Look forward to future editions.
- Notice that it is the 10^{th} edition; asks how often printed and requests sets in the future.
- Truly enjoyed the activities; Students were excited to take the papers home to share with their families; Will team with a colleague and do the lessons again.
- WGO is a wonderful, engaging resource; the definition of a specialty crop is confusing – seems to be everything produced.
- Plan to teach the rest of the segments in the newspaper.
- Surprised how many kids had no idea how to use a newspaper.

Appendix D

Student Survey Results

Correct answers, if applicable are marked with an asterisks (*)

1. I am a _____ Boy _____ Girl (check one)

	Pre (N= 663)	Post (N= 666)
Boy	48.1%	48.6%
Girl	51.9%	51.4%

2. Grade:

	Pre (N= 659)	Post (N= 665)
3	2.9%	2.6%
4	48.6%	48.9%
5	48.1%	48.0%
6	0.5%	0.6%

3. Do you live on a farm?

	Pre (N= 663)	Post (N= 667)
Yes	3.9%	4.6%
No	96.1%	95.4%

4. Do you have friends or relatives who live on a farm?

	Pre (N= 655)	Post (N= 660)
Yes	38.8%	41.1%
No	61.2%	58.9%

5. Fruit and tree nuts are specialty crops.

	Pre (N= 655)	Post (N= 660)
True *	62.3%	85.8%
False	37.7%	14.2%

6. I like to eat pistachios.

	Pre (N= 657)	Post (N= 666)
True	53.6%	75.4%
False	21.3%	14.7%
I don't know	25.1%	9.9%

7. Pistachios grow in wet climates.

	Pre (N= 649)	Post (N= 663)
True	39.1%	32.3%
False *	60.9%	67.7%

8. Pistachios are a good source of fiber and protein.

	Pre (N= 658)	Post (N= 665)
True *	87.7%	94.7%
False	12.3%	5.3%

9. A pistachio tree, if well-cared for, can produce nuts for more than a century.

	Pre (N= 654)	Post (N= 666)
True *	53.7%	82.3%
False	46.3%	17.7%

10. The honeydew melon is related to cucumbers, pumpkins and squash.

	Pre (N= 653)	Post (N= 668)
True	59.7%	59.7%
False *	40.3%	40.3%

11. I like to eat cantaloupe.

	Pre (N= 658)	Post (N= 667)
True	54.4%	64.3%
False	24.5%	21.0%
I don't know	21.1%	14.7%

12. Watermelons are 90% water.

	Pre (N= 657)	Post (N= 667)
True *	82.3%	95.1%
False	17.7%	4.9%

13. I like watermelon lemonade.

	Pre (N= 662)	Post (N= 654)
True	45.0%	62.5%
False	11.0%	11.3%
I don't know	44.0%	26.1%

14. Herbs provide no health benefits.

	Pre (N= 653)	Post (N= 661)
True	26.6%	15.7%
False *	73.4%	84.3%

15. When cooking, fresh herbs are used in the same amounts as dried herbs.

	Pre (N= 644)	Post (N= 659)
True	45.5%	37.8%
False *	54.5%	62.2%

16. Cilantro (leaves) and coriander (seeds) are from the same plant.

	Pre (N= 645)	Post (N= 660)
True *	50.2%	69.8%
False	49.8%	30.2%

17. Wormwood, licorice, witchhazel and foxglove are all herbs.

	Pre (N= 646)	Post (N= 656)
True *	45.4%	74.2%
False	54.6%	25.8%

18. Name one of the top three commodities produced in your county:

	Pre (N= 578)	Post (N= 643)
See Appendix E		

19. Specialty crops grow best in cold weather.

	Pre (N= 647)	Post (N= 661)
True	26.4%	30.1%
False *	73.6%	69.9%

20. California is the leading agricultural state in the nation.

	Pre (N= 642)	Post (N= 660)
True *	74.5%	87.0%
False	25.5%	13.0%

21. California does not have micro-climates that allow farmers to grow many different crops.

	Pre (N= 644)	Post (N= 661)
True	34.3%	22.8%
False *	65.7%	77.2%

22. Name one place where you can buy specialty crops.

	Pre (N= 604)	Post (N= 660)
See Appendix F		

Appendix E

Responses to Q18: "Name one of the top three commodities produced in your county."

Alameda County

The top three commodities for Alameda County are winegrapes, woody ornamentals, and cattle and calves. When taking the pre-survey, 1 student gave at least one correct answer and 26 students said "I don't know." This compares to the post-survey, where 13 students answered correctly, and 7 students said "I don't know."

Del Norte County

The top three commodities for Del Norte County are cows, milk, and lily bulbs. When taking the pre-survey, 11 students answered correctly. When taking the post-survey, 14 students answered correctly.

El Dorado County

The top three commodities for El Dorado County are apples, cattle and calves, and winegrapes. When answering the pre-survey, 20 students answered correctly. This compares to the post-survey, where 29 students gave at least one correct answer. Every student gave at least one correct answer.

Fresno County

The top three commodities for Fresno County are almonds, poultry, and raisin grapes. When answering the pre-survey, 1 student gave at least one correct answer and 2 said 'I don't know.' This compares with the post-survey where 17 students gave at least one correct answer. 'Grapes' and 'raisins' were counted for 'raisin grapes.'

Los Angeles County

The top three commodities for Los Angeles County are woody ornamentals, bedding plants, and vegetable crops. When answering the pre-survey, 12 students gave at least one correct answer (named a vegetable.) This compares to the post-survey, where 33 students gave at least one correct answer.

Nevada County

The top three commodities for Nevada County are cattle, pasture, and pasture and range. When answering the pre-survey, 1 student gave at least one correct answer. This compares to the post-survey, where 27 students gave at least one correct answer.

Orange County

The top three commodities for Orange County are woody ornamentals, strawberries, and vegetable crops. When answering the pre-survey, 9 students gave at least one correct answer (a vegetable). This compares to the post-survey, where 31 students gave at least one correct answer.

Placer County

The top three commodities for Placer County are rice, cattle and calves, and nursery products. When answering the pre-survey, 1 student gave at least one correct answer. This compares to the post-survey, where 15 students gave at least one correct answer.

Sacramento County

The top three commodities for Sacramento County are winegrapes, milk, and Bartlett pears. When answering the pre-survey, 2 students gave at least one correct answer. This compares to the post-survey where 63 students gave at least one correct answer. (Note: Many more students answered the post-survey than the pre-survey.)

San Bernardino County

The top three commodities for San Bernardino County are milk, eggs, and milk cows. When answering the pre-survey, 2 students gave at least one correct answer. 37 students answered 'I don't know.' This compares to the post-survey where 28 students gave at least one correct answer and 12 answered 'I don't know.'

San Joaquin County

The top three commodities for San Joaquin County are milk, winegrapes, and walnuts. When answering the pre-survey, 7 students gave at least one correct answer. When answering the post-survey, 8 students gave at least one correct answer.

San Luis Obispo County

The top three commodities for San Luis Obispo County are winegrapes, strawberries, and broccoli. When answering the pre-survey, 19 students gave a correct answer. This compares to the post-survey where 39 students gave at least one correct answer.

Solano County

The top three commodities for Solano County are processing tomatoes, walnuts, and vegetable crops. When answering the pre-survey, 4 students gave a correct answer. When answering the post-survey, 10 students gave at least one correct answer.

Sonoma County

The top three commodities for Sonoma County are winegrapes, milk, and poultry. When answering the pre-survey, 1 student gave at least one correct answer. When answering the post-survey, 4 students gave at least one correct answer.

Tulare County

The top three commodities for Tulare County are milk, navel oranges, and cattle and calves. When answering the pre-survey, 2 students gave at least one correct answer. This compares to the post-survey where 18 students gave at least one correct answer.

Yuba County

The top three commodities for Yuba County are rice, walnuts, and dried plums. When answering the pre-survey, 3 students gave at least one correct answer. This compares to the post-survey where 13 gave at least one correct answer. Many more students answered the post-survey than the pre-survey.

Summary

Overall, there was a significant difference in the pre- to post-survey results in the students' ability to name at least one of the top three commodities produced in their county. The pre-survey results indicate that 60 students were able to name at least one of the top three commodities produced in their county prior to receiving any instruction or information about specialty crops. This compares to post-survey results where 283 students were able to name at least one of the top three commodities produced in their county.

Appendix F

Responses to Q22: "Name one place you can buy specialty crops."

Alameda County

When answering the pre-survey, 15 students wrote 'I don't know.' This compares to 0 students who answered 'I don't know' when answering the post-survey.

Del Norte County

It appears that most students were aware of where specialty crops were available in Del Norte County when answering both the pre- and post-surveys.

El Dorado County

It appears that all students who responded to this question were aware of where one can buy specialty crops in El Dorado County.

Fresno County

When answering the pre-survey, 6 students said 'I don't know.' This compares to the post-survey where 0 students said 'I don't know.'

Los Angeles County

When answering the pre-survey, 1 student said 'I don't know" and 4 students wrote the name of a state (California or Florida). When answering the post-survey, 1 student wrote 'I don't know' and 4 wrote 'California.'

Nevada County

When answering the pre-survey, 2 students wrote 'I don't know,' 1 student wrote 'Japan.' When answering the post-survey, all students appear to know where to buy specialty crops.

Orange County

When answering the pre-survey, most students from Orange County appear to know where to buy specialty crops; 1 student wrote 'Nebraska.' Two students listed the country Mexico. When answering the post-survey, 3 students wrote 'California', 1 student wrote 'Mexico,' 1 student wrote 'Nebraska' and 1 student wrote 'I don't know.'

Placer County

When answering the pre-survey, it appears that students in Placer County know where they can buy specialty crops. When answering the post-survey, 2 students wrote 'California' and 1 student wrote 'Placer County.'

Sacramento County

When answering the pre-survey, 6 students listed the name of a state and 1 gave the answer 'Cherries.' When answering the post-survey, 6 students named a state (or territory, Puerto Rico), and 1 student wrote 'Not sure.'

San Bernardino County

When answering the pre-survey, 19 students wrote 'I don't know.' This compares to the post-survey, where 5 students wrote 'I don't know.'

San Joaquin County

When answering the pre-survey, most students were aware of where to buy specialty crops; 1 student wrote 'I don't know' and one student gave the answer 'California.' When answering the post-survey, 2 students wrote 'I don't know' and 1 student wrote 'California.'

San Luis Obispo County

It appears that most students were aware of where to buy specialty crops when answering the pre-survey; 2 students wrote 'California.' When answering the post-survey, 1 student wrote 'California.'

Solano County

When answering the pre-survey, most students indicated knowing where to buy specialty crops; 1 student wrote 'CVS', 1 student wrote 'Antarctica.' When answering the post-survey, 1 student wrote 'California' and 1 wrote 'Fresno.'

Sonoma County

It appears that in Sonoma County most students know where to buy specialty crops. When answering the pre-survey, 1 student wrote 'I don't know' and 1 wrote 'California' and 1 wrote 'Santa Rosa.' When answering the post-survey, all students appear to know where to buy specialty crops except for 1 who wrote the names of crops, not where to buy them.

Tulare County

When answering the pre-survey, 7 students wrote 'I don't know' and 1 student wrote 'Plants and Trees.' This compares to the post-survey where 0 students wrote 'I don't know.'

Yuba County

When answering the pre-survey, it appears that students in Yuba County know where to buy specialty crops. In the post-survey, several students listed the names of counties (Lassen, Tehama, Siskiyou, San Diego, Alameda) and 1 student wrote 'California.' Many more students answered the post-survey than the pre-survey.

Summary

Overall, most students who participated in this study could name one place where they could buy specialty crops. In the pre-survey, there were 604 respondents. Of these, 46 stated "I don't know" and 25 gave answers ranging from names of countries, states, cities, and counties, as well as various fruits and crops. This left a total of 533 who correctly named a place where they could buy specialty crops. It is not entirely wrong for students to name states, countries, counties, or cities. The intent was to get a sense of their knowledge, prior to any instruction and involvement with the specialty crop edition, of where it is possible to buy specialty crops.

In the post-survey there were 660 students who responded to this question. Of these, 9 stated "I don't know" (a drop of 37 from the pre-survey) and 23 students listed names of countries, states, counties, or cities, and also plants and trees. This leaves a total of 628 students in the post-survey who could correctly name one place where it is possible to buy specialty crops (an increase of 95 from the pre-survey). Students who participated in this study moderately increased their knowledge about where to buy specialty crops.

Response	Pre (n = 604)	Post (n = 660)
I don't know	46	9
Other	25	23
Correct answer	533	628

PROJECT 22

ATTACHMENT A

BUSINESS PLAN CONTRA COSTA COMMUNITY CSA

December 2011

ABOUT THIS REPORT

Purpose

The Richmond Community Foundation, the Brentwood Agricultural Land Trust and Supervisor John Gioia (the “Project Partners”) prepared this business plan to assess the feasibility of a mission-based enterprise that could:

- Provide 500 CSA-style boxes of locally produced food to households in Richmond and the East Bay,
- Expand direct markets for Contra Costa County and other local farmers,
- Increase access to fresh food for low-income residents in Richmond, and
- Develop a model that can be expanded and replicated in other communities.

In preparation of this business plan, the working group conducted research, reviewed current literature, interviewed farmers, distributors, other CSA businesses and customers of existing Richmond Farm 2 Table CSA and conducted site visits to Richmond Farm 2 Table CSA delivery sites.

The business plan was developed by the Richmond Community Foundation, the Brentwood Agricultural Land Trust and Supervisor Gioia’s office. We also gratefully acknowledge Janet Genser (Stanford University), Fred Smith (UC Davis MBA), Lynn Kutsal and Jay Lifton for their contributions to the project. Kathryn Lyddan was the primary author of the report.

Acknowledgements

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The development of the business plan has greatly benefited from the excellent research that has been done by many colleagues around the country. The working group is particularly grateful to Ryan Galt and his colleagues at UC Davis for their August 2011 report, *Community Supported Agriculture (CSA) in and around the California’s Central Valley.*

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EXECUTIVE SUMMARY

The San Francisco Bay Area, home to more than seven million people, is surrounded with productive farming and ranching. Contra Costa County in the East Bay Area has dense urban populations in West County, and over 25,000 acres of productive farmland in the East. Despite the bounty of Contra Costa County agriculture, many Contra Costa households face the challenge of limited access to fresh fruits and vegetables.

Over the past forty years, Community Supported Agriculture (CSA) has gained in popularity, providing new markets for farmers and offering consumers a direct connection to neighboring farms. CSA's are particularly popular in metropolitan areas like the East Bay where nearby farms produce a diverse abundance of fruits and vegetables. Studies of the Bay Area "foodshed" have consistently identified CSAs as an essential component of building a local food system and increasing food access.

Richmond Farm 2 Table. In April 2009, the Richmond Community Foundation, Brentwood Agricultural Land Trust and Contra Costa County Supervisor John Gioia (the "Partners") joined together to create the Richmond Farm 2 Table CSA. The Richmond Community Foundation operates the CSA and contracts with a local nonprofit educational farm to grow, source, assemble and deliver the CSA boxes to six sites in Richmond, California. The CSA provides fresh, local food to Contra Costa residents twice a month, and provides subsidized boxes to low-income and senior subscribers.

Over the past year, the project partners have developed a business plan to expand the CSA to 500 subscribers. Based on research and financial modeling, the partners believe that (i) there is a market in the Bay Area for an efficient, competitive expanded Farm 2 Table CSA, (ii) Brentwood, Contra Costa and neighboring farmers have the capacity to provide local food for an expanded CSA, (iii) if the CSA can scale to 300 members, it will generate sufficient revenue to subsidize boxes for low-income subscribers.

Mission. The mission of the Contra Costa Community CSA is to increase food access in Richmond and to create a new direct market for Contra Costa farmers. The expanded CSA will also keep food dollars in the local economy, create jobs and educate urban residents about cooking, nutrition and local farming. The partners are committed to creating an efficiently operated, economically sustainable business that can generate the profits necessary to accomplish the social mission of the enterprise.

Opportunity to Scale the Contra Costa Community CSA. Projects like the Contra Costa Community CSA have the greatest opportunity to scale to economically sustainable size in regions like the East Bay Area that have dense urban populations close to farming regions. Contra Costa farmers produce a tremendous diversity of fruits and vegetables, particularly between the months of May and November. During the winter months, produce is available from neighboring farming regions. At the same time, the City of Richmond in West Contra Costa County has been identified as a California city with a high incidence of obesity and diabetes. Sixty-percent of adults and one out of every four children in Contra Costa County are overweight or obese. With a high number of fast food restaurants compared to fresh food outlets, the USDA has identified Richmond has been identified as a "food desert." Many residents have limited access to fresh, healthy foods. In order to increase food access in Richmond through subsidized CSA boxes, the Contra Costa Community CSA must attract full-price subscribers. Consumer demand for local food has grown rapidly over the past twenty years, and studies show that consumers will pay more for source-identified local food. The number of CSAs in California has grown steadily since the early 1990's. The recently published study, *Community Supported Agriculture (CSA) in and around California's Central Valley,* found "CSA is a very bright spot in the current economy."

There is ample evidence that an expanded CSA could accomplish the Partners mission. CSAs provide price-competitive fruits and vegetables, and local food distribution projects like the Contra Costa Community CSA can increase the consumption of healthy food in low-income neighborhoods. The financial analysis shows that, if the CSA can expand, it can generate sufficient revenues to provide subsidized boxes to low-income subscribers. Studies show that people who received subsidized fruits and vegetables continue to eat more healthy food, even after the subsidy ends. CSAs provide higher revenues to farmers than wholesale markets, and have significant advantages over other direct markets.

Financial analysis. The Partners are committed to building an enterprise that is economically self-sufficient. They recognize that without outside grants and sponsorships, that the number of subsidized boxes that can be provided will be constrained by the economic returns of the enterprise. However, the CSA will offer subscribers an opportunity to contribute $5 a box towards subsidizing boxes for low-income subscribers. The financial analysis shows that the CSA reaches efficiencies of scale and begins to generate enough revenue to provide subsidized shares at about 300 members. If the CSA can scale to 600 members and include 46% "sponsor subscribers", it would generate enough profit to provide twenty-percent of the boxes at a reduced rate. Similarly, corporate and community organizations that host pick-up locations, market to their employees and members, provide volunteers and fund sponsored boxes could make it possible for the CSA to serve more low-income families. However, it will take time and a significant marketing effort to increase membership, and the partners will need to find funding to finance the expansion of the CSA.

Competitive Analysis. The Bay Area is served by an efficient produce distribution system. However, the current distribution usually doesn't identify the farm of origin or provide consumers with a connection to the farm. Farmers are satisfying increased consumer demand for farm-identified local produce through farmers markets, roadside stands and CSAs. There are several Contra Costa farms operating CSAs, and the East Bay is also served by CSAs from neighboring farming regions like the Capay Valley. Produce distribution companies also provide Contra Costa customers with "CSA" boxes.

To expand its operations in the current market, the Contra Costa Community CSA must provide local, farm-identified produce of impeccable quality at competitive prices. The CSA also offers subscribers a unique value that is not offered by competitors: an opportunity to participate in the social mission of the enterprise. The Contra Costa Community CSA provides subscribers an opportunity to purchase from the farmers closest to the East Bay and to support food access in Richmond. The CSA can only succeed, if the unique story and civic purpose of the CSA is energetically and successfully branded and marketed to full-price subscribers.

Organization and operations. Because the Contra Costa Community CSA is a mission-based enterprise, an advisory committee of the project partners will provide oversight for management of the CSA, as well as strategic direction, financial performance and adherence to the CSA's social mission. A nonprofit partner will act as fiscal sponsor for the CSA. An experienced CSA manager should be hired to handle the daily CSA operations, billing and accounting, customer relations and to work with the sourcing contractor and farmers. To take advantage of efficiencies in the current East Bay produce distribution system, the Partners are seeking to contract with a local farm, group of farms or distributor for the sourcing, aggregation, assembly and delivery of the CSA boxes.

Branding and Marketing. Because the competitive advantage of the CC Community CSA is its unique civic purpose, the CSA must remain closely connected to the members through communications and direct customer service. A strong web presence, weekly newsletters and strategic marketing with community partners will be essential to build the CSA brand. CSA events, like farm tours and local food dinners, will strengthen the essential connection between the farmers and the CSA subscribers.

Conclusion. The Contra Costa Community CSA must be efficiently operated at a significantly larger scale to be economically sustainable and accomplish the Partners' goal to increase food access in Richmond through subsidized CSA boxes. To build a customer base of full-price subscribers, the Contra Costa CSA will need to brand and market it's unique competitive advantage: providing subscribers with seasonal produce from farms as close to the East Bay as possible, while also offering an opportunity to participate in increasing food access to low-income neighborhoods in Richmond.

The Partners wish to acknowledge that, because the project is still evolving, the project may or may not meet the definition of a CSA. In recognition that the expanded CSA may need to be re-branded, the business plan uses the name "Contra Costa Community CSA" to describe the expanded CSA enterprise.

MISSION OF THE CONTRA COSTA COMMUNITY CSA

As a mission-based enterprise, the Contra Costa Community CSA will operate efficiently and sustainably to generate the revenue necessary to accomplish the social mission of the enterprise. The primary mission of the CSA is twofold:

Increase access to fresh, healthy fruits and vegetables in Richmond. Richmond, a West Contra Costa city with a high percentage of low-income households, faces a public health crisis of childhood obesity, diabetes, and heart disease. Sixty percent of adults and one out of every four children are overweight or obese. Richmond, identified by the USDA as a “food desert” has a high proportion of fast food restaurants compared to fresh food outlets contributing to unhealthy eating habits that lead to a high risk of chronic disease.

Provide new markets for Contra Costa and other local farmers. Contra Costa farmers have grown food for the Bay Area for generations, distributing their products primarily through wholesale markets where their product loses its farm identify. While consumers will pay more for local food, farmers cannot capture the increased value through wholesale markets. Direct marketing through farmers’ markets, roadside stands and CSAs provides farmers with an opportunity to diversify their operations and earn a higher percentage of the consumers’ food dollar. Revenue from direct sales increases the closer the farms are to metropolitan regions, making Contra Costa farmers poised to take advantage of their proximity to seven million consumers in the Bay Area.

The Contra Costa CSA will be a step toward (re)building a local food system in the East Bay. Local food systems stimulate local economies by keeping food dollars in the community and by creating jobs. The CSA classes on health, nutrition and cooking, as well as farm tours and local food dinners will build community and connect local urban residents to the farmers who grow their food, increasing their awareness about the importance of local farming.

BACKGROUND

Development and growth of Community Supported Agriculture (CSA)*.* When consumers join a CSA, they regularly receive a box of food produced by one or more local farms. Sometimes the customers pick up their boxes from the farm or at a central location, and sometimes the CSA farmer will drop the box at the customer's door. While CSA's are by definition farm-based operations that create a direct relationship between farmers and consumers, CSAs are evolving and the operations and business structures of CSAs vary widely.

Over the past forty years, CSA's have become a powerful direct marketing opportunity for farmers, particularly for small and medium size farmers located on the edge of large urban areas. The number of CSA's nationwide doubled between 2004 and 2009, and there are now more than 4,000 CSAs in the United States. The first CSA's in California were formed in the early 1990's. Since then the number of CSA's within California has steadily and rapidly increased and the number of Californians subscribing to a CSA has skyrocketed to 33,000. Galt et al. *Community supported Agriculture (CSA) in and around California's Central Valley*, August 2011, p iii and 31.

The Bay Area Foodshed. The Bay Area is home to more than seven million people. Despite rapid urban growth, the Bay Area remains surrounded by productive agricultural regions. Contra Costa County has over 25,000 acres of prime farmland that produces a remarkable diversity of fruits and vegetables. The 12,000-acre Brentwood farming region of East Contra Costa County is just forty miles from Richmond and other East Bay cities. Further afield, the growing regions of Solano and Yolo County and San Joaquin Valley produce an astonishing quantity and variety of fruits, vegetables and nuts. The San Francisco Foodshed Assessment considered whether the City of San Francisco could feed itself within a 100-mile radius. Noting that "few if any cities in the world are as blessed with such a coincidence of superior farmland and beneficent climate," the report found that farmers and ranchers in San Francisco's "foodshed" produced 20 million tons of food annually, compared with the 5.9 million tons consumed in the Bay Area. More than eighty different commodities are produced in the San Francisco foodshed, including dairy and eggs, fruits, vegetables and nuts and grains.

CSAs as an important component of a Bay Area local food system.
In 2008, Mayor Gavin Newsom convened the San Francisco Urban-Rural Roundtable, bringing fifty urban and rural leaders together to consider how best to collaborate to develop a local food system for the San Francisco foodshed. The Final Recommendations of the Urban-Rural Roundtable published in May 2009, identified CSAs as "one of the best manifestations of urban-rural interdependence, and found that some CSA farms in the Bay Area were over-subscribed by 50% to 100%, with demand outstripping supply. Recognizing the potential of a large-scale CSA to provide fresh local food to urban residents of all incomes, one of the six recommendations of the Urban-Rural Roundtable was to explore the feasibility of a large-scale CSA to serve San Francisco.

In 2009, the Roots of Change Fellows studied the potential for creating a large Bay Area CSA. The recent Santa Clara Health Food Resources Assessment also identified CSAs as having "the potential to provide access to fresh, affordable, locally grown fruits and vegetables to consumers of a variety of income levels, while also increasing household consumption of fruits and vegetables."

RICHMOND FARM 2 TABLE CSA

History of the Richmond Farm 2 Table CSA.

In March 2009, the Richmond Community Foundation (RCF), Brentwood Agricultural Land Trust (BALT) and County Supervisors Gioia and Piepho founded the Richmond Farm 2 Table CSA. Twice a month, Farm 2 Table subscribers receive a box of produce from Brentwood and other local farms. One-half of the CSA members receive the boxes at a reduced rate. RCF manages the marketing, finances and operation of the CSA. The RCF provides support to the CSA through a team that includes (1) a part-time project manager who oversees the CSA, including its financial operations, (2) a full-time coordinator who enrolls customers and provides customer service at several CSA pick-up locations and (3) a part-time administrator who develops the bi-weekly customer emails, marketing materials and other communications, and manages back-end billing and other customer management functions.

Since 2009, RCF has contracted with Eco-Village Farm Learning Center, a Richmond-based non-profit, to grow food for the CSA, source additional product, assemble and deliver the CSA boxes to six CSA pick-up locations in Richmond.

Initial customers for the CSA were recruited through outreach done by the partner organizations. These customers included those paying full market price ($25 per box), as well as low income and senior customers paying subsidized prices between $5 and $15 per box. Customers were also given the opportunity to contribute an additional $5 a box to support subsidized boxes for low-income subscribers. RCF provided “sponsor” subscribers with a record of the their charitable donation at the end of each year. “Sponsor” subscribers reported that they considered the opportunity to increase food access in their community was an important, positive part of belonging to the Richmond Farm 2 Table CSA.

Full-price customers continue to be recruited through the project partners through the Internet and word of mouth, while customers interested in receiving subsidized boxes have been placed on a waiting list because the CSA cannot fund any more subsidized boxes at this time. The Farm 2 Table CSA currently serves about 70 subscribers.

While the project has increased food access and provided a new direct market for local farmers, the Richmond Farm 2 Table CSA is not financially sustainable. RCF continues to provide funding for operations and subsidized boxes. Inefficiencies of scale, low subscriber retention rates and a high percentage of deeply subsidized boxes contribute to the CSA’s poor financial performance.

In 2010, RCF, Brentwood Agricultural Land Trust and Supervisor Gioia (the ”Partners”) committed to develop a new business model for the CSA; a financially profitable, mission-based enterprise that would reinvest profits into the project’s social mission. The partners agreed that the dual mission of the enterprise is to (i) increase access to source-identified local fruits and vegetables in Richmond and (ii) build new direct markets for Contra Costa and local farmers. The Partners goal is to serve as many low-income families as possible, beginning with households in Richmond and then expanding in western Contra Costa County. In addition, the Partners believe that the CSA should source as much produce from Contra Costa farms as seasonally possible, sourcing from the nearby farms only when crops are not available in Contra Costa County.

Lessons learned from the Richmond Farm 2 Table CSA.
RFC has kept careful records of the performance of the Farm 2 Table CSA since 2009, and has produced detailed 6-month and 12-month evaluations of the CSA. During the business planning process, team members studied the reports produced by RCF, interviewed current and former CSA subscribers, visited the Richmond Farm 2 Table CSA pick-up sites, and reviewed the records and reports prepared by RCF. The experience and financial performance the Richmond Farm 2 Table CSA provide lessons that can inform the Contra Costa Community CSA.

Importance of scale and appropriate level of subsidized boxes to financial viability. While the number of subsidized boxes and the deep subsidization of many of the low-price boxes (as low as $5 dollar box price) has benefitted low-income and senior households in Richmond, the level of the subsidies has not been tied to the economic sustainability of the Farm 2 Table CSA. Although the Farm 2 Table CSA has a small core of committed full-price subscribers, the CSA never developed enough full-price subscribers to support the subsidized boxes. Customer retention of full-price members has been significantly lower than competitors, adding the financial strain. Inconsistent produce quality and sourcing, as well as the lack of a strong marketing and communications strategy contributed to lack of customer loyalty. As discussed below, the financial analysis clearly demonstrates that the CSA must build a strong, loyal base of at least 300 full-price customers to support the social mission of the project. Basing the number of subsidized boxes on the profit generated by the enterprise will support an economically sustainable Contra Costa Community CSA.

Competitive CSA management. The Partners began the Farm 2 Table CSA as a pilot effort. RCF has operated the CSA, and contracted with a local nonprofit educational farm to source and assemble the boxes. RCF staff and an AmeriCorps volunteer have managed the administration, billing, marketing, communications and customer service. While the staff has performed admirably, none of the RCF staff have experience with the produce industry or CSA management. The Farm 2 Table CSA does not have a website, marketing plan or CSA software to manage sales and billing. Additionally, the sourcing contractor's labor and assembly costs were significantly higher than competitors, in part because of the inefficiencies of the seventy-member CSA. The combined cost of the sourcing contractor and the RCF staff created overhead that was far higher than competitors and financially unsustainable.

*Sourcing, handling and identification of local food***.** During the winter months when there was little produce available in Contra Costa, the contractor purchased non-local produce from a wholesale distributor. The produce purchased from wholesalers often lacked appropriate source-identification. The CSA did not effectively communicate with members about seasonal availability and sourcing policies, and some full-price CSA subscribers discontinued service because the produce was not consistently local. Additionally, the sourcing contractor did not have the packing facilities, cold storage or a refrigerated truck, and damaged produce contributed a high attrition rate. Any future operating agreement between the Partners and a sourcing contractor should require farm-identified sourcing from an approved set of local farms, and provide the Partners with control of the quality, mission and branding of the CSA.

Box size, quality and quantity. Former CSA members reported that poor product quality and/or quantity were the primary reason why they did not rejoin the CSA. Competitive quality and quantity of farm-identified local produce is essential for a successful CSA.

Expanding product offerings to include small and large boxes would help customers purchase an appropriate amount of produce for their household. Experienced management of the product mix throughout the year will ensure a greater variety is provided to the customers. Improved communication between the CSA manager, sourcing contractor and the farmers could ensure that problems with product quality could be quickly identified and corrected.

Importance of branding and marketing the CSA story. The CSA members interviewed valued both access to fresh, local food and the opportunity to increase food access for their low-income neighbors. However, the Farm 2 Table CSA did not effectively market either aspect of its competitive advantage. While the RCF staff prepared a brief email newsletter every other week, there was no strategic, concentrated effort to effectively tell the story of the CSA, explain sourcing policies and seasonality, connect with local farmers or build a sense of community. Because the sourcing contractor for the Richmond Farm 2 Table CSA did not consistently source local produce, the CSA failed to deliver the "local farms" promise of its brand.

Summary of lessons learned.
The produce distribution industry is intensely competitive, and other CSAs serving the East Bay have staff with specific expertise in farming, produce distribution, CSA management and marketing. The Partners will need to hire experienced management with CSA experience and contract with sourcing partners with the capacity to safely handle and distribute a significant volume of produce. The CSA will need to purchase CSA software to manage inventory, sales and billing. Clear branding of the unique values created by the CSA, energetic marketing, a website and on-line presence, an engaging newsletter and impeccable customer service will be essential to enrolling and retaining full-price subscribers and attracting sponsors.

OPPORTUNITY TO SCALE THE CSA

The recent study, *Market Forces,* finds that "local and regional food systems have the greatest opportunity to "scale" to economically sustainable size in regions that have urban population centers with close proximity to rural areas boasting available farmland." Union of Concerned Scientists*, Market Forces: Creating Jobs through Public Investment in Local and Regional Food System,"* (2011) at p. 11. Geographically divided between productive farmland of Brentwood in the east and dense urban populations of Richmond in the west, Contra Costa County has remarkable potential to build a local food system.

Program, 2008

Contra Costa Farming: Does Contra Costa County have a local source of food?
Contra Costa farmers have grown food for the Bay Area since the Gold Rush: from vast fields of winter wheat in the 1880's to the famous Brentwood sweet corn, peaches and cherries enjoyed today in the Bay Area and beyond. Contra Costa farms produce a tremendous diversity of crops – sweet corn, stone fruit, vegetables, olives and wine grapes. The 2009 County Agricultural Commissioner's Report found that Contra Costa farmers produced almost $40 million of fruit, nuts, vegetable and field crops. Contra Costa agriculture, which is characterized by small and medium size farms, also benefits from a remarkable diversity of farming operations that distribute product through a wide variety of marketing channels.

While almost 24,000 acres in Contra Costa County is actively farmed, the most intensive food-producing region in the County is 12,000 acres of prime farmland south and east of the City of Brentwood. With a Mediterranean climate of hot summer days and cool nights, the Brentwood region of East Contra Costa County has a year-round growing season that could support a wide variety of crops. Brentwood's long tradition of u-picks and roadside stands make it an ideal location for agricultural tourism.

The Alhambra Valley, just twenty miles from Richmond, is also a fertile growing region producing a wide variety of fruits and vegetables. The Richmond Farm 2 Table CSA has sourced consistently from Alhambra Valley Ranch from May through November. In fact, one Alhambra Valley grower reported that he had begun growing vegetable specifically to meet the CSA demand and is expanding his growing season to grow winter vegetables for the CSA. As part of the Contra Costa Community CSA project, the Partners are working with East Bay Municipal Utility District to explore cultivation of a 50-acre parcel of property in Alhambra Valley that is owned by EBMUD.

Richmond itself was once Contra Costa's most fertile farming regions, with a perfect coastal climate for vegetable and nursery crops. In recent years, Richmond has developed an active urban agriculture movement. In June 4, 2011, Vice Mayor Tom Butt and Supervisor John Gioia held an Urban Agriculture Summit that was attended by over 100 people. While Richmond farms may not produce enough to support a large-scale CSA, sourcing from Richmond urban farmers may be a way that the CSA can build a local community around food and expand green jobs in Richmond.

Contra Costa farmers continue to feed the Bay Area, primarily during the harvest season from May through November. Nuts, olive oil and citrus are produced between the months of November and April. While the current food distribution system delivers a Contra Costa grown produce to the Bay Area, it does not track the origin of the product or tell consumers the story of Contra Costa farming. Consequently, when Contra Costa farmers sell into wholesale markets, their products loose their source identification, and the farmers are unable to capture the premium that consumers are willing to pay for local food.

Limitations on sourcing from Contra Costa County. The current growing season in Contra Costa County begins in mid-May and, continues through the summer and ends by late October. In the past, Contra Costa farmers have grown winter crops including lettuce, broccoli and celery, and Contra Costa farmers could extend their season into the winter and early spring to meet market demand. Many CSA consumers prefer organic produce, and the CSA will gain a competitive advantage if it can provide organic local produce. However, there is currently limited organic production in Contra Costa County, and Contra Costa organic growers generally target high-end restaurant and retail markets. In 2010, the Contra Costa Agricultural Commissioner's Report found that only 438 acres in the County were farmed organically. However, increased demand for organic produce through an expanded CSA could increase organic production in Contra Costa County.

Food Access: Is there a need for increased access to healthy, fresh food in Richmond? With a population of 103,000, Richmond and meets the US Census definition of a low-income community (more than 30% of households have incomes below 200% of federal poverty level). The USDA has identified Richmond as a "food desert" where at least one-third of the residents live more than a mile from a supermarket. In 2008, Richmond was ranked among the top ten communities in California with the highest risk of obesity and diabetes. Sixty-percent of adults and one quarter of all children in Contra Costa County are overweight or obese.

In general, Americans eat fewer servings of fruits and vegetables than the USDA recommendation of five servings a day. A 2003 California Health Interview Survey showed that less than twenty-percent of California adolescents eat three or more serving of fruits and vegetables a day. In "food deserts like Richmond, poor selection in neighborhood supermarkets contributes to low consumption of fruits and vegetables.

Policy Link, *Healthy Food, Health Communities: Improving Access and Opportunities Through Food Retailing* at p 12.

There is also growing evidence that neighborhoods with high numbers of fast-food restaurants also have higher rates of diabetes, cardiovascular disease, and cancer. People consistently underestimate how many calories are in fast-food meals, and eating at fast-food restaurants is associated with eating fewer fruits and vegetables. The landmark report*, Designed for Disease: the Link Between Local Food Environments and Obesity and Diabetes*, produced in 2008 by the UCLA Center for Health Policy Research examined the correlation between public health and the mix of retail food outlets in communities. Counties were ranked using a “Retail Food Environment Index” that compared the ratio of fast food and convenience markets to grocery stores with a wider selection of healthy food choices, such as fresh fruits and vegetables. The study showed that people living in neighborhoods crowded with fast food and convenience stores, but without access to fresh fruits and vegetables, are at significantly higher risk of obesity and diabetes. Interestingly, while the study showed that health of low-income communities is hardest hit hardest by this phenomenon, the correlation between access to fruits and vegetables and public health is seen across all geographic regions, income levels and ethnicities.

The Retail Food Environment Index (RFEI) in Contra Costa County is 4.66, putting Contra Costa County high on the list of California counties where residents do not have healthy food choices. In response to the food access issues identified in the RFEI for Contra Costa County, health activists drafted a plan “Healthy and Active Before Five: Action Plan to Reduce Childhood Obesity in Contra Costa County. The Healthy and Active Before 5 Leadership Council recommends, “Increase availability, accessibility and demand for affordable healthy food in all neighborhoods.”

Consumer Demand for Local Food: Is there a market for full-price shares?
To generate enough profit to fulfill its social mission, the Contra Costa Community CSA must sell at least 300 full-priced CSA boxes. The working group considered whether there was a market for additional CSA boxes in the East Bay. Because there is a waiting list for subsidized shares, this section and the Competitive Analysis below focus solely on building the full-price subscriber base.

East Bay Produce Market. There are just over 2 million people living in Contra Costa and Alameda Counties, comprising more than 650,000 households. Additionally, thousand of people come to the East Bay to work in the regional employment hubs of Walnut Creek, Concord, Antioch and Richmond. According to data from the U.S. Census and Bureau of Labor Statistics, the average Bay Area household spends $919 per year on fresh produce and $8,500 per year on total food purchases.

The local food movement continues to grow rapidly. While traditional retailers have been slow to respond to consumer demand for farm-identified food, farmers are supplying the expanding market for local produce through farmers markets, roadside stands and CSAs. The direct sales of food from farmers to consumers more than doubled from 1992 to 2002. Studies show that many consumers will pay more for locally produced food, particularly when additional values are also offered. *Market Forces* at p. 7.

The number of CSA's within California has steadily and rapidly increased since the early 1990's. While some CSA's have experienced a decline of membership in 2009 and 2010, the declines have been attributed to the current recession. The rapid growth in CSA operations has been also been accompanied by an even larger growth in CSA memberships. While CSA membership in California in 1990 was less than 700 people, almost 33,000 Californians are CSA members today. California CSAs experienced an annual growth rate in membership in 2008 and 2009 of 38.4%. Galt et al. *Community Supported Agriculture in and around California's Central Valley* at p. 20. The existing CSAs interviewed by the working group reported significant increases in membership over the past year. For instance, Doorstep Farmers in Central Contra Costa built a non-farm aggregator CSA to over 200 subscribers in less than a year.

The oldest and largest cluster of CSA's in California is the Capay Valley, seventy miles east of the Bay Area. Several Capay Valley CSAs have expanded their operations significantly in the past few years, and some have over 1,000 subscribers. In the study, *Community Supported Agriculture (CSA) in and around California's Central Valley,* Galt and his colleagues found that the CSA's in the Capay Valley have flourished in large part because of the considerable demand for fresh, local, organic produce in the Bay Area, indicating that Contra Costa farmers are in excellent position to take advantage of East Bay markets.

Mission: Can the Partners accomplish their mission with a scaled up CSA?
Socially responsible corporations analyze their returns on a triple bottom-line: people, planet and profit. As a mission-based enterprise, an analysis of the potential returns of the Contra Costa Community CSA should consider whether an expanded Contra Costa Community CSA could fulfill the Partners' mission.

Could the CSA increase access to affordable, healthy food in Richmond?
Available evidence suggests that increased access to fresh fruits and vegetables can help promote the consumption of more healthful food. The *Healthy Food, Healthy Communities* study shows that African American residents increased their fruit and vegetable consumption by an average on one-third for each supermarket in their census tract. Policy Link, *Healthy Food, Healthy Communities: Improving Food Access Through Food Retailing, (2005) at p 11.* There is additional evidence that families receiving subsidized boxes will continue to eat more fruits and vegetables even after the subsidy ends*. Market Forces* at p. 15. *Designed for Disease* directly demonstrated that increased access to fruits and vegetable lowers incidents of obesity and diabetes in all communities, regardless of income, demonstrating that the increased access to fruits and vegetable provided by the Contra Costa Community CSA will benefit both full-price and subsidized CSA subscribers.

Produce purchased in CSA boxes is less expensive than produce purchased in conventional retail outlets. See Brown, C. et al, *Impact of Local Markets at p 1298.* Galt considered whether a CSA could provide competitively priced produce to low-income households. GALT took the USDA "thrifty" market basket food price (a healthy, minimal cost meal plan that shows how a nutritious diet can be achieved with limited resources of $135 weekly for a family of four), and found that the cost of the USDA recommended fruits and vegetable costs is almost $50 a week. Galt concluded that "if the CSA boxes are providing even half of the fresh fruits and vegetables consumed by a family on the "thrifty" plan, they are a good deal from a monetary perspective. [1]

Could the expanded CSA create new, more profitable markets for local farmers?
There are many studies demonstrating that CSAs provide an excellent direct market opportunity for small and mid-sized California farmers. Direct marketing allows local food producers to retain up to seven times greater net revenues from selling locally than through conventional markets where source identification is lost. *Market Forces* at p 7. Galt describes California CSA's as "powerful economic engines." In addition to allowing farmers to diversify their marketing strategy, the average gross sales per acre for crop-based CSAs is $13,354 an acre, compared to $1,336 an acre average for California agriculture. Some CSAs reach gross sales per acre of more than $20,000 an acre. *Community Supported Agriculture (CSA) in and around California's Central Valley* at p. 25. There is also evidence that CSA are particularly cost-effective direct marketing vehicles for farmers with lower marketing costs than farmers markets. See Hardesty, *Determining Marketing Costs and Returns in Alternative Marketing Channels.*

Brentwood has a long history of u-pick and roadside stands. Other farming regions in Costa County like the Alhambra Valley have also begun to develop agricultural tourism, direct marketing and value-added operations. By developing direct connections between farmers and their urban neighbors, the Contra Costa Community CSA will provide local farmers with a powerful marketing opportunity to directly connect with neighboring consumers.

Other benefits of an expanded CSA.
Contra Costa Community CSA will be an important step in creating a local food system for the East Bay. In addition to increasing food access and providing local farmers with new markets, local food systems stimulate local economies by keeping a greater percentage of consumers' food dollars are kept in the community. The expansion of CSA's can also create year-round jobs for farmers and agricultural workers since the complex cropping required for a CSA demand requires more labor than mono-cropping for wholesale markets. Additionally, the Contra Costa Community CSA will provide urban residents with the direct connection with local farms and an increased awareness of local farming in the Bay Area.

[1] While CSAs provide price-competitive allocations of the USDA recommended fruits and vegetables, many households, particularly in low-income areas consume far less fruits and vegetables than the USDA recommendation. Consequently, a CSA box may represent increased spending on fruits and vegetables for many families. *Community Supported Agriculture (CSA and around California's Central Valley* at p 18.

FINANCIAL ANALYSIS
Once it was determined that an expanded Contra Costa Community CSA could accomplish the Partner's mission, the working group analyzed whether a scaled up CSA could generate enough revenue to subsidize boxes for low-income subscribers. The working group considered financial models that assessed the potential financial performance of the CSA at the end of Year 1 (2012) and Year 2 (2013) under several scenarios. The analysis took a conservative approach with regard to revenues, and a 'full cost" approach with regard to expenses.

The working group developed the assumptions used in the financials based on interviews with potential suppliers and customers, as well as research about produce costs and CSA operational costs. The financial analysis included scenarios (i) with and without grants or financial sponsorship and (ii) with and without the Partners using profits from the first year to establish an operating reserve. Different subscriber retention rates were also considered.

Key findings from the financial analysis.
Constraints on subsidized boxes. If the CSA is to be economically sustainable without grants or sponsorship, the number of subsidized boxes is constrained by the profitability of the enterprise. However, the CSA will continue to offer CSA subscribers the opportunity to pay $5 more than the market rate for their boxes to support subsidized boxes. The financial analysis indicated that the Contra Costa Community CSA operation was financially viable with more than 300 subscribers in Year 1. Without grants or corporate sponsorship, the financial analysis shows the number of subsidized boxes that could be supported at each membership level (500, 600, 800) through revenues from the enterprise and a $5 per box revenue from sponsoring subscribers. The percentage of sponsored families was approximately 5%, 20% and 35% respectively in the 500, 600 and 800 member scenarios.

Economies of scale. The financial modeling showed that the CSA achieves optimum efficiencies of scale between 500 and 700 members with increased revenues and higher margins. Economies of scale decline as the CSA grows above 800 members since additional operating expenses become necessary to serve a larger-scale enterprise. The enterprise reaches the next level of efficiency at 1200 to 1400 members.

Retention rates. The financial analysis considers both the number of CSA subscribers who renew their boxes for a second year (retention rate) and the number of new subscribers who join in Year 2 (new member addition rate). The profitability of the CSA is highly dependent upon these two numbers. The scenarios consider retention rates of 60% and 80%, which is higher than the 55% retention rate experienced by the typical CSA but consistent with the 75% - 80% retention rates reported by successful CSAs.

Sourcing, aggregation, assembly of boxes and delivery. The working group considered three models for sourcing, assembling and delivering the boxes to the CSA sites (i) building sourcing and distribution capacity within the enterprise (Full Service CSA Model) (ii) contracting with a local farm (Lead Farm model), and (ii) contracting with a current non-farm aggregator or produce distribution company (Distributor Model). The Full Service CSA model would require that the CSA rent warehouse space, obtain a refrigerated truck, develop relationships with local farmers and establish a pick-up and delivery route. While the Lead Farm and Distribution Partner models showed positive economic returns under many of the scenarios, the Full Service CSA was not viable under most scenarios.

The availability of grants corporate/community partner sponsorship dollars. While the CSA can generate sufficient profits to provide subsidized boxes with over 300 members, corporate and community sponsors could make it possible for the CSA build an operating reserve more quickly and increase the number of subsidized boxes.

Funding of transition costs while the CSA scales up to a profitable scale. The financial analysis concluded that the CSA would not become profitable until it increased its' membership to 300 subscribers. Building the CSA to 300 full-price subscribers will take organizational investment and a significant marketing effort. Based on the experience of other Bay Area CSA projects, it could take one to three years to build the business to 500 subscribers. The Contra Costa Community CSA must find a source of funding for the cost of building the CSA to a financial sustainable business.

Recommendations based on financial analysis. The working group concluded that the Contra Costa Community CSA should endeavor to scale up to 600 members in the Year 1, with a focus on securing seventy-five percent or more full-price subscribers. The Partners should work to secure funding from grants, corporate sponsors and community organizations during Years 1 and 2 to finance the costs of building CSA to 600 members, build an operating reserve for the enterprise and increase the number of subsidized boxes. However, the working group acknowledged that scaling up the CSA to 600 members within a one-year period would require funding and an aggressive marketing campaign

COMPETITIVE ANALYSIS

Existing Produce Outlets in the East Bay. The San Francisco Bay Area is served by a complex produce distribution system that brings food from around the world to East Bay consumers. During the harvest months, Contra Costa farmers sell wholesale to distributors who provide Contra Costa grown produce to retailers, restaurants and institutions. Most wholesale distributors provide their customers with very little information about the source of the fruits and vegetables they sell. As demand for local food has increased, businesses along the distribution chain, from farmer to retailer, have begun to provide sourcing information and create "value-based food supply chain".[2]

Food retailers offer a wide range of store formats and price points for East Bay shoppers, ranging from specialty grocery to mid-price grocery to value-focused big box stores with fresh produce sections. Some local grocery stores like Diablo Foods and Whole Foods provide customers with farm-identification in their produce section and advertise their "buy local" policy. In addition to traditional retailers, there are more than twenty farmers' markets operating in operate Contra Costa Country.

CSA's in the East Bay Marketplace. Most of the farm-based CSAs serving the East Bay are located outside of Contra Costa County. A few Contra Costa farm-based CSAs like Easley Farms provide organic vegetables during the summer. Frog Hollow Farms provides an organic fruit CSA throughout the year. Eating Outside the Box, based in Walnut Creek, has provided a CSA box of organic, local produce to a loyal following for years.

Non-farm aggregators. In the past couple of years, several produce distribution businesses have been developed that provide "CSA boxes" to their customers. Businesses like The Fruit Guys aggregate product from wholesale markets and pack boxes that are delivered to customer's homes. In central Contra Costa, Doorstep Farmers aggregates produce from local farms and an organic produce distributor and makes home deliveries. Established in 2010, Doorstep Farmers has grown rapidly, building their business to 200 customers within six months. Unless these businesses are involved in farming, they are considered non-farm aggregators, and generally do not fall within accepted definitions of a CSA business. Galt, *Community Supported Agriculture in and around the Central Valley. (CSA)* at p 6.

Contra Costa Community CSA's competitive advantage

To compete for full-price subscribers, the pricing and quality of the CSA box must be as good or better than other East Bay CSA programs, many of which are also seeking to expand.

The CSA should offer subscribers an opportunity to purchase obtain high quality, competitively priced produce from local farms with complete transparency and traceability in sourcing. If the CSA cannot source from Contra Costa during the winter months, the CSA will need to communicate with subscribers about seasonal availability and the CSA's sourcing policy. Similarly, while the CSA may not be able to provide all organic produce from Contra Costa farms, the CSA can give farmers a forum to tell

[2] A value-based food supply chains is a network of enterprises that move food from production to consumption (i.e. farmer-processors-distributor-wholesaler-retailer-consumer) that differentiate products based source identification, food quality and environmental and social attributes. *Value – Based Food Supply Chains.*

subscribers about their farming practices. The Contra Costa Community CSA will provide an opportunity for East Bay residents who care about “local” and “organic” to increase demand, and incentivize local farmers to extend their season and expand organic production.

As a mission-driven, social enterprise, the Contra Costa Community CSA can offer subscribers something that other CSAs can not: the opportunity to participate in the mission of the project. By purchasing produce through the CSA, subscribers will increase food access for their low-income neighbors, improve community health and support local farmers. Successful CSA’s create connections between farmers and consumers and build community around food. The Contra Costa Community CSA would expand this concept by creating an East Bay community committed to both supporting local farmers and increasing food access in Richmond. Branding and marketing of the CSA should emphasis this unique competitive advantage of the Contra Costa Community CSA.

ORGANIZATION AND OPERATIONS

The lessons learned from the Farm 2 Table CSA, the financial analysis and the research about other CSA businesses demonstrate that the Contra Costa Community CSA can only become successful at a significantly larger scale with (i) an efficient CSA operation managed by experienced personnel, (ii) cost-effective, quality competitive sourcing and assembly method of the CSA boxes, (iii) clear identification and performance of mission and brand, and (iv) an effective marketing plan that promotes the unique competitive advantage of the mission-based enterprise.

Governance

As a mission-based enterprise, the Contra Costa Community CSA will be governed by an Advisory Board. The Advisory Board will be responsible for overall governance of the business, including oversight of the organization's strategic direction, alignment with the social mission and performance of financial goals. The Advisory Board will also hire the CSA manager and enter into an operating agreement with the sourcing contractor. To ensure that the CSA remains true to it's mission and effectively communicates that mission, the advisory committee will have oversight over messaging and marketing.

Management and Operations

Because the competitive advantage of the Contra Costa Community CSA is its unique civic purpose, the CSA must remain closely connected with it's members through marketing, communication with subscribers and engaged customer relations. An experienced CSA manager should oversee the daily CSA operations, billing and accounting, customer service, work on a weekly basis with the sourcing contractor, produce newsletters and other regular correspondence with CSA members and manage the pick-up sites. Galt noted that operating a CSA takes special data management skills, and this will be particularly true as the Contra Costa Community CSA scales up its membership. *Community Supported Agriculture (CSA) in and around California's Central Valley* at p. 30. The CSA should purchase CSA software for ordering and billing. Direct contact with subscribers at the pick-up sites is essential and, as the CSA grows, additional staff may need to interact with subscribers at the pick-up sites.

As the Contra Costa Community CSA grows, it will be most efficient for the enterprise to continue as a nonprofit association. One of the nonprofit partners, most likely Richmond Community Foundation, will act as fiscal sponsor. During the business planning process, the partners explored other for-profit and nonprofit business models for the CSA, and it may become necessary to revisit the legal structure of the business as the CSA expands.

Sourcing, Aggregation, Assembly and Delivery of CSA boxes.

The Partners are nonprofit and governmental organizations. While the partners have deep roots in Contra Costa agriculture and the Richmond community, the Partners are not in the produce distribution business. Recognizing that the Bay Area is well served by an efficient produce distribution system, the working group explored a business structure for the CSA that is based on collaborations with existing farmers and distributors.

The working group explored three possible ways to source, aggregate, assemble and deliver the boxes (i) develop a distribution system with a warehouse and a truck (Full Service model), (ii) develop a relationship with a lead farmer who can aggregate product and assemble boxes (Lead Farmer model), (iii) contract with a produce distributor that has existing relationships with local farmers (Distributor model). Early financial modeling indicated that Full Service model was not financially sustainable.

The partners interviewed farmers and distributors, and published a Request for Proposal for sourcing, aggregation, assembly and delivery of the boxes (the “RFP”). The Partners requested that the applicant (i) source from Contra Costa farms whenever possible and (ii) build a network of neighboring farms to supply produce when it is not seasonally available in Contra Costa County. The partners reserved the right to review and approve all farms included in the network. The RFP required that the Lead Farm or Distributor be capable of providing, in an efficient and cost effective manner, a mix of high quality, farm-identified seasonal produce to the pick-up sites. The RFP asked potential sourcing contractors to demonstrate their ability to provide adequate cold chain from field to CSA box, food safety and liability insurance. The partners encouraged applicants to partner with others in order to provide the most efficient delivery of source-identified produce that is as local as seasonally possible. The RFP was distributed widely through the partner’s networks and COMFOOD list-serve.

The partners recognize that the sourcing, aggregation, assembly and delivery of the CSA boxes could be performed by a variety of partners including farms, produce distributors, nonprofits and other retailers. The sourcing contractor may have an impact on whether the Contra Costa Community CSA will be defined as a “CSA.”

Other CSA Partners

Corporate and Community Sponsors. The Partners have deep connection with both rural and urban communities, and the social mission of the CSA may make the enterprise an attractive partner for community organizations, faith-based communities and local corporations. If the Contra Costa Community CSA can find corporate and community sponsors to subsidize boxes, solicit full-price subscribers and provide volunteer services, it will be able to reach financial viability more quickly and provide more subsidized boxes.

Education and Community Building Programs: Contra Costa Community CSA will continue to work with the Contra Costa County Public Health, Contra Costa County Resource Conservation District, local farm partners and sponsor organizations to offer educational classes on health, nutrition and cooking. Community building activities like farm tours and community dinners are important marketing tools to build customer loyalty and strengthen connections be local farms and urban consumers.

Is it a CSA?

While there is a great deal of opportunity for social and business innovation in the CSA model, the partners recognize that not all local food distribution methods that deliver boxes of produce to customers can be characterized as “CSAs”. For instance, Galt uses a flexible definition of CSA’s that reflects the innovation in CSA structures but “draws the line between Farm-Linked Aggregator CSA’s . . . and “Non-Farm Aggregators.” Non-Farm Aggregators purchase all of their produce from farms or wholesale business but do not produce any of the food themselves.” Galt et al., *Community Supported Agriculture (CSA) in and around California’s Central Valley* at p 6.

The partners recognize that the decision to use a Lead Farmer or a Distributor model may have implication on whether the enterprise is a CSA or a non-farm aggregator.

The California Department of Food and Agriculture (CDFA) is currently considering new regulations for CSAs, and the choice of the sourcing contractor may impact of any future California Department of Food and Agriculture regulations that apply to the Contra Costa Community CSA.

BRANDING AND MARKETING

To increase membership to 500 members, the Contra Costa Community CSA will need an effective, skillful branding and marketing campaign that distinguishes the enterprise from competitors and attracts and retains full-price customers.

Branding

Studies show that successful CSAs articulate “unique values” and market these unique values through their brand. In addition to providing subscribers with impeccable produce grown as close to the East Bay as possible, the Contra Costa Community CSA will give subscribers an opportunity to participate in the social mission of the enterprise. The CSA must be able to brand and market both its commitment to local sourcing and it’s unique social goal of increasing food access for low-income households.

By maintaining farm identity from the farm to the consumer, the CSA is creating a value-based supply chain. Value-based supply chains must have transparency in every step of the distribution chain. The further removed the CSA is from the farmers, the more attenuated the essential connection between the farmer and the consumer. Without effective communication, non-farm aggregator “CSAs” can lose the connection between subscribers and farms provided by a traditional CSA. Creating direct, clearly articulated relationships with local farmers should be an essential component of branding the Contra Costa Community CSA. The CSA should consider retaining a marketing firm with specific expertise in branding and marketing value-based food businesses.

Marketing*.*

Website, Facebook and social media. The Richmond Farm 2 Table CSA does not have a website or Internet presence. The working group emphasized the importance of building an on-line presence, both for marketing and for communicating with subscribers. To be competitive, the Contra Costa Community CSA will need to have a website that provides information to potential subscribers and facilitates on-line ordering. The on-line marketing should be coordinate with social media so that the CSA Twitter and Facebook accounts engage subscribers and provide information about local farmers, the CSA community and events. Creating U-Tube videos of farmers, sponsors and subsidized members could be a powerful way to engage the CSA’s community.

Crowdsourcing. The Contra Costa Community CSA could use crowd sourcing financing mechanisms like Kickstarter to raise funding for subsidized boxes and to create an on-line buzz with the indirect goal of introducing the CSA to the public.

Radio, billboards and print advertising. While traditional television, radio, billboard and print advertising are expensive, there are some options for nonprofit, public benefit enterprises like the CSA to participate in low cost or free advertising. For example, the Brentwood Agricultural Land Trust has successfully used nonprofit billboards to market Brentwood agriculture. Public radio and community radio stations offer interviews, event listing and other services to nonprofits.

Corporate and Community Partners. The social mission of the Contra Costa Community CSA make it uniquely suited to develop relationships with corporate, community and faith-based sponsors that could co-marketing the CSA boxes to their employers or members and host pick-up locations.

Customer service and retention
Not only does the Contra Costa Community CSA need to attract new customers, but it also must retain existing customers. The financial analysis shows that the CSA's profitability is highly dependent on retention rates. Farmers interviewed by Galt identified member retention as a major factor in the success of a CSA business, and emphasized that the foundation of a successful CSA is customer service. Noting that CSAs are retail businesses, the farmers highlighted the importance of outreach, education and customer service. To identify and build its brand, the Contra Costa Community CSA should engage in active communication with its members about local agriculture, seasonal sourcing limitations and food access in the East Bay. Aarstiderne, the 50,000 Northern European CSA with 50,000 subscribers, has 200 employees devoted entirely to customer service.

Engaging Local Farmers.
Together with the sourcing contractor, the Contra Costa Community CSA must attract local farmers to provide produce and to participate in the education and community activities. In addition to guaranteeing a steady demand for their product at competitive prices, the CSA offers local farmers increased visibility and marketing through the CSA. The CSA could provide farmers with visibility on its websites, blogs and twitter feeds, showcasing the farm's brand and produce without the farmers incurring significant marketing expenses.

CONCLUSION

The Partners envision the Contra Costa Community CSA as an efficiently operated, economically sustainable, mission-based local food enterprise that will generate sufficient revenue to fund the mission of the project. The mission of the enterprise is to increase food access in low-income communities in Richmond and build new markets for local farmers. Local farmers grow the quantity, quality and diversity of produce needed to supply the CSA. Research and financial analysis indicate the Contra Costa Community CSA could generate enough revenue to accomplish its mission if the CSA can expand to more than 300 full-price subscribers. Increasing demand for local food and the rapid rise in CSA membership over the past decade indicate that the Contra Costa Community CSA could expand its membership. However, to be successful, the Contra Costa Community CSA must effectively market its unique competitive advantage: the opportunity to purchase delicious, seasonal produce from East Bay farmers while improving food access for low-income households in Richmond. To do so, the Contra Costa Community CSA must have experienced CSA management and a strategic well-executed branding and marketing campaign.

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Value-Based Food Supply Chains: Strategies for Agri-Food Enterprises-of-the-Middle,
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Attachment A: List of Educational Materials and Samples of Materials

List of Educational Materials:

- Sustainable Winegrowing Highlights Newsletter, The Business Case for Sustainable Winegrowing, Spring 2011
- Sustainable Winegrowing Highlights Newsletter, The Social Equity of Sustainable Winegrowing, Summer 2011
- Spanish Translation of Self-Assessment Workbook chapters: Viticulture, Vineyard Water Management and Pest Management
- Performance Metrics and the California Sustainable Winegrowing Program - A handout for growers and vintners on the importance of performance metrics to measure and track resource use such as water use, energy use, greenhouse gas emissions and nitrogen use.
- Sustainable Winegrowing Highlights Newsletter, Winter 2011 - highlights sustainable practices focused on conserving water, energy efficiency and efficient nitrogen use, and explains the importance of using performance metrics.
- Spanish Translation of Water Conservation Resources
- New Spanish Language resource page on the CSWA website: http://www.sustainablewinegrowing.org/espanol.php
- Sustainable Winegrowing Highlights Newsletter, Summer 2012 – highlights of irrigation efficiency best practices
- Environmentally Preferable Purchasing Workshop Resources – list of resources from USB drive distributed to workshop attendees
- Sustainable Winegrowing Highlights Newsletter, Winter 2013 – Case Studies on the Business and Environmental Benefits of Sustainability
- Biodiversity In Vineyards Workshop Resources - list of resources from USB drive distributed to workshop attendees
- Spanish Translation of 3rd Edition Workbook Chapters – Ecosystem Management, Winery Water Use and Conservation, and Energy Efficiency
- Communicating Sustainability, Integrating Sustainability into Communications Strategies Handout
- Small Winery Water Handbook
- Educational videos on Wetlands Stewardship, The Value of Self-Assessment, Biodiversity in the Vineyard, Solid Waste Management, and the Value of Performance Metrics (available at: http://www.sustainablewinegrowing.org/CSWA-video.php)

CALIFORNIA
SUSTAINABLE WINEGROWING
ALLIANCE

The Business Case for Sustainable Winegrowing: Scouting for Pests at Jordan Vineyard & Winery

Come springtime, Jordan's Viticulturist Brent Young puts on his walking shoes.

"In early spring I walk every block twice a week," says Young, who along with Vineyard Manager Dana Grande, oversee 264 acres of the winery's estate vineyard in Alexander Valley.

While Young is looking at the overall health of the vineyards and vines, he's also looking out for pests such as certain types of mites and thrips that stunt new growth on grapevines. "When I started here in 2008, I was warned about both pests, particularly in a few key areas of the ranch. I noticed that as spring progressed and the cover crops began to dry out, thrips would jump from the cover crop onto the vines."

Although he was tempted to cultivate the cover crops to incorporate the organic matter and potentially disrupt the pests' lifecycles, Young knew that cultivating at the wrong time could cause a potential surge of nitrogen into the soil and affect the vines' ability to set fruit.

Young takes a more precision-oriented approach, essentially walking through each block, checking new growth, pulling leaves, and examining them with an instrument resembling a jeweler's loupe. "I literally count the mites on each leaf," he says.

As he goes through the vineyard blocks, Young uses tape to flag vines and rows with the highest pest pressure, keeping detailed records of his findings. "You can see a pest population build as you move across a block, and by keeping records, you can also start to see trends from year to year," he notes.

This early season "field scouting" and the data collected are valuable for several reasons. If he catches a growing mite population early enough, he can release predatory Occidentalis mites to help reduce problem mites early in the spring. Year-on-year data helps Young and Grande determine what cultural practices, such as cover cropping, cultivation or irrigation strategies, might be useful in limiting the spread of harmful pest populations.

Mapping the vineyard has helped Young reduce treatments and gain significant cost savings. "Before, we would spend around $70 an acre to control specific pests," says Young. "Now, since we scout often and have adjusted our practices and timing for cultivation, we have the ability to shrink input costs or remove them altogether."

"For instance, we had a hillside area which was prone to mites, but after changing a few of our early season cultural practices and by scouting, mapping and keeping records, I realized that 90% of the mites were in one section of the vineyard. We ended up working on this one spot – about two acres out of a 21-acre block – which saved us over $1,300."

Jordan Vineyard & Winery is committed to precision farming techniques and sustainable winegrowing. Young says it pays off to learn quickly from peers and surroundings because "knowledge is power."

Jordan Viticulturist Brent Young checks for pests on a leaf sample to help determine the winery's early season cultural practices. Photo by Matt Armendariz

OTHER SUSTAINABLE PRACTICES AT JORDAN

- Three-quarters of estate acreage dedicated to natural habitat.
- Jordan takes into account the impact every viticultural and winemaking decision has on the native ecosystems under its care.
- Among the first wineries certified in the Sonoma Green Business Program (1999) and in the Bay Area Green Business Program (2000).
- Winery energy use was certified carbon neutral in 2009.
- Use of ground cover and composting, beneficial predators and water recycling.

STUDENT HABITAT RESTORATION PROJECT BUILDS BENEFICIAL INSECT POPULATIONS

Vino Farms has been restoring the environment surrounding its vineyards as much as maintaining the health of the vineyards themselves. Several years ago, they undertook a project to restore nearly 23 acres of habitat bordering its Grand Vin Lands Vineyards and the Mokelumne River in Lodi. Designed to improve bird, insect and wildlife habitat, the project involved removing invasive non-native vegetation – such as the Chinese tree of heaven – and replacing it with native species such as oaks, cottonwood, primrose willow, native blackberry and valley elderberry.

Working with a program called SLEWS (Student Landowners Education Watershed Stewardship) which engages local high school students in experience-based learning through ecosystem restoration work, Vino Farms gradually transformed this acreage into a vibrant riparian habitat for hawks, waterfowl, fauna, as well as several species of wasps which prey on crop-damaging leafhoppers.

Viticulturist Chris Storm shows a restoration project undertaken by Vino Farms. *Photo courtesy Lodi Winegrape Commission.*

"In addition to restoring the land to its natural state, this habitat provides a nectory resource for wasps and other insects which are beneficial to our vineyards and – because they lessen the need for applications – to our bottom line," says Chris Storm, Vino Farms Viticulturist.

For more information, on SLEWS, go online to: http://www.landbasedlearning.org/slews.php.

Weather Station Pays Off at Vino Farms

Although mites, vine mealybugs and leafhoppers are worrisome to Chris Storm, Viticulturist for Vino Farms' Lodi operation, there is perhaps no greater headache than the threat of powdery mildew.

"It can spread like wildfire across a vineyard," says Storm, who explains that unlike most pests and weeds, the economic threshold for powdery mildew is *zero* at Vino Farms. Nobody wants the quality and taste of their wines to be compromised, he explains.

A weather station provides a daily email report that includes a mildew pressure rating, used to determine a course of action to prevent powdery mildew. *Photo courtesy Vino Farms.*

Vino Farms has 4,300 acres of vines in the Lodi/Clarksburg region, all certified under the Lodi Rules for Sustainable Winegrowing. Vino Farms manages a total of 14,000 acres of vines in eight California counties and is also a participant in Certified California Sustainable Winegrowing, Sustainability in Practice (SIP) Vineyard Certification Program and Fish Friendly Farming.

Because powdery mildew requires living plant tissue to thrive, Storm and his team begin vigilantly monitoring for it in the springtime, beginning with budbreak. That's also when he begins to use the Powdery Mildew Index (PMI), a University of California at Davis-developed weather monitoring software system built in to weather stations placed in Vino Farms' vineyards. Every day, from budbreak through veraison, Storm receives a daily email with a "weather report," outlining all the pertinent data along with a mildew "pressure rating" – low, medium or high. The data can also be relayed by text or phone if a grower prefers.

"Powdery mildew doesn't grow well in extreme cold or heat. It needs to be between 70°-85°degrees for at least six continuous hours for three consecutive days," explains Storm. "If those weather conditions don't occur – which the PMI monitors tell us – we know we can hold off on any treatments."

And delaying or avoiding powdery mildew treatments result not only in less soil compaction in the vineyard, but also in big cost savings. "Between the labor, the diesel and the product itself, one application in our Lodi vineyards can cost $65,000 to $75,000," says Craig Ledbetter, VP of Sales/Partner at Vino Farms, a multi-generational family business owned and operated by the Ledbetter family. "Eliminating one or two events has a significant impact on the bottom line."

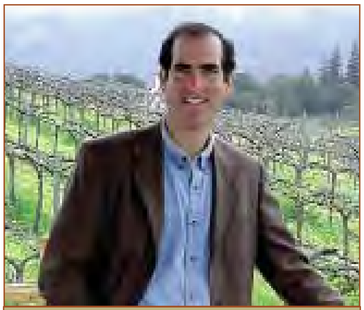
In 2009, for instance, an unusually cool spring meant that Vino Farms was able to delay inputs for a month and a half. "From budbreak until mid-May, we didn't need to do one application," says Storm.

For information about the Powdery Mildew Index and the UC Statewide Integrated Pest Management Program, go to: http://www.ipm.ucdavis.edu/PMG/r302100311.html.

The Dollars and Sense of Barn Owls at Bargetto Winery

Although comparisons to the 1980 hit comedy *Caddyshack* may be inevitable, John Bargetto of Bargetto Winery in the Santa Cruz Mountains understands all too well that gophers – which proliferate in the spring – are no laughing matter.

"They kill grapevines, plain and simple," says the third generation vintner, who oversees Bargetto's 40-acre Regan Estate Vineyard. "A gopher can eat through 100% of a vine's roots. One week you'll walk by a 20-year old vine and it's perfect; the next week you'll kick the same vine and it swings like a pendulum. The root system has been wiped out."



Sustainable practices are "wise investments that pay for themselves," says John Bargetto

In the past, gopher tunnels were often filled with a mixture of propane and oxygen and ignited, but it didn't work, he explained "The gophers usually came right back." But 10 years ago, Bargetto and many others in the industry hit upon barn owls as a more effective and natural solution.

Using a "if you build it they will come" mentality, Bargetto erected two 15-foot high posts topped by owl nesting boxes designed to attract these natural predators of gophers. Facing the boxes away from prevailing winds and the trees that surround his vineyard (to avoid owlet predators), Bargetto waited, and within six months, he had an owl. "It was a great natural solution," says Bargetto, who notes that his vineyard crew also sets gopher traps to augment the work done by the owls.

Bargetto thinks that even with the traps, the relatively small investment he made to attract owls has more than paid off. "Over the last decade, I estimate that owls in each owl house would have eaten one gopher per night and that perhaps 5% of those gophers would have killed one plant per year (36 vines). Calculating the loss from this represents over $6,000 in lost income," says Bargetto. "This doesn't count the labor costs the winery would have incurred to set more traps."

"Considering it's only a couple hundred dollars for each nesting box, keeping those Pinot Noir vines in production has been a pretty good return on investment."

Gopher-preying owls help prevent the loss of some three dozen vines annually at Bargetto.
Photos courtesy of Bargetto'Winery.

BARGETTO SUSTAINABLE PRACTICES

For Bargetto Winery, the close proximity of its Regan Estate Vineyard to the ecologically diverse Monterey Bay Sanctuary is a constant reminder of the importance of growing and making wine in a sustainable manner. "I believe these practices are a good thing to do in that they are wise investments that pay for themselves," says John Bargetto. "They are the right thing to do in that we have a duty as individuals, as growers and business owners to do our part to create a more sustainable world." Sustainable practices at Bargetto include:

• Planting cover crops, especially crimson clover, to attract beneficial insects and add nitrogen and organic material to the soil.

• Opening the vine canopy with a lyre trellis system along with fruit thinning and removal of excess shoots and leaves to prevent powdery mildew.

• Using a 3.0 kilowatt solar system that covers most of the electricity used for pumping water from the vineyard's well. "My forecast shows that this system will pay for itself in 6.6 years and realize about $2,000 per year after that."

• Replacing incandescent bulbs with energy efficient fluorescent bulbs in the winery, which use less electricity and last much longer.

• Insulating the pipes in the winery's refrigeration systems. "Refrigeration is our biggest electrical expense, and the insulation tubes are inexpensive and easy to install. I imagine they pay for themselves in the first year."

• Installing skylights in the fermentation, barrel aging and tasting rooms to reduce electrical lighting needs.

"Collectively, between the new age light tubes and bulbs, skylights and insulation of refrigeration piping, we're saving thousands of dollars per year," says Bargetto. "We hope to raise the awareness of both employees and customers of the importance of developing a more sustainable world."

California's Sustainable Winegrowing Program

Three Projects to Expand Sustainable Winegrowing Practices

The California Sustainable Winegrowing Alliance (CSWA) launched two projects to expand sustainable winegrowing education and address air quality. Additionally, Wine Institute, in collaboration with the National Grape & Wine Initiative (NGWI), is developing a third project to reduce water use and salts in process water. The three projects are being supported with $1,275,000 from USDA's Specialty Crop Block Grant Program, along with matching funds from recipients. Project details include:

1. "Data-Driven Targeted Education to Speed Adoption of Sustainable Winegrowing Practices"

This project will help improve the sustainability of California winegrowing by identifying educational workshop needs through analyses of vintner and grower self assessments from the 2009 California Wine Community Sustainability Report. The goal is to speed adoption of sustainable practices that conserve natural resources and enhance California wine competitiveness.

2. "Field Testing A Carbon Offset and Greenhouse Gas Emissions Model for California Wine Grape Growers"

This CSWA project will field test, evaluate and implement a climate protection incentive system incorporating the DeNitrification DeComposition (DNDC) model and practices that improve air quality, reduce emissions, improve carbon sequestration potential, and promote other environmental benefits.

Project objectives are: 1) to validate DNDC using existing field data; 2) assess emission reduction and carbon sequestration opportunities associated with California wine, table and raisin grape production; 3) develop standard greenhouse gas and carbon sequestration quantification methodologies related to winegrape production and contribute to the development of carbon accounting protocols that will enable growers to access carbon markets and address demands of regulatory organizations; and 4) provide a user-friendly web-based interface for easier access to these technologies in order to drive conservation innovation and create incentives for adoption of sustainable practices by the state's winegrowers and other specialty crop producers.

3. "Scalable Solutions to Reduce Water Use & Salinity in California Winery & Food Processing Cleaning Operations"

Wine Institute, in collaboration with NGWI, will compare and analyze current cleaning and sanitation practices of California wineries and food processors. This information will then help interested facilities select methods that offer improved environmental performance (e.g., reducing water use, minimizing chemical inputs, reducing entrained salts, reducing the volume and strength of process wastewater, and other factors). Project partners will evaluate conventional, widely used products, as well as more innovative "green" products and approaches; original work on green chemistry options will also be tested. Results will be shared with California wineries and other specialty crop processors nationwide. For further information on CSWA, see www.sustainablewinegrowing.org.

Governor Schwarzenegger gave the GEELA award to CSWA: (l–r) Nancy Light, Wine Institute; John Aguirre, CAWG; Chris Savage, E. & J. Gallo Winery; Governor; Allison Jordan and Lisa Francioni of CSWA and Wine Institute. *Photo by cityclickers.com.*

CSWA Receives GEELA Award

Former Governor Arnold Schwarzenegger last winter honored CSWA with the 2010 Governor's Environmental and Economic Leadership Award (GEELA), the state's highest environmental honor, for the California Sustainable Winegrowing Program. A 2004 GEELA recipient, CSWA received the award in the category of Enhanced Environmental and Economic Leadership. This category honors prior GEELA award recipients who have sustained exceptional leadership and demonstrate significant and robust improvements in voluntary efforts previously recognized, which conserve California's resources, protect and enhance the environment and strengthen the economy.

CSWA is a 501(c)(3) educational nonprofit organization founded by Wine Institute and CAWG to support adoption of sustainable winegrowing practices. The program has broad industry participation with 1,680 winery and vineyard organizations, representing 70% of California's winegrape acreage and 65% of the state's 240 million case shipments, which have evaluated their operations with CSWA's Code of Sustainable Winegrowing Practices workbook. CSWA has held nearly 400 sustainable winegrowing workshops throughout California since the inception of its program.

Please share this newsletter with your staff. An online copy is at www.sustainablewinegrowing.org/publications.php. To reprint any portion of this publication, please gain prior written consent from CSWA. Contact 415/356-7525 or communications@wineinstitute.org.

WINE INSTITUTE

CALIFORNIA ASSOCIATION of WINEGRAPE GROWERS

5. LA GESTIÓN DEL AGUA DE VIÑA [1]

Clifford P. Ohmart y Stephen K. Matthiasson, Lodi-Woodbridge Winegrape Commission

En la descripción de la demanda por agua en California, Mark Twain dijo: "El whisky es para beber, y el agua para pelear." Uvas de vino usan menos agua que la mayoría de los cultivos, y a pesar de que los viticultores pelean menos que los productores de otros cultivos, sino que deben manejar el agua con prudencia, un recurso muy valioso y limitado. Debido a la creciente población de California y la probabilidad de un cambio climático, un enfoque más integral para la gestión del agua a largo plazo es mejor a través de la planificación eficaz del paisaje. Este alto nivel de planificación y evaluación se aborda en el capítulo de gestión de los ecosistemas. En este capítulo se centra específicamente en los aspectos del día a día de la gestión del agua a nivel de la viña.

En algunas situaciones, en California, sobre todo cuando existen suelos profundos, los productores de uva de vino práctican la agricultura de secano, la última propuesta agrícola de la conservación del agua. La agricultura de secano, sin embargo, puede resultar en rendimientos por debajo de lo deseado y otras compensaciones. En consecuencia, la mayoría de los viticultores utilizan algún tipo de riego.

La conversión del riego por inundación con agua al riego por goteo revoluciono la viticultura en muchas regiones del estado. Viñedos con riego por goteo puede producir vides saludables con un crecimiento y rendimiento más uniforme, dando lugar a un vino mejor. Sin embargo, los sistemas de riego por goteo no siempre logran su máximo potencial. Es importante que los productores controlen y mantengan con diligencia sus sistemas de riego. Problemas como los emisores obstruidos le roban todos los beneficios del riego por goteo.

El gran beneficio del riego por goteo es el control que da a los cultivadores para decidir exactamente qué cantidad de agua que se aplica y cuándo. Esta flexibilidad, sin embargo, conlleva la responsabilidad de programar de manera eficiente y entregar sólo las cantidades necesarias de agua. Es difícil justificar los derechos de agua para la agricultura si los productores mal gastan de este recurso limitado. Numerosos métodos para monitorear el uso de agua y programación del riego se encuentran disponibles. El método de balance de agua se describe en este capítulo.

Uso del agua con una mano lijera, independientemente del sistema de riego, probablemente impacta la calidad del vino, más que cualquier otra práctica. Riego deficitario (RDI) mejora la calidad del vino de uva y en algunas regiones de California. Los resultados de extensas investigaciones confirman que todos los parámetros objetivos de calidad de la uva se ha mejorado, mientras que el rendimiento es sólo un poco menor para algunas variedades. Para seguir siendo competitivos, los productores de uvas de vino deben esforzarse por mejorar la calidad de la fruta. RDI es una importante herramienta a utilizar para lograr esto en muchos viñedos y se caracteriza en el final del capítulo.

[1]Este capítulo ha sido adaptado del Lodi-Woodbridge Winegrape Commission's *Lodi Winegrower's Workbook* (Ohmart y Matthiasson, 2000). Muchos de los criterios de este capítulo aparecen como preguntas en el Central Coast Vineyard Team's Positive Points System, la primera sistema de auto-evaluación de viña de California (CCVT, 1996 y 1998).

El propósito de este capítulo es proporcionar con 13 criterios para autoevaluar:

- La estrategia de gestión del agua para su viña.
- La calidad del agua de su agua de riego.
- Movimiento del agua fuera de sitio de el viñedo.
- La configuración del sistema de riego y mantenimiento.
- Programación de riego y la cantidad de tu viña.
- Sus prácticas de fertirrigación.

Lista de Criterios Gestión del Agua de Viña

5.1 Estrategia de Gestión de Calidad del Agua
5.2 Seguimiento y Modificación del Agua de Riego
5.3 Movimiento de Agua Fuera de las Instalaciones
5.4 Sistema de Riego
5.5 Uniformidad de Distribución para Sistemas de Micro Riego
5.6 Filtros y Líneas
5.7 Medidores de Flujo
5.8 Capacidad de Suelo para Retener Agua
5.9 Humedad del Suelo y Métodos de Monitoreo de Estado de Agua de la Planta
5.10 La Evapotranspiración
5.11 Agua de Riego
5.12 El Riego Déficit Previsto a Través de Riego Deficitario Controlado
o Parcial Secado de la Zona de Raíz
5.13 Fertirrigación

LA GESTIÓN DEL AGUA - ESTRATEGIA GLOBAL				
Criteria	**Categoría 4**	**Categoría 3**	**Categoría 2**	**Categoría 1**
5-1 Estrategia de Gestion del Agua	Mi estrategia* de gestión del agua se basa en la viticultura objetivos fijados antes de la temporada de cultivo (rendimiento, calidad de la fruta, las características del dosel, la gestión del suelo, y los requisitos de la fertilidad) y representa el tipo de suelo, pendientes, la calidad del agua de riego y la eficiencia energética. ** ***Y*** Las herramientas están en su lugar para lograr estos objetivos (dispositivos de vigilancia del suelo, las estaciones meteorológicas, etc). ***Y*** Por lo menos tres parámetros apoyar las decisiones de gestión del agua (por ejemplo, la evapotranspiración (ET), el estrés visual planta, hoja potencial de agua a través de bomba de presión, la humedad del suelo). ***Y*** La estrategia es mejorar e implementado anualmente.	Mi estrategia* de gestión del agua se basa en la viticultura objetivos fijados antes de la temporada de cultivo (rendimiento, calidad de la fruta, las características del dosel, la gestión del suelo, y los requisitos de la fertilidad) y representa el tipo de suelo, pendientes, la calidad del agua de riego y la eficiencia energética. ** ***Y*** Las herramientas están en su lugar para lograr estos objetivos (dispositivos de vigilancia del suelo, las estaciones meteorológicas, etc). ***Y*** Por lo menos tres parámetros apoyan las decisiones de gestión del agua (por ejemplo, la evapotranspiración (ET), el estrés de planta visual, potencial de agua de hoja a través de bomba de presión, la humedad del suelo).	Mi estrategia* de gestión del agua se basa en la viticultura objetivos fijados antes de la temporada de cultivo (rendimiento, calidad de la fruta, las características del dosel, la gestión del suelo, y los requisitos de la fertilidad) y representa el tipo de suelo, pendientes, la calidad del agua de riego.	No he desarrollado una estrategia de gestión del agua por mi viña.

* Ejemplos de estrategias de gestión del agua son riego deficitario regulado y el parcial secado de la zona de raíz. Las estrategias deben considerar los impactos potenciales de las plagas, como los nematodos o filoxera que dañan la raíz, y la capacidad de las vides para absorber el agua.

** Por ejemplo, regar durante las horas no-pico.

LA GESTIÓN DEL AGUA - CONTROL DE LA CALIDAD DEL AGUA DE RIEGO				
Criteria	**Categoría 4**	**Categoría 3**	**Categoría 2**	**Categoría 1**
5-2 El Montitoreo y la Enmendia de la Calidad del Agua de Riego (saltar si el agua de riego proviene de una fuente pura como la nieve se derriten)	Si mi agua de riego proviene de un pozo, se pone a prueba cada año* y al mismo tiempo para el pH, la salinidad o sólidos disueltos totales (conductividad eléctrica), el nitrato, bicarbonato, sólidos suspendidos, cloruros, boro, manganeso y magnesio (como apropiado para el sitio y la región **). ***Y*** Si problemas con la calidad del agua de riego son existentes, entonces el agua se modifica y / o gestionado (por ejemplo, a través de ácido sulfúrico, el yeso, los polímeros, lavado de la zona de las raíces).	Si mi agua de riego proviene de un pozo, que se pone a prueba cada año* y al mismo tiempo para el pH, la salinidad o sólidos disueltos totales (conductividad eléctrica), y el nitrato. ***Y*** Si los problemas con la calidad del agua de riego son existentes, entonces el agua se modifica y / o gestionado (por ejemplo, a través de ácido sulfúrico, el yeso, los polímeros, las raíces de la zona de lavado).	Si mi agua de riego proviene de un pozo, se pone a prueba de vez en cuando por lo menos pH, la salinidad o sólidos disueltos totales (conductividad eléctrica), y el nitrato.	La calidad de mi agua de riego no ha sido probado.

* Pruebas posible tengan que ocurrir más a menudo si la calidad del agua (por ejemplo, los niveles de nitrato, salinidad) fluctúa con el tiempo.

** Pueden haber importantes temas regionales sobre la calidad del agua de riego. Por ejemplo, altos niveles de hierro puede conducir a la formación de precipitados en las líneas de riego que puede obstruir los emisores. Póngase en contacto con expertos locales, tales como una adecuada UC Farm Advisor, empresas de riego, o los laboratorios de análisis para más información.

RECUADRO 1.5 CÁLCULOS DE NITRÓGENO

Hay dos medidas para informar de nitratos en una muestra de agua: NO_3 o NO_3-N. NO_3 es una medida de la concentración de nitratos (por ejemplo, a través de un Laboratorios A & L), mientras que NO_3-N es una medida de la concentración de nitrógeno en forma de nitrato (por ejemplo, a través de Cardy meter o EM Quant strip).

Para convertir a libras de nitrógeno por acre-pie de agua,

multiplicar ppm NO_3 por 0.614
o
ppm de NO_3-N por 2.72

LA GESTIÓN DEL AGUA - OFF-SITE MOVIMIENTO FUERA DEL AGUA				
Criteria	**Categoría 4**	**Categoría 3**	**Categoría 2**	**Categoría 1**
5-3 Movimiento del Agua Fuera del Sitio (Véase **Criterios de 4-10 – 4-12** y **4-16** y **Recuadro 4-9** en el capítulo de gestión de la erosión del suelo y de temas relacionados)	Mis prácticas de riego no causan el escurrimiento. ***Y*** Técnicas de prevención (por ejemplo, cultivos de cobertura) se han establecido para prevenir la mayoría de las aguas de escorrentía. ***Y*** Si la escorrentía puede ocurrir durante algunos eventos de alta precipitación, los sistemas de drenaje están en su lugar* para reducir al mínimo el movimiento fuera de las instalaciones de sedimentos, pesticidas y / o fertilizantes. ***Y*** Cualquier problema de la permeabilidad del suelo ha sido tratado (por ejemplo, cultivos de cobertura, las enmiendas del suelo, y / o antes de la siembra de labranza profunda).	Mis prácticas de riego no causan el escurrimiento. ***Y*** Técnicas de prevención (por ejemplo, cultivos de cobertura) en lugar de reducir la escorrentía, reduciendo al mínimo el movimiento fuera de las instalaciones de sedimentos, pesticidas y / o fertilizantes.	Mis prácticas de riego no causan el escurrimiento, pero se produce escorrentía durante las lluvias de alta precipitación. ***Y*** Sistemas de drenaje no están en su lugar para reducir al mínimo el movimiento fuera de las instalaciones de sedimentos, pesticidas y / o fertilizantes.	Escorrentía se produce tanto cuando riego mi viña y durante eventos de lluvia. ***Y*** Sistemas de drenaje no están en su lugar para reducir al mínimo el movimiento fuera de las instalaciones de sedimentos, pesticidas y / o fertilizantes.

* Es importante ser consciente de la dinámica de la recarga de agua subterránea de la lluvia que cae en un pendiente. Si viñedos ocupan una parte importante de un paisaje de colinas y tienen sistemas de drenaje que rápidamente desvia el agua de la lluvia, es importante saber cómo los patrones de drenaje afectará a largo plazo la recarga de aguas subterráneas y para mitigar los impactos significativos negativos.

RECUADRO 5-2 INTERCEPTANDO AGUA DE LA SUPERFICIE Y MOVIMIENTO DE SEDIMENTACIÓN

Existen varias técnicas para interceptar las aguas superficiales y el movimiento de sedimentación como resultado del flujo de agua fuera del sitio. Algunas técnicas ofrecen soluciones temporales, a menudo utilizado para los nuevos viñedos o en situaciones de emergencia, mientras que otras son permanentes. Viñedos empinados en colinas deben tener varias medidas permanentes para el control de erosión puesto en su lugar, tales como cultivos de cobertura permanente, terrazas apropiadas, adecuadas tiras de filtro entre la viña y las vías fluviales y los fosas de sedimento permanente.

Medidas Temporales

Cercado de tela de filtro: Una barrera de tela de filtro con alambre tejido se extendía entre los postes temporales a través de una pendiente para reducir el movimiento del suelo.

Dique de pacas de paja: Pacas de paja limpia atado con alambre o hilo de plástico colocada en un área de flujo laminar horizontal de superficie o la erosión en quebradas y ancladas en la superficie del suelo con varillas o estacas.

Barras de agua hechas de pacas de paja: Las pacas de paja para crear una barra de agua temporal a través de un camino o una barrera de sedimentos temporal para proteger las entradas de las fosas de drenaje. Una serie de barras hechas con pacas de paja puede ser necesario para una larga cuesta.

Fosa temporal de sedimentos: Utilizadas para la captura y que se asientan los sedimentos antes de que pueda entrar en un canal de agua. Fosas de sedimentos por lo general se colocan en la base de un área de pendiente o drenaje. Una pequeña fosa se puede crear mediante la formación de un muro de contención (no más de 4 pies de altura) de tierra compactada y piedras o pacas de paja. Un drenaje o salida debe restringir el flujo de la fosa para permitir a los sedimentos ser atrapados.

Zanja forrado con plástico: Cuando un camino de viñedo o una zanja al lado de un camino comienza a erosionarse, el plástico puede ser colocado sobre la parte de la erosión para reducir temporalmente la pérdida de suelo. Plástico resistente se debe utilizar para evitar la perforación con piedras y palos.

Medidas Permanentes

Filtro de franja de hierba: Una franja de hierba u otra vegetación densa que separa la viña de un canal de agua. Fluya hacia alcantarillas y la tira se ve reducida por la densa vegetación y los sedimentos transportados se filtra y se capturan. El ancho recomendado de la banda de filtro es proporcional a la pendiente del área de origen de drenaje. La anchura van desde un mínimo de 10 pies en laderas de grados menos de 1% a 25 pies por pendientes de 30%. Tiras de filtro también se puede colocadas a través de una pendiente de viñedo entre los bloques para reducir el movimiento de sedimentos por escorriente de flujo laminar.

Fosa de sedimentos: La fosa se crea mediante la construcción de un muro de contención, una estructura de liberación (vertical, por ejemplo, tubos perforados), y un aliviadero de emergencia. La fosa se encuentra en la parte inferior de una pendiente de viñedo, donde el drenaje entra en un terreno pantanoso o canal de agua. Estas fosas deben ser diseñados de forma específica del sitio del Departamento de Agricultura de EE.UU. Servicio de Conservación de Recursos Naturales (NRCS) o un ingeniero civil y construido con materiales adecuados, dimensiones y técnicas.

Fuente: Marcus et al, 1999.. Para obtener más información acerca del programa Fish Friendly Farming y prácticas asociadas, véase el **Recuadro 8-13** en el capítulo de gestión de los ecosistemas.

LA GESTIÓN DEL AGUA - INSTALACIÓN Y MANTENIMIENTO DE SISTEMAS DE RIEGO				
Criteria	**Categoría 4**	**Categoría 3**	**Categoría 2**	**Categoría 1**
5-4 Sistemas de Riego (saltar si viñedo secano)	Un sistema de micro riego diseñado de ingeniería* está instalado en mi viña.	Un sistema de riego aspersor diseñado de ingeniería* está instalado en mi viña.	Un sistema de riego diseñado de ingeniería de alto volumen se ha instalado en mi viña.	Un sistema de riego diseñado de ingeniería no está presente en mi viña.
5-5 Uniformidad de la Distribución de Sistemas de Micro-Riego (ver la **Tabla 5-1** para obtener información sobre los sistemas de evaluación de micro-riego)	Yo cada año compruebo la uniformidad de la distribución de mi sistema de riego mediante el control de ambas salidas de emisor y de las diferencias de presión en el bloque y hago las correcciones necesarias para garantizar que se cumplen las directrices de la **Tabla 5-1**.	Yo cada año compruebo la uniformidad de la distribución de mi sistema de riego mediante el control de las salidas de emisor a través del bloque y hago las correcciones necesarias para garantizar que se cumplen las directrices de la **Tabla 5-1**.	De vez en cuando compruebo uniformidad en la distribución de mi sistema de riego mediante el control de las salidas de emisor a través del bloque y hago las correcciones necesarias para garantizar que se cumplen las directrices de la **Tabla 5-1**.	Nunca compruebo la uniformidad de la distribución de mi sistema de riego.
Uniformidad de distribución es generalmente mucho mas peor de lo que la mayoría de los productores creen. A diferencia de 2:1 dentro de un bloque no es infrecuente.				

* Un sistema de riego bien diseñado consta de componentes tales como dispositivos de prevención de reflujo, controla el flujo, y equipos de filtración y de la inyección y tiene características tales como compensación de la presión, la eficiencia energética, y el alojamiento de la variación del sitio.

TABLA 5-1 EVALUACIÓN RÁPIDA DE CAMPO DE SISTEMAS DE GOTEO Y DE MICRO RIEGO		
Medición / Observación	**Lo que es bueno para ver**	**Comentarios**
La diferencia de presión de la descarga de la bomba de agua en el lado abajo de los filtros.	Menos que una caída (diferencia) de 6-10 psi.	Una gran caída (diferencia) en la presión indica: -El exceso de presión que se consume por un regulador de presión -filtros sucios -grandes pérdidas a través de válvulas y accesorios *La caída de presión no afectan directamente la eficiencia del riego o la uniformidad, pero el impacto es a la factura de electricidad.*
Las presiones en la primera manguera inmediatamente abajo de cada regulador de presión en el campo.	Diferentes presiones por no más de 1 psi, a menos que se utilizan emisores de compensación de presión.	Los reguladores de presión se desajustan con facilidad. Esto es fácil de superar mediante la medición de la presión con un manómetro con un tubo piloto metió en la manguera de agua mientras está en funcionamiento.
Las presiones en la primera manguera inmediatamente abajo de cada regulador de presión en el campo.	Presiones apropiadas - generalmente 15 a 30 psi para el goteo sobre la superficie, 10-12 psi para la cinta, y 10-15 psi para el riego por goteo subterráneo (SDI).	Presión demasiado baja causa una falta de uniformidad. Presión más alta que la presión deseada causa en sistemas de SDI que el agua burbuje a la superficie, mientras que las presiones excesivamente altas causan problemas de ajuste de componentes y las fugas para otros sistemas.
Presiones a la cabezera de muchas mangueras en cada bloque (abajo de regulador de presión).	Las presiones deben estar dentro de un 5-10% a menos que los emisores de compensación de presión se utilizan.	Ninguno.
El color del agua en los extremos de las mangueras cuando lavado (las mangueras más lejanas son peores).	El agua debe ser un poco sucio por no más de 5 segundos (toma de agua en un calcetín para evaluar el color, es decir, el potencial de causar la obstrucción de los emisores).	Este es un excelente indicador del éxito global de el mantenimiento de evitación de la obstrucción de los emisores, es decir, la inyección de cloro, una buena filtración, y el frecuente lavado de la manguera.
El tiempo requerido para que los emisores llenarán a recipientes pequeños (muestra de menos de 30 segundos). Se toma una muestra de 20 a 40 emisores de todo el campo, incluidas las mangueras de los extremos de la cabeza y la cola de los bloques y de centros de las mangueras.	Tiempos deben estar dentro de un 5-10%.	Las diferencias pueden ser causadas por: -Conexión -Gastado -Variación de presión - Variación de fabricación La obstrucción y el gastado se puede identificar cortando y examinando los emisores o pulverizadores. Las presiones deben ser medidos, mientras que el agua está fluyendo, con un manometro de 0-30 psi si presiones estan a 10-25 psi.

Fuente: Charles M. Burt, Cal Poly Irrigation Training and Research Center (ITRC), San Luis Obispo, CA.

LA GESTIÓN DEL AGUA - INSTALACIÓN Y MANTENIMIENTO DE SISTEMAS DE RIEGO				
Criteria	**Categoría 4**	**Categoría 3**	**Categoría 2**	**Categoría 1**
5-6 Filtros y líneas	Mi sistema de riego está equipado con un buen estado de funcionamiento del sistema automático para el lavado de filtros y líneas y se monitorea para mantener un funcionamiento óptimo. ***Y*** Una inspección de mi sistema de riego es parte de un programa de mantenimiento regular (es decir, las condiciones de elemento filtrante revisadas por lo menos dos veces al año).	Filtros de agua en mi sistema de riego son inspeccionadas y limpiadas cuando las diferencias de presión se encuentran, y las líneas de riego se limpian 2-4 veces al año.	Filtros de agua en mi sistema de riego son inspeccionadas y limpiadas cuando las diferencias de presión se encuentran, y las líneas de riego se limpian cada primavera.	Filtros de agua en mi sistema de riego no son inspeccionados regularmente y limpiados, y las líneas de riego no se lavan con regularidad.
5-7 Medidores de flujo	Medidores de flujo se instalan en las líneas de mis pozos u otras bombas, y los flujos son monitoreado y registrados en cada riego. ***Y*** La inspección de medidores de flujo es parte del mantenimiento regular, es decir, monitoreados y calibrados por lo menos cada dos años.	Medidores de flujo se instalan en las líneas de mi pozos u otras bombas, y los flujos son monitoreados durante cada riego. ***Y*** La inspección de medidores de flujo es parte del mantenimiento regular, es decir, monitoreados y calibrados por lo menos cada dos años.	Medidores de flujo se instalan en las líneas de mi pozos u otras bombas, pero los flujos no son monitoreados en cada riego.	Medidores de flujo no se instalan en las líneas de mi pozos u otras bombas.

LA GESTIÓN DEL AGUA - PROGRAMACIÓN DE RIEGO Y CANTIDAD				
Criteria	**Categoría 4**	**Categoría 3**	**Categoría 2**	**Categoría 1**
5-8 Capacidad de Retención de Agua del Suelo	Yo sé y cuantifico (por ejemplo, acre-pulgadas) la capacidad de retener agua del suelo (según el tipo de suelo y la profundidad de las raíces), la precipitación anual, y el agua utilizada por el cultivo de cobertura en mi viña. ***Y*** Esta información es utilizada para elaborar el presupuesto de agua, el ajuste de la fecha de inicio para el riego de primavera / verano, y la programación del riego y posterior gestión del agua en general.	Sé la capacidad de retención de el agua en el suelo de mi viña (según el tipo de suelo y la profundidad de las raíces). ***Y*** Esta información se utiliza para programar el riego y la gestión del agua en general.	Supongo cual es la capacidad de retención de el agua en el suelo de mi viña (basado en el tipo de suelo). ***Y*** Esta información se utiliza para programar el riego y la gestión del agua en general.	No sé la capacidad de retención de el agua en el suelo de mi viña.

LA GESTIÓN DEL AGUA - PROGRAMACIÓN DE RIEGO Y CANTIDAD				
Criteria	**Categoría 4**	**Categoría 3**	**Categoría 2**	**Categoría 1**
5-9 Métodos de Monitoreo de Humedad del Suelo y Estado de Agua de la Planta	He instalado y uso la medición de la humedad del suelo con dispositivos de monitoreo directo (por ejemplo, la sonda de neutrones) de seguimiento de la disponibilidad del agua y el agotamiento y programar el riego para mi viña. ***Y*** Yo muestro con un sinfín de pala o pala cuchara para confirmar la cantidad de agua disponible. ***Y*** Estado de la planta de agua se monitorea visualmente con la evaluación de puntas de los brotes y los zarcillos. ***Y*** Una herramienta (planta aplicada) se utiliza para cuantificar el estrés hídrico de las plantas (por ejemplo, bomba de presión) para determinar la fecha de inicio de regadío de la primavera / verano.	He instalado y uso la medición de la humedad del suelo con dispositivos de monitoreo indirecto (por ejemplo, bloques de yeso, tensiómetros, sensores de capacitancia) de seguimiento de la disponibilidad del agua y el agotamiento y programar el riego para mi viña. ***Y*** La humedad del suelo se utiliza para determinar la fecha de inicio de regadío de la primavera / verano. ***Y*** Estado de la planta de agua se monitorea visualmente con la evaluación de puntas de los brotes y los zarcillos.	Yo uso un sinfín de pala o pala cuchara y la "prueba de presión manual" para estimar la cantidad de agua disponible en el suelo de mi viña y programar el riego. ***O*** Estado de la planta de agua se monitorea visualmente con la evaluación de puntas de los brotes y los zarcillos.	Yo no mido la humedad del suelo y la disponibilidad de agua en mi viña para programar el riego.

RECUADRO 3.5   INDICADORES CUALITATIVOS DE ESTADO DE HUMEDAD DE LA VID
Números o medidas, dentro de cada uno de los siguientes grupos - puntas de los brotes, hojas y frutos - el progreso de la vid desde que no falta la humedad hasta un estrés severo. Números idénticos entre los grupos no corresponden necesariamente con los mismos niveles de estrés.

Puntas de los Sarmientos*

1. La punta del brote está activo y en crecimiento más rapido de la expansión de las hojas. Zarcillos activa y se extienden por encima de la punta de crecimiento. Hojas perpendicular a los rayos del sol con la coloración verde brillante.
2. La punta del brote está activo y en crecimiento. Última hoja expandida aún detrás de la punta. Zarcillos, parejo con la punta de crecimiento con zarcillos basal caídos. Hojas perpendicular a los rayos del sol.
3. La punta del brote está menos activo en crecimiento. Última hoja expandida cubriendo la punta. Zarcillos secos se caen si colocados en la base de la caña si no apegado a algo. Zarcillos, cerca de la punta estan marchitos caídos. Las hojas comienzan a doblar lejos de los rayos del sol y el cambio a más apagados tonos de verde.
4. La yema terminal es de color amarillo o marrón, y claramente no está creciendo. Última hoja expandida plegando y cubre la punta. Zarcillos cerca de la punta son marchitos caídos o caen fácilmente al tacto. Más hojas a desviarse de la perpendicular y paralela a más los rayos del sol.
5. La yema terminal está muerto o caída. Todos los zarcillos no apegado a algo secos y caídos. Hojas amarillas y cayendo de estrés. El resto de las hojas son ver opaco y han engrosado.

Ojas

1. No hay pérdida de hojas causado por el estrés hídrico.
2. 20-10 hojas perdidas o de color amarillo por cepa. Cambio de color de las hojas de un verde opaco.
3. 10-30 hojas perdidas o amarillas por cepa.
4. Pérdida de hojas y hasta dentro de la zona de la fruta.
5. Pérdida de hojas por encima de la zona de la fruta.

Fruta

1. No hay signos visibles de deshidratación de frutas. Racimos firmes al tacto.
2. Algunos signos visibles de deshidratación de frutas. Racimos en ablandamiento al tacto.
3. Más del 5% de las vides con algún grado de deshidratación de la fruta. Cambios visibles en las bayas.
4. Más del 5% pero menos del 40% de las vides con algún grado de deshidratación de la fruta.
5. Más del 40% de las vides con algún grado de deshidratación de la fruta.

Fuente: Robert Mondavi Family of Fine Wines, Statewide Grower Relations.

* El estado deseable de humedad de la vid depende de la fenología de la vid. Por ejemplo, el paso numero 1 en Agosto no es deseable desde una perspectiva de calidad de la fruta, pero el paso numero 3 o 4 es deseable en esta época del año.

LA GESTIÓN DEL AGUA - PROGRAMACIÓN DE RIEGO Y CANTIDAD				
Criteria	**Categoría 4**	**Categoría 3**	**Categoría 2**	**Categoría 1**
5-10 Evapotranspiración (ET)	Yo monitoreo ET con una estación meteorológica en campo (con los sensores apropiados) para su uso como una de las herramientas para el cálculo de riego necesario. ***Y*** Las medidas son verificados comparándolos con los datos de una estación de California Irrigation Management Information Service (CIMIS) (véase **Recuadro 5-4**).	Yo monitoreo ET con una estación meteorológica cercana (con los sensores apropiados) para su uso como una de las herramientas para el cálculo de riego necesario. ***Y*** Las medidas son verificados comparándolos con los datos de una estación CIMIS.	Yo monitoreo ET con CIMIS para usar como una de las herramientas para el cálculo de riego necesario.	No monitor ET en mi viña.
5-11 Presupuesto de Agua (véase el recuadro 4.5 para una descripción del enfoque de balance de agua)	Yo sé la cantidad de agua utilizada por mi viña entre cada riego (ET acumulada de los cultivos (ETc)) y solamente lo que se utiliza (o menos si el déficit de irrigación), se sustituye. Las cantidades utilizadas se determinan mediante la evaluación de la disponibilidad de humedad del suelo y el estado de humedad de la planta tal como se describe en la categoría 4 de los **Criterios 5-9** y mediante la medición de ET como se describe en la categoría 4 de los **Criterios de 5-10.**	Yo baso la cantidad de agua aplicada en cada riego en las evaluaciones de la disponibilidad de humedad del suelo y el estado de humedad de la planta tal como se describe en la categoría 3 de los **Criterios 5-9** y en las mediciones de ET como se describe en la categoría 3 de los **Criterios 5-10**. Sólo esa cantidad utilizada (o menos si el déficit de irrigación), se sustituye.	Yo baso la cantidad de agua aplicada en cada riego en el aspecto general de la vid y las condiciones meteorológicas.	Puedo aplicar el agua a mi viña en una base de calendario (por ejemplo, la misma cantidad cada semana o cada año, independientemente de la ETc).

RECUADRO 5.4 PROGRAMACION DE RIEGO USANDO EVAPOTRANSPIRACIÓN (ET)

El enfoque del presupuesto de agua a la programación del riego se basa en el seguimiento y el cálculo de los complementos y las pérdidas de agua para un campo. El componente más importante es una estimación precisa del uso de agua para los cultivos, o ET. Una referencia genérica figura ET (ETo), las acre-pulgadas de agua por día por un campo de hierba alta 4.6 pulgadas, se registra a nivel estatal por el Servicio de Riego de California de Información de Gestión (CIMIS). CIMIS se puede acceder en http://wwwcimis.water.ca.gov. Para tener en cuenta las diferencias de ET entre los cultivos y el pasto, cada cultivo se le asigna un coeficiente de conversión específico (Kc) que cambia con la temporada. La tabla 5.2 muestra los coeficientes de cultivo para un viñedo típico que tiene un dosel que sombrea del 50-60% de el suelo del viñedo. Evapotranspiración de la viña (ETc) se calcula multiplicando la ETo por Kc. Utilizando el ejemplo de un intervalo de 2 semanas que comenzó el 16 de Mayo y tenía un acumulado de 1.0 ETo y Kc de 0.54, la uva se ha utilizado 0.54 acres-pulgadas de agua (es decir, la evapotranspiración por el cultivo o ETC). En consecuencia, 0.54 pulgadas de agua tendría que ser añadido al suelo por riego para reemplazar ETc completo. La capacidad de retención de agua del suelo y las lluvias de invierno también tienen que ser conocidos, registrados, y cuenta en el presupuesto de agua para permitir el cálculo de la cantidad de agua disponible en el suelo antes de que comienza el crecimiento de la primavera. Por ejemplo, un viñedo con las raíces a 9 pies de profundidad en un suelo arenoso típico detiene aproximadamente 1 pulgada de agua por cada pie de suelo, debe tener 9 pulgadas de agua disponible en la primavera. Un buen programa de monitoreo del suelo de campo y la incorporación de monitoreo de la planta es esencial para asegurar que los cálculos son correctos. Este enfoque convencional de presupuestos de agua para la programación del riego es apropiado para la mayoría de los cultivos, pero las uvas se benefician realmente con el uso de menos agua. Revisión al **Recuadro 5-5** del riego deficitario controlado para una discusión acerca de la programación de riego para la calidad del vino.

TABLA 5-2 COEFICIENTES QUINCENALES TÍPICOS DEL CULTIVO DE UVA DE VINO (KC) PARA DOSELES SOMBREANDO 50-60% DE SUELO DEL VINEDO AL MEDIO DIA

Días después de brotación	1999 ejemplo de dos semanas de la fecha de inicio del período	Kc
1-15	1-Abril	0.13
16-30	15-Abril	0.28
31-45	1-Mayo	0.42
46-61	16-Mayo	0.54
62-76	1-Junio	0.65
77-91	16-Junio	0.73
92-106	1-Julio	0.79
107-122	16-Julio	0.83
123-137	1-Agosto	0.85
138-153	16-Agosto	0.86
154-168	1-Septiembre	0.84
169-183	16-Septiembre	0.81
184-198	1-Octubre	0.75
199-214	16-Octubre	0.68
215-229	1-Noviembre	0.58
Multiplique acumulado ETo (suma de los valores diarios) por el correspondiente dos semanas Kc para obtener ETc (pleno uso potencial de agua para los viñedos de acre-pulgadas). 1 acre-pulgada (cantidad de agua necesaria para cubrir un acre a 1 pulgada de profundidad) = 27,154 galones.		

Fuente: Prichard et al., *en prensa.*

LA GESTIÓN DEL AGUA - PROGRAMACIÓN DE RIEGO Y CANTIDAD				
Criteria	**Categoría 4**	**Categoría 3**	**Categoría 2**	**Categoría 1**
5-12 Riego Deficitario Planificado a Través de Riego Deficitario Controlado (RDI) o el Secado Parcial de Zona de Raíz (PRD) (no aplicable a todas las regiones o variedades, consulte a su Asesor Agrícola UC)	Yo uso un nivel predeterminado de RDI o PRD para mejorar la calidad del vino y conservar el agua y la energía. ***O*** Mi viña es secano.	Yo experimento con RDI o PRD y mis viñas se riegan en menos de ETc completo.	Yo riego menos para que un poco de estrés hídrico se aplica a las vides.	Yo riego para asegurar que no se produce estrés hídrico en la vid, produciendo un dosel foliar abundante y saludable como sea posible.

RECUADRO 5-5 RIEGO DEFICITARIO Y CONTROLADO (RDI)

El concepto del RDI originó en Australia (Hardie y Considine, 1976). Basado en una investigación considerable relevante en California, el estrés hídrico moderado, particularmente entre floración y pinta, tiene un impacto positivo significativo en la calidad del vino (Prichard et al, 1995; Y Prichard et al, en prensa)* por aumento de la acidez total, disminuyendo pH y malato, y la mejora de color. Además, el estrés hídrico moderado reduce la podredumbre del racimo. Sin embargo, todavía hay mucho que aprender acerca de la aplicación con éxito de conceptos RDI para las diferentes regiones, sitios y variedades. Debido a su rápido crecimiento, el período de floración a envero es el más crítico para la mejora de la calidad del vino. Estrés hídrico moderado durante este intervalo tiene resultados en hojas más pequeñas, menos laterales, bayas más pequeñas, y facilita el cese deseado de crecimiento de punta de los sarmientos cerca del envero. La reducción de la vegetación permite más luz y aire penetre en la zona productiva, las bayas más pequeñas aumentan la relación de la piel a lo del jugo, y el cese del crecimiento de las puntas de sarmiento estimula la vid para madurar las semillas (y sabores) para ayudar a producir un vino de menos calidades herbáceas. Después de envero, el estrés se reduce para permitir la fotosíntesis adecuado y la maduración del fruto. Para uvas de vino, los dos métodos más comunes son la RDI el enfoque de balance de volumen (véase el **Recuadro 5-6**) y el método umbral deficitario mas el RDI (véase el **Recuadro 5-7**). Ambos métodos funcionan igual de bien, pero difieren en que el primero es más complejo, pero no requiere ningún equipo especial, mientras que el segundo es simple, pero requiere el uso de una bomba de presión. Secado Parial de Zona Raíz (PRD, Caja 5-8) es la estrategia más reciente desarrollado de tipo déficit de riego.

* Véase también: http://cesanjoaquin.ucdavis.edu/Custom_Program/Publications_Available_for_Download.htm?$=682.

RECUADRO 5.6 ENFOQUE DE BALANCE DE VOLUMEN

Para este método, la capacidad del suelo de la viña de retener agua y la lluvia acumulada deben ser conocida y aplicada para determinar la cantidad de agua disponible en el suelo antes de que el crecimiento anual se inicia. Consejeros agrícolas del UC o el personal de NRCS puede ayudar a determinar la capacidad de retención de agua de los suelos. Además, la vid ETc diaria debe ser seguido para el cálculo de la cantidad de agua acumulada que se utiliza (véase el **Recuadro 5.4** para el cálculo de la ETc desde ETo y Kc). Riego de primavera / verano comienza sólo después de que una parte del agua del suelo determinado se utiliza. Una sonda de neutrones o un dispositivo equivalente es útil para la toma de determinaciones más precisas de agua almacenada en el suelo. El riego comienza en menos de ETc completo (en 30-66% de la ETc completo es ideal, ajustado sobre la base de medida de follaje del cultivo por hectárea). Si el dosel foliar es más pesado que el promedio (por ejemplo, enrejados, cuadrilátero, surcos estrechos), el 66% de la ETc se aplica, si el dosel foliar es más liviana que el promedio (por ejemplo, la posición, espaldera vertical, las filas anchas), el 30% de la ETc se aplica. Porcentajes exactos pueden ser ajustados con la experiencia. Después de pinta y hasta la cosecha, el riego se incrementa ligeramente para ayudar a madurar la uva, - pero aún se mantiene por debajo de ETc completo. Después de la cosecha, las vides se riegan en los niveles plenos de la vid uso del agua.

Fuente: Terry Prichard, Especialista en Riego y Gestión del Agua, UC Cooperative Extension, San Joaquin County; y Prichard et al., *en prensa.*

RECUADRO 5-7 MÉTODO UMBRAL DÉFICITARIO MÁS RDI

Este método consiste en la espera para el riego de hasta un determinado nivel de estrés de la planta de agua (el umbral de disparo) se mide, después de lo cual, el riego comienza en una reducción de (déficit) la tasa. En lugar de monitoreo de agua del suelo, el estado de agua de la vid se mide con una bomba de presión, para hacer un sistema más simple. La bomba de presión es utilizada por la eliminación de una hoja al medio día y se coloca en la cámara de la bomba de presión con su pecíolo que se extiende desde una arandela de silicona. Se aplica presión en la cámara hasta que una gota de humedad aparece en el extremo del corte del pecíolo. La presión medida necesaria para forzar la savia fuera del corte del pecíolo (potencial hídrico foliar) refleja el nivel de estrés hídrico experimentado por la planta. Agua almacenada en el suelo, como se utiliza por la planta en la primavera, se monitorea con la bomba de presión y se detecta aumento de los niveles de estrés hídrico de la vid. Los experimentos en Lodi y la Costa Norte con variedades de uva de vino de Merlot, Cabernet Sauvignon, Zinfandel han demostrado que el comienzo de riego cuando potencial hídrico foliar alcanza -12 bares y el comienzo de riego deficitario en un 60% de la ETc (idéntico al del método de balance de volumen) es exitoso, pero conservador. En la práctica, el punto umbral para comenzar el primer riego está por encima o por debajo de -12 bares y déficit de riego comienza en o por debajo del 60% ETc. A medida que más productores aplican este método de RDI, es evidente que el umbral de comienzo preciso y el grado de déficit de riego depende de la región, tipo de suelo, variedad y patrón. Además, se necesita investigar más por hacer para normalizar la rutina apropiada para las hojas de muestreo. Se recomienda que las medidas adicionales, tales como el aspecto vid y la humedad del suelo, se utilizan para confirmar el estado de humedad de la vid.

Fuente: Terry Prichard, Especialista en Riego y Gestión del Agua, UC Cooperative Extension, San Joaquin County; y Prichard et al., *en prensa.*

RECUADRO 5.8 SECADO PARCIAL DE LA ZONA DE RAÍZ (PRD)

PRD es un concepto reciente que, como RDI, que se originó en Australia (Dry et al., 1995). PRD se lleva a cabo por la alternancia de la retención de agua de los lados de la vid durante el cuajado del fruto hasta el intervalo de la cosecha, por lo que sólo la mitad de la tierra en la zona de la raíz se seca en cualquier momento. La investigación muestra que las raíces responden a la desecación del suelo mediante la producción de ácido abscísico (ABA). La ABA se traslada a las hojas lo que provoca la cerrada de los estomas, la inducción de un estrés de agua suave en la vid. Este estrés afecta el crecimiento de la vid de manera similar a la de los métodos de RDI, por ejemplo, la reducción del crecimiento foliar (Grant, 2000). Debido a que sus raíces en el secado del suelo producen ABA sólo durante unas dos semanas, un ciclo de alternancia de secado y humectación se repite varias veces antes de la cosecha para mantener la tensión leve y la producción de ABA. Resultados del PRD en el uso del agua disminuyó (30 a 50% menos;. Gu et al, 2000) y los costos de bombeo y parece que hay menos riesgo de grave escasez de agua que a veces ocurre con los métodos de RDI (Grant, 2000). Uso PRD al parecer va en aumento en Australia y está siendo estudiado más para su aplicación en California. Los resultados preliminares de experimentos que comparan PRD al riego tradicional en el Valle de San Joaquín, indican que el PRD efectivamente mejora el balance de la vid, reduce el consumo de agua, y limita vigor de la planta y la densidad de follaje, sin reducir el rendimiento (Gu et al., 2000).

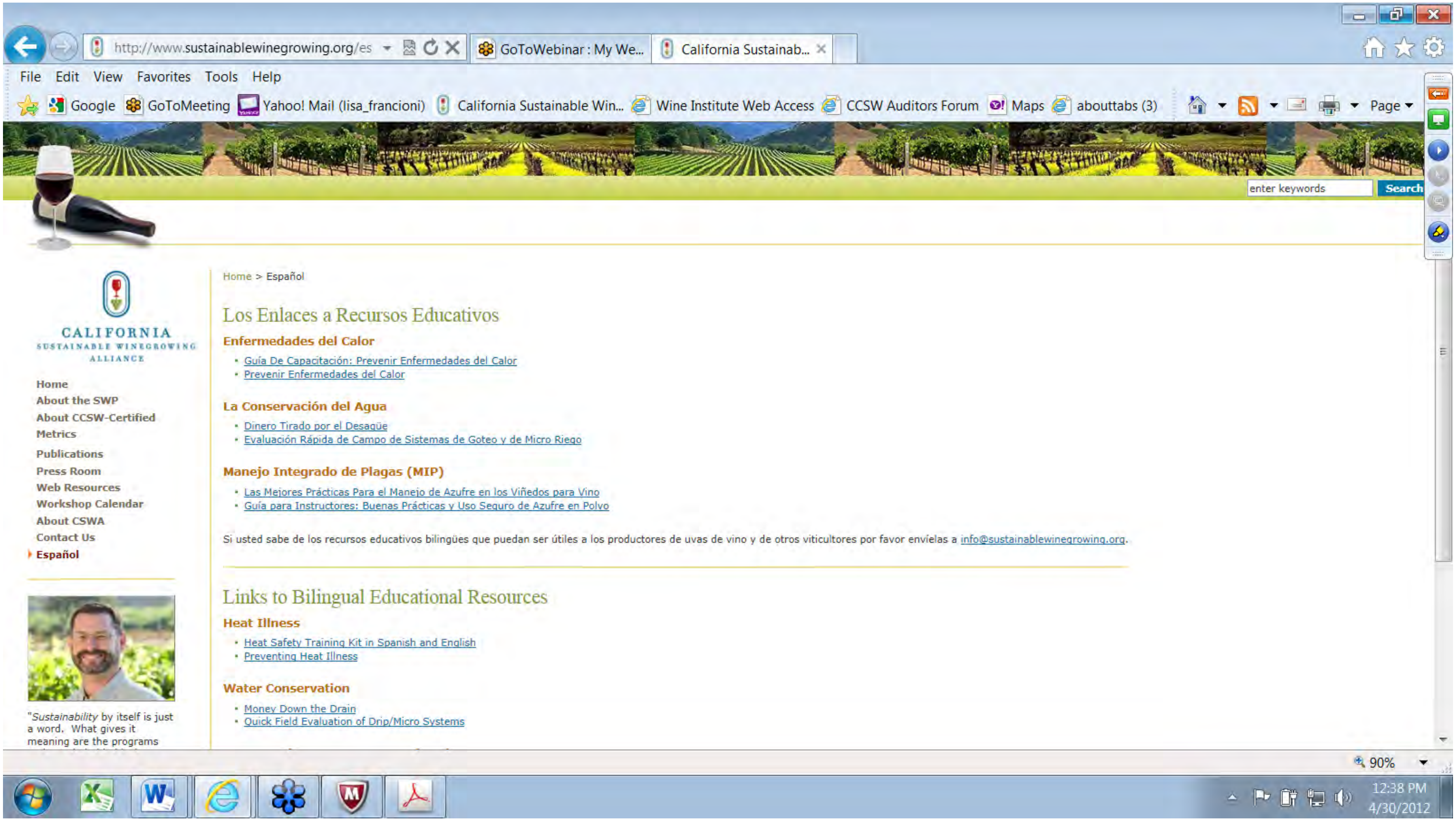
LA GESTIÓN DEL AGUA - FERTIRRIGACIÓN				
Criteria	**Categoría 4**	**Categoría 3**	**Categoría 2**	**Categoría 1**
5-13 Fertirrigación* (saltar si no se aplica fertilizante a través de riego por goteo) (ver Criterios 4.4 y 4.5 en el capítulo de gestión del suelo para las prácticas pertinentes para la nutrición de la viña)	Yo fertirriego si la fertilización es necesaria** sobre la base de suelo y de nutrientes de la vid. ***Y*** La frecuencia y el ritmo de las aplicaciones se calculan tanto para satisfacer la demanda de vid y evitar la lixiviación de los fertilizantes por debajo de la zona de las raíces. ***Y*** Los dispositivos de prevención de reflujo estan en su lugar.	Yo fertirriego si la fertilización es necesaria** sobre la base de suelo y de nutrientes de la vid. ***Y*** El calendario de las aplicaciones se basa en la conveniencia, sin saber si el fertilizante esta en la lixiviación por debajo de la zona de las raíces. ***Y*** Los dispositivos de prevención de reflujo estan en su lugar.	Yo fertirriego sin comprobar primero el suelo o el estado nutricional de la vid.	Tengo un sistema de riego de goteo, pero nunca lo uso para aplicar fertilizantes.

* Fertirrigación es el uso del sistema de riego (por ejemplo, el surco, aspersión, goteo) para entregar fertilizantes y enmiendas.

** En este contexto, la fertilización necesaria la fertilización implica una garantía de mantenimiento nutricional. En algunas situaciones donde una deficiencia de nutrientes importantes corregido, es necesario hacer que las aplicaciones individuales de los fertilizantes en cantidades que no se puede aplicar a través de riego por goteo (de la que este criterio no se aplica).

RECUADRO 9.5 PRACTICAS DE BUEN FERTIRRIGACIÓN

- Mantenga los materiales en la zona de la raíz.
- En primer lugar analizar la calidad del agua de riego para los actuales niveles de nutrientes y composición química del agua (**Criterios 5-2**)
- Asegurar los materiales que se fertirriegan son compatibles con la calidad del agua de riego y la química del suelo.
- Use la seguridad del trabajador adecuado.
- Use las tasas de inyección adecuadas.



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CALIFORNIA SUSTAINABLE WINEGROWING ALLIANCE

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"*Sustainability* by itself is just a word. What gives it meaning are the programs

Home > Español

Los Enlaces a Recursos Educativos

Enfermedades del Calor

- Guía De Capacitación: Prevenir Enfermedades del Calor
- Prevenir Enfermedades del Calor

La Conservación del Agua

- Dinero Tirado por el Desagüe
- Evaluación Rápida de Campo de Sistemas de Goteo y de Micro Riego

Manejo Integrado de Plagas (MIP)

- Las Mejores Prácticas Para el Manejo de Azufre en los Viñedos para Vino
- Guía para Instructores: Buenas Prácticas y Uso Seguro de Azufre en Polvo

Si usted sabe de los recursos educativos bilingües que puedan ser útiles a los productores de uvas de vino y de otros viticultores por favor envíelas a info@sustainablewinegrowing.org.

Links to Bilingual Educational Resources

Heat Illness

- Heat Safety Training Kit in Spanish and English
- Preventing Heat Illness

Water Conservation

- Money Down the Drain
- Quick Field Evaluation of Drip/Micro Systems

90%

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CALIFORNIA SUSTAINABLE WINEGROWING ALLIANCE

HIGHLIGHTS

WINTER 2013 CALIFORNIA SUSTAINABLE WINEGROWING ALLIANCE NEWS

Green Initiatives at Coppola

Francis Ford Coppola Winery continuously proposes, evaluates and executes sustainable practices throughout the winery and vineyards. "Sometimes just asking the question about how we can reduce waste is enough to get the ball rolling," says Rhonda Hood, Alcohol and Environmental Compliance Manager. Recent initiatives include:

- Establishing a winery "Green Team," comprised of staff from different departments, to work on sustainable practices;
- Installing synthetic air curtains in the barrel room to keep cool air in, significantly reducing the need for air conditioning and refrigeration;
- Recycling unused corks and using up capsules before re-ordering; folding boxes used for shipping corks and returning to the vendor;
- Using local trucking companies to support the community and reduce the carbon footprint;
- Installing two electric car charging stations, serving visitors with clean air vehicles;
- Diverting grape pomace to compost;
- Reducing paper use by sending invoices by email;
- Using barrels from certified sustainable forests;
- Encouraging carpooling among employees at health and wellness fairs.

Photo to right: Pellets that induce microbial activity to treat wastewater replaced the ammonia- activated system.

Case Studies: the Business and Environmental Benefits of Sustainability

Sustainability at Francis Ford Coppola Winery

SINCE ITS OPENING, Francis Ford Coppola Winery in Geyserville has become a mecca for visitors. In 2010, after extensive renovations, the winery reopened with new tasting rooms, a restaurant, movie gallery and a winery park area with swimming pools and a performing arts pavilion, all sharing space with a working winery. Behind the scenes, however, is an abiding commitment to sustainable winegrowing practices, some with side benefits of reduced operating costs.

FRANCIS FORD COPPOLA PHOTOS

Coppola's CCSW-certified winery and vineyard operations reduced energy costs 35% the first year after adding a new hot water system.

For its winery operations, Coppola recently switched from a traditional steam boiler system to a hot water heater with a thermal efficiency of 88%. Unlike boilers, the new system automatically adjusts for demand, heating water only when the winery needs it. Although the upfront cost was not insignificant, Coppola began to see energy cost savings immediately.

"In the first year the new system reduced our natural gas costs by 35%," says Rhonda Hood, who oversees Alcohol and Environmental Compliance for the winery, which received Certified California Sustainable Winegrowing (CCSW) in 2012. "That's an incredible savings for a winery of our size."

Another sustainable initiative with cost savings benefits was changing the winery's wastewater ponds from a double containment ammonia-activated system to one that uses pellets to induce microbial activity that processes the waste. The new system resulted in a cost savings of 80%. "The environmental impact is a no-brainer. Instead of having trucks full of ammonia arrive at the winery, we get little boxes filled with pellets," said Hood.

"Sustainable winegrowing is key to a successful business, motivated work force, and improved environment. With the mantra of continuous improvement, California continues to lead the way in sustainability in the global wine business."

STEVE SMIT, CONSTELLATION BRANDS AND CSWA CHAIRMAN

CALIFORNIA SUSTAINABLE WINEGROWING ALLIANCE

Nutrient Accounting at Terra d'Oro

THE STRATEGIC USE of cover crops and compost by Terra d'Oro's vineyard team has significantly reduced its reliance on synthetic fertilizers. The Trinchero family's Amador winery both saves money and significantly improves its vineyard soil composition through careful accounting of nutrients transported into and out of the soil.

"We work using industry standards for net export of nutrients from the vineyard per ton of fruit," says Viticulturist Melinda Costigan.

Terra d'Oro uses a cover crop that blends 40% fava beans, 20% forage peas, 20% vetch (all legumes) and 20% cereal oat or barley. Sown each fall in every other row, the crop composition varies depending on nutrient requirements but provides approximately 10-15 pounds of nitrogen per acre, plus other nutrients such as potassium and calcium. Because they decompose gradually over time (as the crop is mowed and disked in the spring), the nutrients are not as prone to leaching as with typical inorganic fertilizers.

Terra d'Oro, certified by Lodi Rules for Sustainable Winegrowing, estimates that using cover crops and compost saves approximately $80 per acre in conventional fertilizer. The team is quick to note there are other reasons for undertaking these practices.

"Using organic forms of nutrient delivery improves soil structure and water holding capacity and increases microbial activity and organic matter," says Costigan. "These soil improvements aren't easy to quantify but they are soil building—vs. depleting—practices that are consistent with the aims of sustainable agriculture."

Terra d'Oro spreads about two tons per acre of its composted grape pomace in its vineyards, according to Viticulturist Melinda Costigan and Vineyard Manager Kevin Steward.

TERRA D'ORO PHOTOS

Minding Your PEAS at Terra d'Oro

Terra d'Oro General Manager Jeff Meyers checks the health of the vines and grapes.

Minimizing the use of chemical inputs via scouting is another way the vineyard team at Terra d'Oro practices sustainability. Each of the winery's more than 65 acres of vineyard is scouted weekly to evaluate the level of pests and/or fungal disease, with treatment determined on an as-needed basis, according to infestation levels and proximity to harvest.

When treatment is necessary, Terra d'Oro uses the Pesticide Environmental Assessment Scheme (PEAS) established by the Lodi Rules for Sustainable Winegrowing, which assigns environmental impact values to agrochemical inputs. In order to be certified under Lodi Rules, the winery always selects materials with low PEAS values.

THE CALIFORNIA SUSTAINABLE WINEGROWING ALLIANCE (CSWA) program has broad industry participation with 1,800 wineries and vineyards, representing 72% of California's winegrape acreage and 74% of the state's case production, which have evaluated their operations with CSWA's Code workbook.

In 2010, CSWA added voluntary Certified California Sustainable Winegrowing (CCSW), which requires an annual assessment, meeting 58 prerequisites and doing a third-party audit. Fifty-six wineries and 178 vineyards are CCSW-Certified with more applications in process. See: www.sustainablewinegrowing.org.

WIES: Energy Efficiency Resource

Stags' Leap Winery is one of over 150 wineries (including Francis Ford Coppola Winery) enrolled in the Wine Industry Efficiency Solutions (WIES) Program. Providing energy efficiency engineering services and incentives to qualifying wineries that receive gas or electric service from PG&E, WIES is sponsored by PG&E and administered by Resource Solutions Group.

WIES offers wineries custom technical service, education and support which identifies upgrades that reduce operating expenses, improve efficiency and help meet sustainability goals. Project evaluation can begin with a comprehensive audit or be isolated to a specific system depending on the winery's priority and schedule.

See: www.wiesprogram.com, email WIES@rsgrp.com or call the Resource Solutions Group, 650/726-7628.

Efficient lighting helped reduce energy usage per gallon by 18%.

Energy and Cost Savings Go Hand in Hand at Stags' Leap Winery

ALTHOUGH STAGS' LEAP Winery is one of California's oldest wineries, dating back to 1893, this Napa Valley estate winery is thoroughly modern when it comes to energy conservation.

STAGS' LEAP PHOTOS

Dissolved oxygen sensors on process water aerators ensure operation only when needed.

"One of the guiding principles of our corporate social responsibility platform is to use as little as we need, as efficiently as we can," says Scott Curwood, Senior Manager, Environment and Sustainability for Treasury Wine Estates, which owns Stags' Leap Winery.

From 2007 to 2011, Stags' Leap's energy usage per gallon of wine processed was reduced by 18%, both lowering greenhouse gas emissions and saving costs. The winery already had a good track record with about 70% of its electricity coming from its solar panel installation, but the reduction in total power used per gallon was a fantastic outcome.

To achieve it, the facility upgraded to more efficient lighting, installed variable frequency drives on motors and placed dissolved oxygen sensors on wastewater aerators to ensure operation only when needed.

Solar panels supply about 70% of the winery's electricity needs.

Upcoming projects include additional lighting and refrigeration control upgrades. Stags' Leap works with PG&E and the Resource Solutions Group as part of the WIES program to identify conservation and cost saving opportunities and rebates.

Stags' Leap's vineyard received CCSW certification in 2012 and the winery has a target to reduce energy and water usage by a further 30% over the next three years. "The '30 in 3' program is a company-wide initiative that gives our people a goal and a good rallying cry," says Curwood. "We're already making good progress."

"We want a winery that makes less of an environmental footprint, and speaks about the quality of the wine and our vision for the future."

JOHN DYSON, PRESIDENT, WILLIAMS SELYEM

Video Case Studies Show Sustainability in Action

CSWA VIDEOS offer case studies that demonstrate how California wineries gain environmental benefits and cost savings, often through PG&E rebate and incentive programs. See: www.pge.com/mybusiness/energysavingsrebates/incentivesbyindustry/agriculture. Videos can be viewed online at: www.sustainablewinegrowing.org/media.php.

Solar Hot Water System at Williams Selyem

The solar hot water system cuts propane use to heat the water at the winery for sanitation and other purposes.

Korbel Champagne Cellars Process Water Ponds Efficiency Measures

A new aerator system increased energy efficiency, saved money, reduced CO2 emissions and improved water quality.

Saving Energy with High Speed Roll-up Doors at J. Lohr Vineyards & Wines

The winery saved over 32,000 kilowatt hours and 20,000 lbs. in CO2 emissions per year through the installation of two high-speed roll-up doors in their barrel rooms.

Jordan Vineyard & Winery Energy Efficiency Measures

Jordan used refrigeration efficiency measures, pipe insulation and other sustainability strategies.

Wetlands Stewardship at Turner Road Vintners

Turner Road Vintners provides wetlands habitat for local wildlife and employee enjoyment, while improving water quality and conservation through process water ponds and wetlands restoration efforts.

Imagery Estate Winery: Energy Efficiency and Variable Frequency Drives

Variable frequency drives on glycol pumps increased the energy efficiency of the refrigeration system, saving costs and reducing CO2 emissions.

Gallo Vineyards: Water Efficiency in the Vineyards

Gallo Vineyard used various elements of infrastructure to contribute to energy and water efficiency in the vineyard, including source meters, regular testing of equipment, and uniformed distribution.

Building an Energy Efficient Winery at LangeTwins Family Winery & Vineyards

The winery received design assistance and cost savings to build and expand an energy efficient winery.

Get Ready for "California Wines: Down to Earth Month" in April

Wineries and regional associations are encouraged to plan a green-themed consumer event or immersion experience to offer during the "California Wines: Down to Earth Month" celebration the entire month of April 2013. Wine Institute created the campaign to highlight California's leadership in adopting sustainable and other green winegrowing and winemaking practices. The goal is to inform consumers, media, trade and policy leaders about California's commitment to environmental stewardship, high quality wine and community education.

The collective event offerings will be given exposure through websites, social media and publicity. Contact communications@wineinstitute.org or 415/356-7520.

CSWA is a 501(c)3 nonprofit organization established in 2003 by Wine Institute and the California Association of Winegrape Growers. For information, contact 415/356-7525 or communications@wineinstitute.org.

WINE INSTITUTE

CALIFORNIA ASSOCIATION of WINEGRAPE GROWERS

Biodiversity in Vineyards Workshop

Saturday, February 23, 2013
Santa Cruz Mountains

CALIFORNIA
SUSTAINABLE WINEGROWING
ALLIANCE

Table of Contents for Workshop Resources USB Drive

Biodiversity Conservation Practices

- **Biodiversity Conservation An Organic Farmers Guide**, Wild Farm Alliance. Provides background and information on practices that support biodiversity.
- **Biodiversity Conservation Practices in California Vineyards: Learning from Experiences**, California Sustainable Winegrowing Alliance (CSWA). Specific biodiversity conservation practices are examined in several northern California vineyard locations.
- **Biodiversity: What it is, and How to Increase it on your Farm**, Wild Farm Alliance and Community Alliance with Family Farmers. Describes specific practices that farmers can implement to conserve biodiversity on their farms, including cost-share opportunities.
- **BIODIVERSIDAD¿QUÉ ES? Cómo Incrementarla En Su Ranchosources**, Wild Farm Alliance and Community Alliance with Family Farmers. (Spanish version of the Biodiversity: What it is, and How to Increase it on your Farm)

Code of Sustainable Winegrowing Workbook

- 3rd Edition California Code of Sustainable Winegrowing Workbook PDF. Includes all self-assessment workbook chapters, including Chapter 8 Ecosystem Management.

Hedgerows & Wildlife Corridors

- **Establishing Hedgerows on Farms in California**, University of California Agriculture and Natural Resources. Covers how to establish a hedgerow including site selection, planning, preparation, and management.
- **Hedgerows for California Agriculture**, Community Alliance with Family Farmers. Covers how to choose and care for regionally appropriate plants that attract beneficial insects and prevent erosion, and lists native plant nurseries and consultants/contractors specializing in hedgerow and other restoration projects.
- **Wildlife Corridors and Habitat**, Wine Institute. Case studies at California vineyards on preserving grasslands and wetlands, creek restoration, and conserving marshland.
- **Establishing Hedgerows for Pest Control and Wildlife**, Yolo County Resource Conservation District.

Sheep & Animals

- **Babydoll Sheep Integrate Wine Country**, By Deb Kiger. A case study with results and lessons learned from using sheep at Kiger Family Vineyards.
- **Sheep in Organic Vineyards**, Western Sustainable Agriculture Research & Education (WSARE). Organic Vineyard/Orchard Weed and Grass Management Using Miniature Sheep project summary report.
- **Using Animals to Manage Pests in Vineyards**, Wine Institute. Case studies from California vineyards on the use of dogs, falcons, and chickens.

Communicating Sustainability

Integrating Sustainability into Communications Strategies

Integrating sustainability into a vineyard and/or winery's communication strategy is similar to any successful communications campaign.

- Establish objectives
- Develop key messages
- Determine target audiences
- Develop tactics to reach them

Following are some guidelines and ideas for incorporating sustainability messages into your communications strategy.

Establish Objectives

Before embarking on a campaign, think about what you want to achieve and what you want your audiences to know about your vineyard, winery and brand. Is *Sustainability* part of your brand's core identity, or are there other, more important, attributes to communicate first? Thinking this through will help determine the extent to which you use sustainability messages in your communications.

Take an Audit

Make a list of what your vineyard and/or winery is doing in the area of sustainability practices. Talk to your vineyard manager(s), winemaker(s), engineer(s), etc. and catalogue what is being done. Have them explain the practices to you in laymen's terms so that they can easily be conveyed to others. Find out if your vineyard and/or winery has any sustainability certifications. Make sure you understand the rules associated with using certification language, logos, seals, etc.

Develop Key Theme/Messages

Develop an "umbrella" message about your vineyard and/or winery's overall philosophy regarding sustainability, and back it up with a list of supporting messages about specific practices. Your overall message may be in the form of a mission statement, details about practices being used by your winery and vineyard, or focus on a specific certification with supporting messages about how the winery/vineyard earned that certification. Having these key themes and messages in one place will give you material from which to draw when you are creating brochures, videos, website content, etc.

Consider developing a tag line or quote to be used on your website, in trade materials, on shippers, etc. The tag line could reference your winery's commitment to earth-friendly farming or could be a quote about how sustainability and multi-generational businesses go hand-in-hand. Alternatively, you may have a recurring message on various pieces of collateral that simply refers people to your website where they can find more information about your sustainable practices.

Determine Audiences and Messages

Think about the various audiences that might be interested in learning about the vineyard and/or winery's sustainable practices. Then, determine the specific messages that will resonate with each audience. For instance, a visitor to the winery may be interested to know that your landscaping is watered with recycled water (you might consider a sign), while a winemaker dinner attendee may be interested to know that the menu is printed on recycled paper. A wine writer may want to know that you've switched to a lighter weight bottle; a local newspaper or radio station may report on what your vineyard is doing to save water. Here are audiences to consider:

Internal	All Staff, including Tasting Room
Consumers	Winery Visitors, Tasting/Winemaker Dinner Attendees, Website Visitors, Social Media Engagers
Trade	Buyers, Distributors, Brokers, Retailers, Restaurateurs
Media	Wine, Local/Community, Lifestyle

Determine Touchpoints/Communication Vehicles

Finally, think of the vehicles you use to communicate with each audience, and determine if and how to include a sustainability message in the communication. For example, make sure internal audiences are kept apprised of the vineyard/winery's sustainability practices via company meetings, or perhaps periodic vineyard and winery tours with the vineyard manager and/or winemaker. Include sustainability messages in consumer-facing vehicles, such as the website, brochure, or tasting cards/sheets used at tastings. Here is a list of vehicles, by audience, that can be used to communicate sustainability news and messages:

Internal	Company Meetings, Tours, Announcements, Emails (and email signatures), Social media
Consumer	Websites, Brochures, Tasting Cards, Maps, Vineyard/Winery Signage, Social media, Videos, Eco-tours
Trade	Presentations, Case Cards, Shelf Talkers, Neck Hangers, Shippers, Labels, Brochures, Tech/Fact Sheets, Website, Social media, Videos
Media	Press releases*, Press materials, Boilerplates, Website, Social media, Videos

*A note about press releases: a press release should only be considered when a newsworthy event has occurred. This might be when a certification has been earned, or when the winery has invested in a process or piece of equipment that has a substantial impact on the winery's environmental footprint.

Opportunities for Participating in California Sustainability Communications
Expand the reach of your sustainability story through statewide promotional opportunities.

Down to Earth Month
Wine Institute is hosting the 2nd annual **"California Wines: Down to Earth Month"** celebration in April to highlight the sustainable and green commitment of California vintners and growers. A toolkit was developed to help member wineries and regions participate in the Wine Institute's coordinated campaign of publicity, website features, social media and legislative outreach available at http://www.discovercaliforniawines.com/files/Down_to_Earth.html). Last year's inaugural "Down to Earth Month" celebration generated 108 million audience impressions through 400 media outlets, many of which promoted winery and regional association events that were posted at www.discovercaliforniawines.com/d2e. To be part of the 2013 campaign, submit winery activities (Wine Institute members and regions only) to http://www.discovercaliforniawines.com/event-submission/ through April. For further information, contact communications@wineinstitute.org.

Discover California Wines Campaign
Green and sustainably focused events and activities can be promoted year-round on Wine Institute's global consumer website http://www.discovercaliforniawines.com/. Sustainability is one of the key themes in California First and Discover California Wines global marketing communications, events, and materials. The website has a Winery Finder that allows visitors to search for Wine Institute member wineries by region and amenities that include CSWA participation, CCSW-Certification and Sustainable/Organic/Biodynamic. Update your winery profile (Wine Institute members only) at
http://www.discovercaliforniawines.com/winery-submission/.

Case Studies and Practices
Wine Institute and California Sustainable Winegrowing Alliance are always looking for sustainability stories and photos for the quarterly Highlight Newsletter, media opportunities, news releases, social media posts on Facebook, Twitter and Pinterest, practice-specific fact sheets (such as solar powered wineries), videos and other public relations needs. Please submit case studies, information on activities and photos to communications@wineinstitute.org.

Visit California
Wine Institute works with California's statewide tourism association, Visit California, on a global basis to promote California wine and food. Visit California has an industry portal where wineries or vineyards can submit information about their green destination, activities and events. The information is used for media opportunities, news releases and the organization's "What's New in California" newsletter. Post events and information at
http://industry.visitcalifornia.com

Attachment B – Targeted Education Events List and Sample Agendas

March 1, 2011 - Grape Grower Tailgate Meeting - Shafter
March 2, 2011- Grape Grower Tailgate Meeting - Madera
March 3, 2011 - Grape Grower Tailgate Meeting - Modesto
March 22, 2011- Livermore Valley Grower Tailgate Meeting
April 26, 2011 - Grape Grower Tailgate Meeting - Visalia
April 27, 2011 - Grape Grower Tailgate Meeting - Madera
April 27, 2011 - Water & Energy Efficiency Workshop - Paso Robles
April 28, 2011 - Grape Grower Tailgate Meeting - Ceres
May 6, 2011 - Irrigation Workshop - Lake County
June 21, 2011 - Water & Energy Workshop - Livingston
July 19, 2011 - Ecowinegrowing Symposium - Hopland
July 20, 2011 - Ecowinegrowing Workshop - Hopland
August 10, 2011 - Sustainable Winegrowing Field Day - Sonoma County
November 17, 2011 - Lake County Sustainable Winegrowing Seminar - Lakeport
December 7, 2011 - Winery & Vineyard Water & Energy Efficiency Workshop - Santa Ynez
March 6, 2012 - Sustainable Winegrowing Tailgate - San Joaquin Valley
March 7, 2012 - Sustainable Winegrowing Tailgate - San Joaquin Valley
March 8, 2012 - Sustainable Winegrowing Tailgate - San Joaquin Valley
March 21, 2012 - Environmentally Preferable Purchasing Workshop - Napa
April 18, 2012 - Performance Metrics Workshop - Lake County
May 1, 2012 - Sustainable Winegrowing Tailgate - Visalia
May 2, 2012 - Sustainable Winegrowing Tailgate - Madera
May 3, 2012 - Sustainable Winegrowing Tailgate - Manteca
May 9, 2012 - Environmentally Preferable Purchasing Workshop - Paso Robles
August 3, 2012 - Performance Metrics Workshop - Paso Robles
August 9, 2012 - Sonoma Sustainable Winegrowing Field Day – Santa Rosa
January 16, 2013 - Cost-Effective Purchasing Workshop - Manteca
February 20, 2013 - Cost-Effective Purchasing Workshop - Santa Rosa
February 21, 2013 - Sustainable Winegrowing Workshop - Lake County
February 23, 2013 - Biodiversity Conservation Practices - Santa Cruz Mountains
March 5, 2013 - Grower Educational Tailgate - Bakersfield
March 6, 2013 - Grower Educational Tailgate - Madera
March 7, 2013 - Grower Educational Tailgate - Ceres
March 26, 2013 - Communicating Sustainability – San Francisco
March 28, 2013 - Sustainability and Performance Metrics Workshop - Napa
April 11, 2013 - Community Relations Workshop - Santa Rosa
April 16, 2013 - Dry Farming Winegrapes - Plymouth
April 30, 2013 – Sustainable Grape Tailgate - Wasco
May 1, 2013 - Sustainable Grape Tailgate – Fresno
May 2, 2013 - Sustainable Grape Tailgate – Hughson
May 14, 2013 - Sustainability Workshop - Temecula
May 15, 2013 - Sustainability Workshop - Ramona
June 26, 2013 - Water Efficiency Bus Tour – Sonoma County

LIVERMORE VALLEY
Wine Country
Grower Tailgate

March 22, 2011
8:30am – Noon

Crooked Vine Winery
4948 Tesla Rd., Livermore CA

TOPIC: Irrigation Decision Making & New Pest Threats*
Hosted by the California Sustainable Winegrowing Alliance, University of California Cooperative Extension, and the Livermore Valley Winegrowers Association.

AGENDA

8:30 AM	**Registration & Refreshments (Bagels and Coffee)**
9:00-9:45	**Soil Sampling in Winegrapes – Procedures & Interpreting & Applying Results** *Presenters: Michael Princevalle and Bryan Rahn, Coastal Viticultural Consultants*
9:45 – 10:15	**Vine Nutrition – Needs and Management** *Presenter: Janet Caprile, University of California Cooperative Extension*
10:15 -10:45	**Mitigating Erosion and Runoff from Vineyards** *Presenter: Kent Reeves & Morpheus Anima, Alameda Country Resource Conservation*
10:45-11:00	**Break**
11:00-11:30	**Air Quality Issues and Resolutions** *Presenter: Lucinda Roth USDA/Natural Resource Conservation Services*
11:30-12PM	**Sustainable Winegrowing Program Certification and Metrics** *Presenters: Lisa Francioni, CA Sustainable Winegrowing Alliance and Joe Browde, SureHarvest*

** This Grower Tailgate is funded in part by a grant from the CA Department of Food and Agriculture*

March 2011 Grape Grower Tailgate Meetings

Sponsored by San Joaquin Valley Winegrowers Association & California Sustainable Winegrowing Alliance
Funded in part by grants from USDA RMA & CDFA

Tuesday, March 1	Wilson Ag 29736 Fresno Avenue Shafter, CA 93263
Wednesday, March 2 (Sponsored by: Rain for Rent)	Mission Bell Winery 12667 Rd 24 Madera, CA 93637
Thursday, March 3	Wend-Tyler Winery 8737 Shoemake Avenue Modesto, CA 95358

<u>AGENDA (identical per date)</u>

9:00 a.m.	**Registration and Introduction** Peter Vallis, San Joaquin Valley Winegrowers,
9:10 – 9:40 a.m.	**Powdery Mildew & Wet Spring Fungicide Needs** Kip Green, Britz, or Jim Alfieri, Wilbur-Ellis or Joe Graff, Superior Pest
9:40 – 10:10 a.m.	**Air Quality Update: PM10, Trucks, Tractors & More** Lucinda Roth, USDA NRCS
10:10 – 10:30 a.m.	**Sustainable Winegrowing & Metrics – An Update** Lisa Francioni & Joe Browde CSWA
Break	
10:40 – 11:10 a.m.	**Early Grape Market Update** The Ciatti Guys
11:10 – 11:40 a.m.	**PG&E- Time Varying Pricing & Energy Saving Tips for Vineyards** Greg Race or Stuart Chase, PG&E
11:40 – Noon	**What OSHA is looking for and info on Recent Citations** Bill Krycia, OSHA Code Enforcement, Guest of United Valley Insurance
Noon-12:30 p.m.	**On Vineyard Sustainable Pest Management Procedures and Practices** Host Grower

The Famous SJVWA Gourmet BBQ Lunch to Follow

1.0 Hour of Continuing Education Credits for Pesticide Applicators and PCAs

To RSVP or for more information contact San Joaquin Valley Winegrowers at:
559-618-1856 or info@sjvgrapes.org

Paso Robles Winery & Vineyard
Water & Energy Efficiency Workshop
Wednesday April 27, 2011
J. Lohr Winery
Paso Robles, CA

Co-sponsored by **California Sustainable Winegrowing Alliance** and **PG&E**
with funding from CDFA

Partnering organizations: Paso Robles Wine Country Alliance, Central Coast Vineyard Team, Wine Institute, and the California Association of Winegrape Growers

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7:30	**Registration and continental breakfast**
7:45am	**Energy Efficiency and Water Use Self Assessment** If you haven't assessed your energy and water use, this is the opportunity to check your current practices against the Sustainable Winegrowing Program chapters on water use and energy efficiency. Find out how you rank against regional and statewide averages.
8:45am	**Multiple Benefits of Water Conservation** Every gallon of water saved in the production of wine saves energy and contributes to the reduction of greenhouse gas emissions. Learn about how to calculate and track this important and valuable information. **John Garn, CSWA**
9:15am	**Paso Robles Groundwater Management** As resource issues become more imperative due to natural and manmade factors (financial, drought, regulatory, climate change, etc.) it is increasingly more important for public and private entities to work cooperatively to create solutions. Hear how the industry and government partners are working together on Groundwater Management. **Lisa Bodrogi, Government Affairs Coordinator, PRWCA** **Keith Larson, Public Works, City of Paso Robles**
10:15am	**Break**
10:30am	**Partnering for Energy Efficiency** Information on PG&E's online web services, free energy audits, incentive programs, equipment rebates, Savings By Design, technical support services and other resources for winery and vineyard customers. **Tom Lorish, Account Executive, PG&E**
11:00am	**Winery Tour** Walk through J. Lohr Winery to look at areas of opportunity and measures already implemented for water conservation and energy efficiency. **Steve Lohr, Ex VP/COO Vineyards, J. Lohr Vineyards & Winery** **Jeff Zucker, Safety and Env. Coordinator, J. Lohr Vineyards & Winery**
12:15pm	**Water and Energy Efficiency Opportunities** Facilitated discussion about actions other wineries can take to conserve water and become energy efficient. **John Garn--CSWA**
12:30pm	**Lunch**
1:30pm	**Adjourn**

The Lake County Winegrape Commission
&
The California Sustainable
Winegrowing Alliance
Present:

Getting Ready for the Irrigation Season

May 6, 2011, 9:00 a.m.-12:30 p.m.
Big Valley Grange, 1510 Big Valley Rd. Lakeport

This meeting will cover several ways that you can improve irrigation system maintenance and scheduling in order to save water, save money, and continue to grow high quality winegrapes.

AGENDA

9:00-9:30 a.m. Registration, coffee and pastries.

9:30-9:45 a.m. Welcome by Shannon Gunier, LCWC President, and Lisa Francioni, California Sustainable Winegrowing Alliance, will provide a brief update on the Sustainable Winegrowing Program.

9:45-10:15 a.m. Tim Goetz, Wyatt Irrigation Supply, will cover irrigation system maintenance, including how to recognize, prevent, and treat sources of clogging.

10:15-10:45 a.m. Tim Goetz, Wyatt Irrigation Supply will discuss using flow meters to improve irrigation effectiveness and save money. Different types of flow meters, installation considerations, and how to utilize the numbers from flow meters will be discussed.

10:45 - 11:15 a.m. Dr. Erica Lundquist, Natural Resources Conservation Service, will show how to find irrigation related information from the local network of weather stations, and how to use evapotranspiration (ET) numbers as part of your approach to irrigation scheduling.

11:15 a.m.- 12:00 noon. Bryan Rahn, Coastal Viticultural Consultants, will discuss irrigation scheduling to maximize winegrape quality while keeping water use and pumping costs to a minimum. He will cover methods of soil moisture and plant water status monitoring and how to use these measures along with ET numbers for irrigation scheduling.

12:00 noon- 1:00 p.m. Lunch will be provided on site.

** This meeting is funded in part by a grant from the CA Department of Food and Agriculture*

Eco-winegrowing Symposium - July 19-20, 2011

Brutocao Schoolhouse Plaza, 13500 S Hwy 101, Hopland, CA

GET CURRENT INFORMATION ON GREEN PRACTICES FOR WINERIES AND VINEYARDS

REGISTER ONLINE: www.mendowine.com

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Agenda for Day 1

7:30 Registration, coffee, pastries
8:00 **Welcome and Introduction** - Megan Metz, MWWC, Glenn McGourty, UCCE, Ann Thrupp, moderator
8:15 **Energy challenges and opportunities**
Energy efficiency in wineries and vineyards - Clem Lee, PG&E
Examples of Green energy innovations – solar installations and others:
Mike Lukan, Chief Financial Officer, Sonoma Wine Co
Russ Fish, Assistant Winemaker, Kunde Winery
9:30 **Water challenges and opportunities in wineries**
Waste water treatment and reuse in wineries and vineyards – Bob Chrobak, Kennedy Jenks0
Example of wetlands waste water recycling system - Tim Thornhill, Mendocino Wine Co
Innovative water conservation measures (Water harvesting and more) – Roger Boulton, UC Davis
10:40 **Break**
11:00 **Ecosystem services and Carbon policy & market** – Is there an opportunity for added value?
Update on important wine industry initiatives - Andrew Arnold, Sure Harvest
Current Policy Issues related to climate change & renewable energy - Renata Brillinger, CalCAN
12:15 **Lunch**
12:45 **Keynote speaker**
Secretary Karen Ross, Secretary of California Department of Food and Agriculture
1:30 **Grower dialog** - panel discussion on Challenges & Solutions for becoming more "green" in vineyards
Pat Rogers, Tyler Nelson, Dave Koball, Naomi Olvera, with Glenn McGourty, UCCE, Moderator
2:40 **"Green" Wine Market trends and communication**
Robert Boller, Jackson Family Wines
Ann Thrupp, Fetzer & Bonterra vineyards
Susan Orenstein, Marketing consultant
3:40 **Break**
4:00 **Update on "green" certification programs** – sustainability and beyond in the wine industry
Lisa Francioni, California Sustainable Winegrowing Alliance
4:30 **Keynote speaker**
Congressman Mike Thompson, US Congress
Q&A and Discussion
5:15 **Reception**
6:30 **Closing** ***(See back page for field workshop on morning of June 20 & registration form)***

Day 2 of Ecowinegrowing Symposium - Vineyard Workshop

Solutions for Water Scarcity?
Dry Farming and Water Conservation Methods

July 20, 2011 7:30 to 11:30 am
Dark Horse Vineyards, 5341 Old River, Rd, Ukiah

Organized by MWWC, UCCE, CSWA, and Community Alliance with Family Farmers

Agenda

7:30 am	Coffee and pastries
8:00 am	Introduction & purpose – Glenn McGourty, UCCE, Rich Schaefers, MWWC, Pat Rodgers, MWWC
8:10 am	Dry Farming and water management practices at Dark Horse Overview by Jason or Heath Dolan, Dark Horse
8:40	Walking tour in vineyard, Q&A, discussion among growers
9:15	Dry Farming insights from Sonoma county and Mendocino County Joe Votek, Loma Del Sol Vineyards Terry Harrison, Community Alliance with Family Farmers John Chiarito, Chiarito Vineyards Q&A, discussion
10:30	Update on Water issues & urgency of water conservation approaches Devon Jones, Director, Mendocino Farm Bureau
11:00	Overview of regulated deficit irrigation and water monitoring methods Glenn McGourty, UCCE, Demo of practical application of “pressure bomb”
11:30	Depart

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REGISTRATION FORM FOR ECOWINEGROWING SYMPOSIUM - JULY 19-20,1011

Name ________________________________ Company/Organization __________________________

Mailing Address: ____

Email address: __________________________________ Phone ________________________

SEND to: Mark Stern, MWWC, 525 South Main St, Ukiah, CA 95482

Environmentally Preferable Purchasing Workshop
When: March 21, 2012
Where: Robert Mondavi Winery

Sponsored by **California Sustainable Winegrowing Alliance**

This workshop is funded in part by a grant from the California Department of Food and Agriculture

Partnering organizations: **Napa Valley Vintners, Wine Institute**, **and the California Association of Winegrape Growers**

8:00am **Registration and continental breakfast**

8:30 am **Paying to Throw it Away**

What if you could save 10 or 15 cents, or more, off the cost of every case of wine? How would that impact your business? There are many elements to the full cost of wine packaging, including the unwanted materials that come with your supplies. Learn how to close the loop and save money at the same time.

John Garn, Project Consultant, CSWA

8:50 am **Recycled Facts**

What is the difference between what is technically "recyclable" and the materials that are actually recycled? Learn the facts about the percentage of recyclable materials that are actually recycled, where these materials end up, and varying amounts of recycled content in glass, paper and packaging materials. Includes ideas for working with vendors on product take back, and enhancing recycling among smaller wineries.

Panel: Steve Botic, Senior Environmental Engineer, Robert Mondavi Winery
Tim Dewey-Mattia, Public Education Manager, Napa Recycling & Waste Services

9:30am **Focus on Glass**

Bottles are a clear place to start an EPP review of wine packaging. Learn how one company tackled the transition to a lighter glass solution with an EPP assessment. Considerations include shape/weight/punt, carbon footprint, current recycled content, sourcing and quality control. Weigh the costs and benefits of bottle reuse versus sourcing new bottles (whether domestically or internationally).

Panel: Ann Thrupp, Manager of Sustainability and Organic Development, Fetzer Vineyards
JP Giovanni, President, Saverglass

10:10 am **Break**

10:20am **Beyond the Bottle**

Bottle presentation includes the choice of closures, capsules and labels. Explore the environmental implications of screw caps, corks, tin/aluminum/plastic/glass capsules and different label alternatives. One of the most important partners in the "green supply chain" is your printer. Learn about green printing and labeling.

Panel: Natasha Granoff, VP Business Development, Sonoma Wine Company
Jason Grossman, President, Paragon Label

11:00am **Packaging and Transport**

Greening the production chain from "ground to glass" needs to include packaging materials and boxes. Get the latest on sustainable packaging alternatives, including issues such as temperature, weight, safety, durability, fuel use and carbon footprint. Find out what's going on with alternatives to the box.

Panel: David Dobrow, Wine Team Customer Support, FedEx
Erik Harvey, Integrated Proof Systems

11:40am **Perception v. Proof**

While environmental benefits can be achieved with lighter bottles and recycled content glass, paper and packaging, no winery wants to lose customers due to changes in wine presentation. What are the potential concerns, and what are consumers really looking for?

Panel: Amy Hoopes, VP Marketing, Wente Family Estates
Marie Gewirtz, President, Marie Gewirtz Marketing & Public Relations

12:20pm **Lunch**

Catered by Robert Mondavi Winery--with brief presentation from chef on where the meal came from and how it was it sourced.

1:00-2:00 pm **Visit supplier booths to learn more**

May 2012 Grape Grower Tailgate Meetings

Sponsored by San Joaquin Valley Winegrowers Association
& California Sustainable Winegrowing Alliance (CSWA)
Funded in part by grants from USDA RMA & CDFA
Lunch Sponsors: The Deerpoint Group & Cal West Rain

Tuesday, May 1	Shannon Ranch Corner of Shirk Road and Ave. 320 Visalia, CA 93292
Wednesday, May 2	Bapu Farms 18704 Ave. 19 Madera, CA 93637
Thursday, May 3	San Joaquin Delta College Farm 5298 Brunswick Rd. Manteca, CA 9533

Cal West Rain
Irrigation Services Pipelines Pumps Engines
(559) 846-5326

<u>AGENDA (identical per date)</u>

9:00 a.m.	**Registration and Introduction** Peter Vallis, San Joaquin Valley Winegrowers Associations
9:10 – 9:40 a.m.	**Health Care Update & Issues (Laws and Regulations)** Patti Oliver, United Valley Insurance
9:40 – 10:10 a.m.	**Vine Nutrition and Pesticides** Arthur Chavez, Mc Manis Family Vineyards, or PCA alternate
10:10 – 10.40 a.m.	**The Grape Market Today** Gary Agajanian, Agajanian Vineyards Jeff Bitter, Allied Grape Growers
10:40 – 11:10 a.m.	**Crop Insurance Issues** Rain & Hail Insurance Services
11:10 – 11:40 a.m.	**News in Solar Uses and Power Rates for Farms** SCE and/or PG&E
11:40 – 12:10 a.m.	**Farm Labor and You (including Law and Regulations)** Guadalupe Sandoval, California Farm Labor Contractor Association

The Famous SJVWA Gourmet BBQ Lunch to Follow

1.5 Hours of Continuing Education Credits for Pesticide Applicators and PCAs Applied For

To RSVP or for more information contact San Joaquin Valley Winegrowers Association at:
559-679-0836 or pam@idrinkwine.net

CALIFORNIA
SUSTAINABLE WINEGROWING
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Paso Robles
Performance Metrics Workshop

Friday, August 3, 2012

Paso Robles Inn - Matador Room
1103 Spring Street, Paso Robles
8:30am-12:00pm

Agenda:

8:30 Registration

8:45 Welcome, Introductions, and SWP Overview, Lisa Francioni, CSWA

9:00 What are Performance Metrics and CSWA 's Initial Metrics, Lisa Francioni, CSWA

9:30 J. Lohr Winery Testimonial, Jeff Zucker, J. Lohr Vineyards and Wines

9:45 Live Demonstration of SWP Online System (Practices & Metrics), Andrew Arnold, SureHarvest

10:15 Group Hands-On Exercise Using Metrics Calculators

10:45 Break

10:55 Group Metrics Discussion, Andrew Arnold, SureHarvest

11:15 Energy Efficiency Rebate and Incentive Programs for Wineries and Vineyards, Tom Lorish or TBD, PG&E

11:45 Wrap-up

12:00 LUNCH

Sustainable Winegrowing Field Day

August 9, 2012 ♦ Santa Rosa Junior College's Shone Farm

7:30-7:55	Registration, check-in & CEU sign-up Coffee & pastry sponsored by Wilbur-Ellis
7:55	Welcome by Nick Frey, President Sonoma County Winegrape Commission
8:00 – 8:30	IPM Season Highlights – Discussion of grower IPM practices in 2011– Laura Breyer, Breyer IPM Vineyard Service EBSN Trial Report – Laura Breyer
8:30 – 9:30	**Overview of CSWA Carbon Projects and Sustainable Winegrowing Programs** – Allison Jordan, California Sustainable Winegrowing Alliance **Assessing and Improving Vineyard Greenhouse Gas Footprints** – Dr. David Smart, UCD Viticulture & Enology **Performance Metrics/GHG and Small Grower Certification Pilot Program** – Lisa Francioni, California Sustainable Winegrowing Alliance
9:30-10:00	**SARE Grant/Water Management Presentation**: educational component topic on irrigation management and water conservation – Dr. Mark Greenspan, Advanced Vit
10:00-10:50	**Scientifically Addressing Spray Coverage**: doing the best with traditional technology and what's new – **Dr.** Dr. Franz Niederholzer, Farm Advisor Orchard Systems UCCE
10:50-11:20	**Break and table displays by agencies** – refreshments hosted by Wilbur-Ellis
11:20-12:10	**Breeding PD Resistant Winegrapes**: PD resistant winegrapes are now ready for field and wine testing. The history of their development will be presented as well as wines from selections with 50%, 88%, 94% and 97% vinifera parentage. The next phase of breeding and field evaluation will also be discussed. – Dr. Andy Walker, UCD
12:10-1:30	Lunch sponsored by California Sustainable Winegrowing Alliance

Biodiversity in Vineyards Workshop

Saturday, February 23, 2013
9:00am – 1:00 pm

Loma Prieta Community Center
Santa Cruz Mountains

Partnering Organizations: Viticulture Association of the Santa Cruz Mountains and California Sustainable Winegrowing Alliance

Funding provided by CDFA

Agenda:

9:00 **Welcome**, Mary Lindsay, VASCM & Lisa Francioni Hai, CSWA

9:10 **Managing Habitat to Encourage Beneficial Species**, Kent Reeves, The Whole Picture

10:00 **Biodiversity Conservation Practices in the Vineyard**, Ann Thrupp, Manager of Sustainability and Organic Development at Fetzer and Bontera Vineyards

10:45 **Break**

10:55 **Implementing Conservation Practices using Cost-Share Programs**, Rich Casale, District Conservationist, NRCS, Santa Cruz County

11:25 **Ecosystem Management in the California Code of Sustainable Winegrowing Workbook Session**, Lisa Francioni Hai, Program Manager, California Sustainable Winegrowing Alliance

12:10 **Sheep Grazing for Weed Management Case Study and Resources**: Steve Storrs, owner, winemaker, Storrs Winery and Vineyards and Alison Charter-Smith, Madrone Coast Farms

12:30 **Lunch**

Communicating Sustainability Workshop

San Francisco City Club & via Webinar
Tuesday, March 26, 2013
10:00 am -12:30 pm

Partnering organizations: California Sustainable Winegrowing Alliance, Wine Institute, & the California Association of Winegrape Growers

Agenda

9:30 **Registration and Coffee**

10:00 **Welcome and Introductions**
- *Nancy Light, Wine Institute*

10:15 **The Market for Sustainably Produced Wine**

- Results from two new research studies of wine consumers and trade
  - *Allison Jordan, Executive Director, California Sustainable Winegrowing Alliance (moderator)*
- Panel discussion with wine trade regarding their perceptions on sustainability in the marketplace
  - *Emily Wines, Master Sommelier and Director of Wines, Kimpton Hotels & Restaurants*
  - *Peter Granoff, Master Sommelier, Ferry Plaza Wine Merchant*
  - *Matthew Colling, CSW, Key Account Specialist, American Wines & Spirits*

11:15 **Winery Case Studies: Communicating Sustainability and Certification**

- Overview of Sustainable Winegrowing in California
  - *Lisa Francioni Hai, Program Manager, California Sustainable Winegrowing Alliance (moderator)*
- Panel discussion with wineries effectively communicating about sustainable practices and certification
  - *Michael Honig, Honig Vineyard & Winery*
  - *Cynthia Lohr, J. Lohr Vineyards & Wines*
  - *Marissa Lange, LangeTwins Family Winery & Vineyards*

12:00 **Integrating Sustainability into Communications Strategies**
- *Mora Cronin, Cronin Communications*

12:15 **Opportunities for Participating in California Sustainability Communications**
- *Nancy Light & Gladys Horiuchi, Wine Institute*

12:30 **Lunch**

CALIFORNIA
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Napa County
Hands-On Sustainability Assessment Workshop

Thursday, March 28, 2013

Napa County Office of Education
2121 Imola Avenue, Napa
9:00 am – 12:00 pm
(Lunch included)

AGENDA:

8:30	Registration & Coffee
9:00	Welcome & Introductions, Self-Assessment Overview, Online Demo - Lisa Francioni Hai, CSWA
9:40	Hands-on Online Self-Assessment of Energy and Water Chapter
10:10	Why Metrics are Important & How to Get Started - John Garn, CSWA
10:30	Metrics Online Demo
10:45	Hands-On Metrics: Set up Profile
11:00	Break
11:10	Group Discussion
11:30	Overview of Certified California Sustainable Winegrowing
12:00	Lunch

Sustainable Winegrowing Workshop

May 14, 2013

9:00 am – 3:30 pm

Registration begins at 8:30 am; Lunch included

South Coast Winery

34843 Rancho California Road, Temecula, CA

Sponsored by Temecula Valley Winegrowers Association, California Sustainable Winegrowing Alliance, Wine Institute, & California Association of Winegrape Growers

Agenda:

8:30	Sign-In and Coffee
9:00	Welcome & Introductions, *Peggy Evans, TVWA & Lisa Francioni Hai, CSWA*
9:10	Sustainable Winegrowing Self-Assessment & Certified California Sustainable Winegrowing Overview and Online Demo, *Lisa Francioni Hai, CSWA*
9:50	Ponte Family Estate Winery's Experience with Sustainability & Certification, *Claudio Ponte, Ponte Family Estate Winery & Jennifer Razo, Antea Group, CCSW-Certified Accredited Auditor*
10:15	Hands-on Online Self-Assessment of Energy and Water Chapter
10:45	Break
11:00	Why Measuring and Tracking Water, Energy and Nitrogen is Important, How to Get Started with Metrics & Online Demo, *Lisa Francioni Hai, CSWA*
11:30	Hands-on Metrics: Profile Set-Up
Noon	LUNCH
1:00	Energy Efficiency Best Practices for Vineyards & Wineries, *Caroline Lee and Bill O'Neil, Southern California Edison*
1:30	Biodiversity Conservation Practices in the Vineyard, *Ann Thrupp, Fetzer Vineyards*
2:30	Winery Water Conservation and Sanitation Best Practices, *Bob Chrobak, Kennedy Jenks*
3:30	End

Funding support by California Department of Food and Agriculture

Encouraging California Specialty Crop Growers to Adopt Environmentally Beneficial Management Practices for Efficient Irrigation and Nutrient Management

Lessons from A Producer Survey and Focus Groups

April 2013

American Farmland Trust
SAVING THE LAND THAT SUSTAINS US

Steve Shaffer
Consultant and Project Director

Edward Thompson, Jr.
AFT California Director

Encouraging California Specialty Crop Growers to Adopt Environmentally Beneficial Management Practices for Efficient Irrigation and Nutrient Management

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April 2013

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Edward Thompson, Jr.
AFT California Director

American Farmland Trust is a private, nonprofit conservation organization that works cooperatively with the agricultural community and other partners to protect farmland from development, help agricultural producers improve environmental quality and keep farmers and ranchers on the land. In California, AFT focuses on promoting more efficient urban development that reduces farmland conversion and on encouraging more widespread adoption of environmentally beneficial farm management practices. For more information, please see our web site at www.farmland.org/california.

About the Authors

Principal investigator and author Steve Shaffer is the principal in Shaffer Environmental Consulting for Agriculture and a consultant to AFT on environmental issues and practices. He was Director of the Office of Agriculture and Environmental Stewardship at the California Department of Food and Agriculture from 2000 until he retired from civil service in 2008. He began his journey in Agricultural Stewardship in 1981 after six years in the CDFA Plant Pest Diagnostics Laboratory. He is a graduate of UC Santa Barbara with a BS in Biochemistry/Molecular Biology.

Co-author and editor Edward Thompson, Jr., is the director of AFT's California office. He has worked for AFT since it was founded in 1980 and during his tenure has served as its general council, national policy director and senior vice president. Thompson is an attorney and specialist in land use and environmental policy with degrees from Cornell and George Washington University Law School. He began his career as Washington Counsel for the Environmental Defense Fund and later directed the Agricultural Lands Project at the National Association of Counties.

Specialty Crop Block Grant Program

This project is supported by a 2010 USDA-AMS Specialty Crop Block Grant (SBC 10026) administered by the California Department of Food and Agriculture. The Specialty Crop Block Grant Program supports projects that sole enhance the competitiveness of California specialty crops through a competitive solicitation in areas of Market Enhancement, Agriculture Education, Nutrition, Environmental Stewardship and Conservation, Plant Health and Invasive Species Mitigation and Food Safety. http://www.cdfa.ca.gov/Specialty_Crop_Competitiveness_Grants/

On the Cover: Julie Fallon, Soil and Water Resource Conservation Manager for the Cachuma Resource Conservation District, records flow meter readings to assure efficient irrigation water application in broccoli. Photo by Steve Shaffer.

Acknowledgements

There were many contributors to this report. In particular, the authors would like to thank the 78 specialty crop growers who took the time out of their busy schedules to share their experience with us.

The following collaborators provided invaluable support by reviewing the survey and focus group questions, identifying grower participants, providing focus group venues, assisting in recording the focus group sessions, and reviewing the draft report:

California Association of Resource Conservation Districts and participating local Resource Conservation Districts

California Farm Bureau Federation and participating county Farm Bureaus

California State University Fresno – California Agricultural Technology Institute

Western Growers Association

Central Coast Agricultural Water Quality Alliance

Kings River Conservation District

Sustainable Conservation

University of California Davis – Agricultural Sustainability Institute

United State Department of Agriculture – Natural Resources Conservation Service

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Encouraging California Specialty Crop Growers to Adopt Environmentally Beneficial Management Practices for Efficient Irrigation and Nutrient Management:

Lessons from A Producer Survey and Focus Groups

Executive Summary

Between November 2011 and June 2012, American Farmland Trust (AFT) conducted a survey and focus groups involving 78 specialty crop growers throughout California to better understand why they adopt or fail to adopt environmentally beneficial management practices (BMP) for irrigation and nutrient management. AFT seeks to promote these practices because they can result in more efficient use of scarce water resources, and reduce surface and ground water pollution and greenhouse gas emissions. We were interested in learning about the barriers growers encounter in considering the adoption of these practices and what kind of assistance would help them overcome these barriers and, thus, encourage more specialty crop growers to adopt the practices.

Our research found that the three most important grower motives for adopting new BMP are reducing production costs, improving crop yield and/or quality and improving competitiveness. Improving the environment is also important to them, but as a secondary motivation. To our surprise, regulatory requirements and the demands of buyers in the food value chain were cited less frequently as reasons for adopting BMP.

The three most important barriers to specialty crop grower adoption of BMP were the up-front costs – by a large margin – followed by risk of diminished crop yields and/or quality and, finally, lack of information about BMP or the unavailability of technical assistance. Up-front costs appear to be an especially significant obstacle because our research also found that the overwhelming majority of growers self-finance implementation of new BMP rather than seeking funding from commercial banks or government cost-share programs.

Specialty crop growers recommended that BMP adoption could be accelerated if they had better access to timely information from trusted sources concerning all aspects of irrigation and nutrient management. They are interested in the potential impacts of BMP on crop yield and quality, how easily BMP would fit into their existing operations, what equipment would be needed and at what cost, how much training would be needed for them and their field workers, what type of outside service might be required to implement BMP, how easy it would be to scale up BMP across their farming operation and what regulatory implications might be associated with adopting BMP.

To remain competitive, growers are willing to assume some financial risk associated with BMP adoption. A common risk management strategy among those who have experimented with new BMP is to apply the practices on a small scale in collaboration with technical assistance providers; then, once the grower is comfortable with the new practice and its results, expanding it to whole fields and eventually across their operation. In general, growers are unfamiliar with, but interested in, strategies that combine technical assistance with risk reduction through indemnification for potential crop yield and/or quality loss. (AFT has been pioneering risk management through its “BMP Challenge” program. See http://www.farmland.org/programs/environment/solutions/bmp-challenge.asp)

As a financial incentive to BMP adoption, growers recommend tax incentives more often than cost-share programs. They would also like to have the market recognize and reward BMP adoption, for example, through ecosystem services credits or buyer contract preferences. Finally, growers also recommend greater collaboration from regulators to reduce reporting requirements while supporting BMP adoption.

Based on what we have learned, we believe that a significant expansion of irrigation and nutrient management BMP adoption will require a broad-gauged, coordinated effort to address all of the key challenges growers face in considering whether to adopt new practices. We recommend that the California Department of Food & Agriculture, the USDA Natural Resources Conservation Service, the California Association of Resource Conservation Districts, specialty crop grower associations such as Western Growers Association and the California Grape & Tree Fruit League, and other interested parties come together to discuss the findings of this report and begin to develop a comprehensive strategy for helping growers meet the challenges they must overcome to gain confidence in BMP adoption. Specific recommendations are made for financial assistance, information and technical assistance, market recognition of environmental benefits, and risk management.

As contemplated by the Specialty Crop Block Grant under which this report was prepared, AFT will follow up with recipients of this report after its release to determine the extent to which the recommendations contained herein are being acted upon.

Introduction

California agriculture supplies more than half of the fruits, vegetables, nuts and other specialty crops consumed in the United States and a good deal of the nation's exports of these crops. The state's Mediterranean climate, one of only five such growing regions in the world, is ideal for producing these healthy foods. And California growers have taken advantage of it, along with massive public and private investments in irrigation water supplies, to increase their annual production of specialty crops to $20 billion on just 5.4 million acres of farmland (roughly 5 percent of California's land area).

This success has not come without costs. Among these are the environmental impacts of the California agriculture, in particular the impacts associated with the use of irrigation water and plant nutrients (fertilizers). As a result of the depletion of natural stream flows, ground and surface water pollution, and concern about greenhouse gases, government regulators and consumers are calling for greater accountability on the part of growers for reducing the environmental impact of agriculture.

A significant number of California growers have risen to the challenge by improving irrigation efficiency – getting more "crop per drop" – and applying nitrogen fertilizers more carefully and precisely so that less runs off into streams or finds its way into underground aquifers. But the adoption of such beneficial farm management practices is not as widespread as it could or should be if California agriculture is to continue to contribute to national food security while helping to maintain a healthy environment for all Californians.

California growers rightly pride themselves on their good stewardship of the environment. But they, too, recognize that further improvements in farm management practices are needed to assure that agriculture remains environmentally and economically sustainable. A notable example of this recognition is California Agricultural Vision, a blueprint for sustainability of the state's agricultural and food system designed by leaders of the agriculture community in collaboration with representatives of groups representing the environment, farm labor, nutrition and feeding, and other interests. (See http://www.cdfa.ca.gov/agvision/) Ag Vision identified twelve key challenges facing California agriculture and among them was the need for improved stewardship of land and water resources through wider adoption of environmentally beneficial farm management practices.

AFT's Sustainable Stewardship Initiative

Since its inception, American Farmland Trust has promoted environmentally beneficial farm management practices (BMP) as part of its mission to conserve agricultural resources. In 2009, AFT launched its Sustainable Stewardship Initiative in California to expand the use of BMP by the state's growers, as recommended by California Agricultural Vision. This initiative began with three inter-related strategies:

First, through field trials called the "BMP Challenge" AFT is demonstrating risk management tools (similar to crop insurance) to encourage the adoption of BMP that will reduce the environmental impact of agriculture while maintaining or improving profitability. http://www.farmland.org/programs/environment/solutions/bmp-challenge.asp The focus of these trials is on improving the efficiency of irrigation to stretch limited water supplies and reducing applications of plant nutrients that can be the source of ground and surface water pollution and of greenhouse gases.

Second, as a participant in the Stewardship Index for Specialty Crops (SISC), AFT is helping to design performance metrics by which to measure how well the BMP we seek to encourage are achieving actual environmental improvements when applied to California's signature fruit, vegetable and nut crops. (See http://www.stewardshipindex.org/) Increasing irrigation efficiency and reducing nutrient applications are among the goals of this exercise.

Third, AFT worked with the USDA Natural Resources Conservation Service to catalogue the types of BMP available for the leading California specialty crops and the specific environmental improvements they can achieve. We published these results in an on-line publication called *A Guide to Beneficial Management Practices for California Specialty Crops* available at http://www.farmland.org/programs/states/CA/specialty-crops-beneficial-management-practices-guide.asp It includes direct links to detailed descriptions of more than 100 BMP. This publication also identifies federal and other sources of funding available to growers who wish to adopt these practices on their farms.

Reasons for this Study

As it pursued these projects, AFT quickly came to realize that it needed a better understanding of the process by which specialty crop growers make decisions about whether or not to adopt new environmentally beneficial management practices. The BMP Challenge, for example, is based on the premise that the risk of a decline in crop yields and, hence, income is a major barrier to BMP adoption. Yet, nobody seemed to have actually asked California growers themselves whether this was true or if they faced other barriers that could discourage BMP adoption.

For these reasons, American Farmland Trust decided to study how specialty crop growers cope with adopting new irrigation and nutrient management practices, commonly referred to as Beneficial Management Practices (BMP). BMP are activities currently recognized to be the most practical and effective means of meeting an environmental objective while making the optimum use of resources. An example of a BMP is soil monitoring and testing to determine the precise application of water and fertilizer required to assure crop yield and quality while protecting water quality and supply.

Examples of BMP for Irrigation and Nutrient Management	
Irrigation (Efficient Water Use)	*Nutrients (Pollution Prevention)*
Drip and micro irrigation systems	Nutrient management planning
Irrigation scheduling	Soil testing
Soil moisture monitoring	Plant tissue testing
Crop evapotranspiration monitoring	Precise placement of fertilizer application
Tail water return systems	Precise timing of fertilizer application
Drainage water return systems	Timed release fertilizers
Alternate furrow irrigation	Fertigation
Conservation tillage	Soil amendments
Cover crops	Cover crops

The development, demonstration and deployment of BMP on California farms is a key strategy, not only for improving environmental performance, but also for maintaining and increasing the industry's economic competitiveness. Specialty crops are grown by more than 50,000 California farmers on about 5.4 million acres using about 20 million acre-feet of water. These growers face increasingly higher costs for water, fertilizer, fuel and crop protection materials. And more stringent demands from regulators and consumers to protect air and water quality and biodiversity further contribute to economic pressures on growers. More growers need to adopt BMP to cope with these new demands, but appear reluctant to do so because of uncertainty about costs, implementation logistics and the risk to crop yields and quality.

Because of its commitment to helping farmers improve environmental quality – while remaining economically viable – AFT wanted to understand more about why some growers adopt BMP and others do not. We also wanted to gain insight into how to overcome the barriers that may be preventing wider adoption of these practices, so we could recommend steps that will lead to a more effective, efficient technical and financial support system for growers and better environmental protection. On the premise that the best source of this kind of information is the growers themselves, we decided to go straight to the horse's mouth. What we learned should help growers, technical assistance providers and policy makers with a better understanding of how to achieve wider adoption of BMP that can improve environmental quality while maintaining the economic competitiveness of California agriculrture.

Study Methodology

In October 2010, AFT was awarded a Specialty Crop Block Grant from the California Department of Food & Agriculture (CDFA) to investigate motivations and barriers to implementation of BMP for irrigation and nutrient management by specialty crop growers. Between autumn 2011 and summer 2012, AFT and its partners (primarily county Farm Bureaus and Resource Conservation Districts) conducted nine grower focus groups throughout California to better understand these motivations and barriers. The venues of the focus groups were: Bakersfield, Fresno (East and West sessions), Santa Maria (English & Spanish sessions), Santa Rosa, Stockton, Watsonville and Yuba City.

Participants were recruited by invitation to obtain a diversity of growers in terms of size of the operation, crop type and approach to farming. Focus groups were conducted by Steve Shaffer with assistance from local partner organizations.

Participants in the focus groups were also asked to take an anonymous survey (Appendix 1) so that quantitative data could be collected and analyzed. This survey, which asked growers to confine their responses to their primary specialty crop (by acreage) and on irrigation and nutrient management practices for that crop, was also administered at industry conferences and workshops. The survey asked growers to rank their top three responses to each question and to mark any other response that would apply. This enabled us to identify primary as well as secondary factors affecting growers' decision-making.

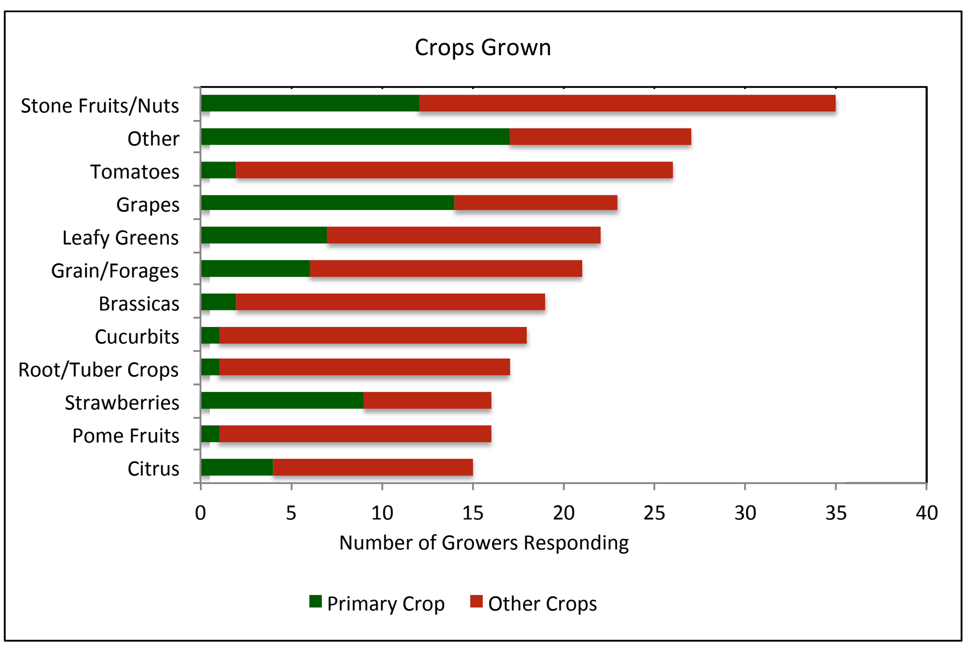
Study Results

A total of 58 growers participated in the nine focus groups and 78 completed the survey, which was also distributed at the Fertilizer Research and Education Program's 2010 annual conference. Participating growers represented a broad range of commodities, size of operation and approach to farming. Fifteen percent of them were Hispanic. This information was obtained from the focus groups rather than the survey.

Crops Grown

The survey asked growers to identify their primary crop as well as all other crops they produce. Approximately one third of those surveyed produce only one crop, but most growers produce multiple crops. In addition to the specific crops listed in Chart 1, "other" crops included artichoke, avocado, cane berries, herbs, kiwi, olives, peppers, persimmon, turf and various seed crops.

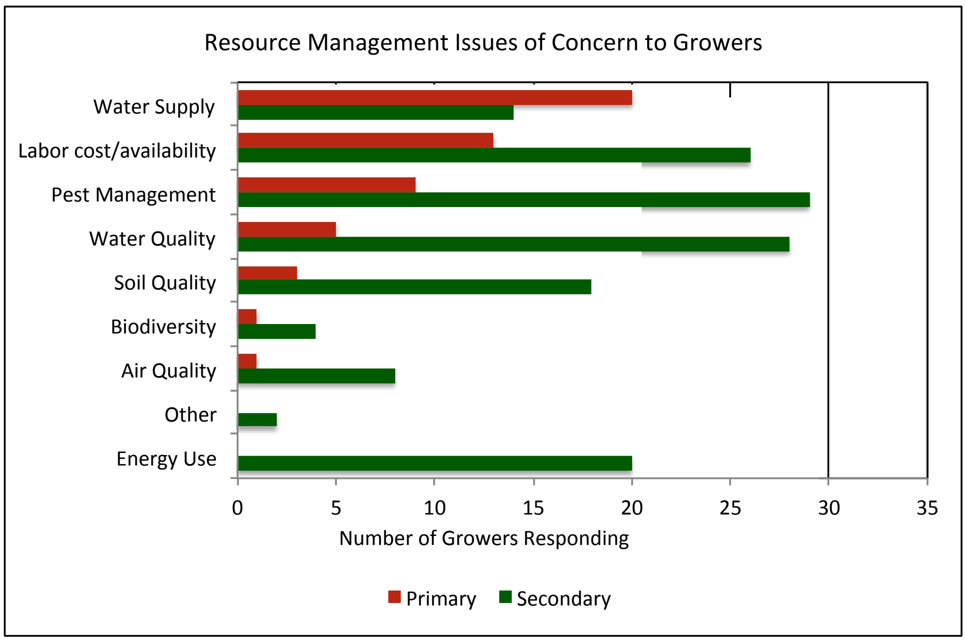
Chart 1



Resource Management Areas of Concern

Our BMP adoption discussion focused on irrigation and nutrient management, so we wanted to know how significant water quantity and quality issues are to growers compared with other resource management concerns. During the focus group sessions, growers described their concerns as cost (e.g. labor and input costs), crop yield and quality (e.g. soil quality, water supply and pest management), regulatory pressures (e.g. water quality, air quality) and long term environmental quality and agricultural productivity (e.g. soil quality, water quality, air quality, biodiversity). The results are shown in chart 2 and will be important in tailoring programs to better meet growers' future needs.

Chart 2



While it is not surprising that water supply is a concern to most growers in the San Joaquin Valley and on the Central Coast, even growers on the North Coast and in the Sacramento Valley are concerned about water supply. Growers in all regions are increasingly aware of water quality issues and associated impending regulations. Long-term soil quality was often mentioned as a high priority resource area of concern, reflecting growers' awareness that maintaining and improving soil properties is key to high crop yields and quality. The high cost of labor and the availability of qualified labor were also of great concern to growers across all regions. Pest management, including weeds and diseases as well as arthropods was often the primary crop management concern across all geographic areas. Out of the seven Latino growers who responded to the survey, four identified pest management as their primary resource management issue, while soil quality, water quality and water supply were each identified by one grower. Note that water quality was not mentioned as frequently as the primary concern of growers, even with the emergence of new regulatory requirements. But it does rank high as a secondary concern.

The results of the survey also shed light on how resource management concerns vary by region. As previously mentioned, water supply reliability was the primary resource priority in all regions. Water quality was identified as the primary concern only by leafy green growers on the Central Coast, probably because recently implemented water quality regulations are going to impact them more significantly than growers of other crops, due to higher fertilizer requirements. Strawberry growers, as well as tree crop growers in the same region were more concerned with water supply. When primary and secondary resource concerns are aggregated, labor, pest management, water supply and water quality all rank high across all crops and regions.

Early and Late BMP Adoption

When designing BMP incentives and support strategies, it is important to understand when a grower is more likely to adopt new BMP relative to his/her peers. Targeted support needs to change depending on where a grower fits on the adoption continuum[1] (whether the grower is an early, middle or late BMP adopter), and where the grower is on the steps towards BMP adoption[2] (education, planning, implementation, on-going management), how he or she views different sources of information, different forms and sources of technical and financial assistance, and how a grower views collaboration. In other words a large, but well organized tool box needs to be at a growers fingertips.

For BMP adoption support strategies to be effective in meeting environmental goals, the concept of "disproportionality"[3] needs to be recognized and understood. It describes the oft-occurring situation that the majority of water pollution is generated by a minority of landowners or managers. Disproportionality often leads to high adverse impacts when inappropriate behavior by the minority occurs in vulnerable areas. It is important to make the distinction here between bad actors and inappropriate behavior. Most inappropriate behavior is born out of ignorance, which with proper education can be remedied. While targeting the innovators and early adopters may provide internal community leadership to accelerate BMP adoption, targeting the late majority adopters, that is to say those most likely to exhibit inappropriate behavior, may provide greater and more timely results in achieving environmental goals.

Growers were asked when they thought they adopted new BMP compared with their peers. Of those who responded, 43 percent believed they adopted new practices earlier

[1] The adoption continuum, first proposed by Everett M. Rogers in *Diffusion of Innovations* (1983), describes a conceptual model of adoption of any new technology by a community consisting of a population distributed in a typical bell-shaped curve of innovators (2.5 %), early adopters (13.5%), early majority (34%), late majority (34%), and laggards (16%).

[2] The BMP adoption process stages: Stage 1 - awareness of a problem or opportunity and a potential BMP response; Stage 2 - persuasion to implement the BMP, Stage 3 - decision to adopt the BMP; Stage 4 - implementation of the BMP; Stage 6 - managing and confirming the performance of the BMP.

[3] Described by Professor Emeritus Pete Nowak at the University of Wisconsin, “disproportionality,” is one of his four axioms when attempting to solve water quality problems.

than most other growers, while 28 percent thought they implemented a new BMP at about the same time as most. Only 7 percent of growers admitted that they tended to adopt new practices later than their peers. Interestingly, none of the Central Coast Latino growers said they adopted new BMP earlier than most others.

When asked if they were considering adopting a new irrigation or nutrient BMP in the near future, 86 percent of growers responded yes or maybe, while only 14 percent responded no. The “near future” was not specifically defined in the survey, but from the focus group discussions, we deduced that growers considered it to be within one or two seasons.

Most growers have adopted a new BMP within the last four years, with about 40 percent of respondents having done so within the last year. Several growers indicated that they had transitioned to micro-irrigation (drip or sprinkler) in the late 1990’s or early 2000’s, and now continue to improve the management of these systems. For example, some were now incorporating soil moisture monitoring to schedule irrigation more precisely.

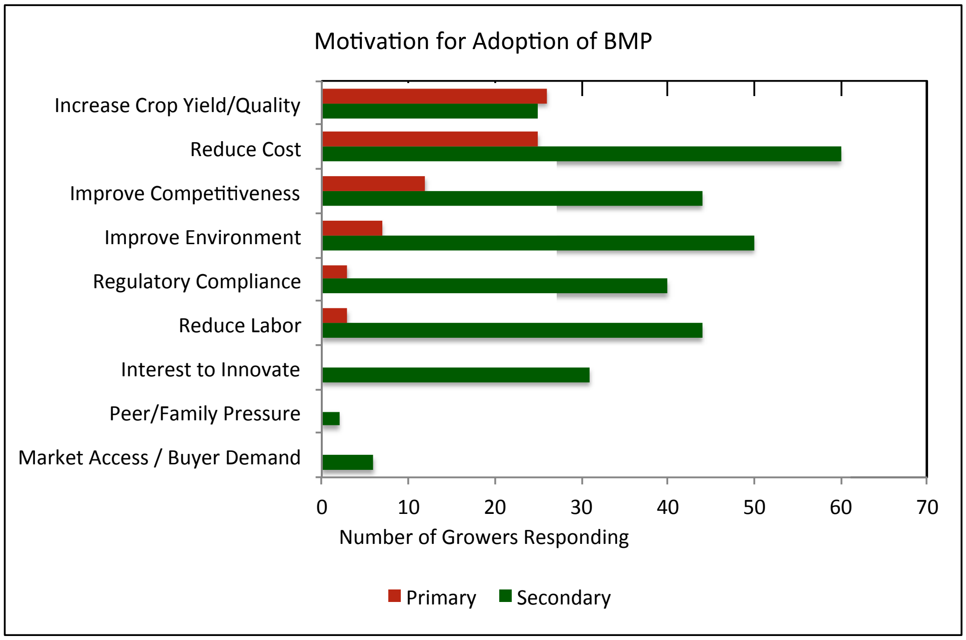
One way to look at these results is to ask whether growers are "Unable" or "Unwilling" to adopt new BMP. These data seem to indicate that most growers would be classified as “Unable to Adopt” new irrigation and nutrient management BMP, due to a lack of information and little or no experience with the BMP, and/or an inability to finance implementation of the BMP. Few are “Unwilling to Adopt” new BMP, even when robust technical and financial assistance is available. This observation suggests that an effort to provide comprehensive technical and financial support to growers will be effective in accelerating BMP adoption.

Motivations for Adoption of BMP

Growers were asked to identify the reasons that motivated them to adopt new irrigation or nutrient management BMP. They were asked to rank up to three motivating factors. As shown in Chart 3, improving crop yield or quality was most frequently cited primary motivating factor, followed closely by reducing costs. Improving competitiveness also ranked highly, probably because it implicates production costs as well as crop yield and quality. It is also interesting to note that improving the environment was listed more than twice as frequently as either reducing labor or regulatory compliance as a primary motivating factor. When primary and secondary motivations were aggregated, reducing production costs was the most often cited, followed by improving the environment. Among Latino growers the primary motivation for adopting a new BMP was to improve crop yield/quality, while improving the environment and reducing costs were the most frequently mentioned secondary motivational factors.

Despite the general concern in the agricultural community about regulations, regulatory compliance was not often cited as a primary motivation for adopting BMP, but was frequently cited as a secondary motive. Most grower participants in focus groups on the Central Coast and in the Central Valley expressed their awareness that new water quality regulations were coming and that they are starting to look more closely at what they will have to do to comply. While some are acting now, most are waiting to see how new regulations will affect their operations on a practical level. Most acknowledged that they have a responsibility to protect water quality, but expressed their deep concern about how new regulations will impact their costs and whether they will really result in environmental improvement. Their hope was that consumers would reward improved environmental performance with better commodity prices in the marketplace.

Chart 3

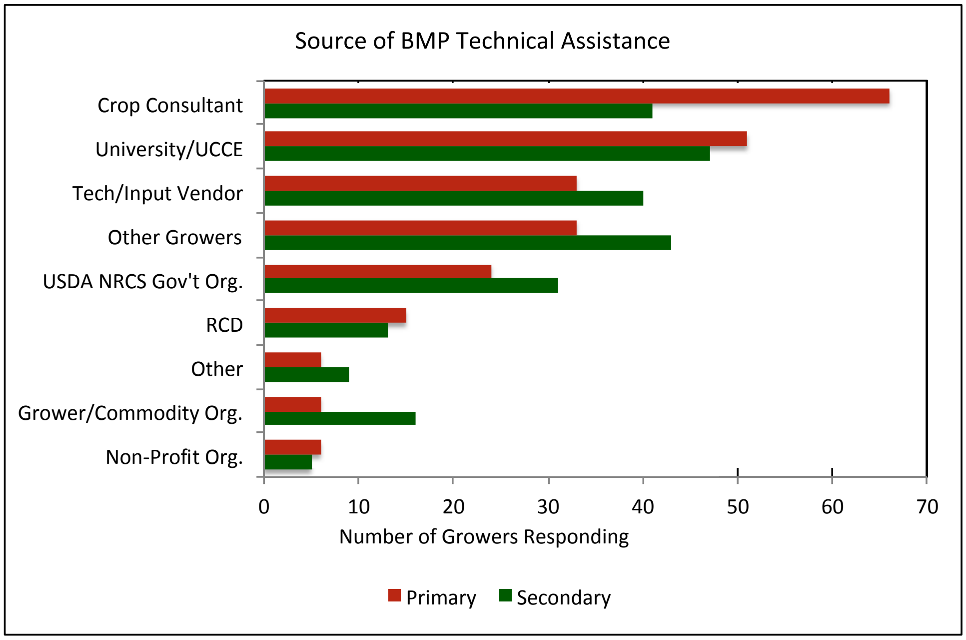


Sources of Technical Assistance

When considering adoption of a new BMP, growers usually consult multiple sources for their technical information and assistance. They seek this information because, while they are quite familiar with their existing practices, they have not had experience with new ones. In the focus groups, virtually all growers indicated that after they consult multiple sources of information, they perform their own feasibility analysis for their own specific circumstances. In so doing, they rely not only on hard data, but also on a feel for the specific crops under specific growing conditions.

As illustrated in Chart 4, private crop consultants are the source of technical information to which most growers turn first, while the University of California and its Cooperative Extension (county Farm Advisors, Specialists, and UCCE web sites) is the source used most frequently. Extension is highly valued by growers, but most believe it is significantly understaffed and underfunded. Growers also frequently seek advice from private technology vendors and other growers. Some growers commented that long-standing relationships with vendors are quite valuable. When new products become available, vendors seek out the early adopters who are also good managers to “kick the tires” of new products. While most growers are willing to share information with and learn from other growers, some indicated that they are in competition with each other and keep innovation information closely guarded to maintain a competitive advantage.

Chart 4



Some growers were quite proud of the fact that they innovate independently, having adopted precision irrigation and nutrient management technologies ten or more years ago, and continue to improve upon them. As one Central Coast grower said, "Too much support for keeping an even playing field can reduce weeding out the weaker players." This support limits the opportunities for the stronger growers to expand. This grower was also confident that however the water quality regulations are implemented, he was better positioned to respond effectively than other growers.

While some growers were confident in their ability to compete in the marketplace, most other growers saw the value of some level of collaboration. Many articulated a different level of self-reliance, seeing the value of local collaboration within their watershed, wanting to see, "More money such as block grants should be available to local Watershed Coalitions. This will help with technical assistance capacity and allow the coalitions to hire people to help." Another grower in the Sacramento Valley took a longer view, wanting the industry to survive for future generations, "Working together is important. I don't agree that only the strong should survive and push out the weak. It should not be all about the money but include stewardship and helping usher in a new generation of farmers."

The USDA-NRCS and many Resource Conservation Districts (RCDs) also received high marks for providing technical assistance. But some growers mentioned the issue of having to deal with a cumbersome bureaucracy and were also concerned about the confidentiality of the information they would have to provide government. Surprisingly, approximately 30 percent of growers were not aware of USDA-NRCS or RCDs and their function of providing technical assistance. A testament to the efforts of Cachuma RCD and the local NRCS office, Latino growers on the Central Coast cited them most frequently as their primary source of technical assistance.

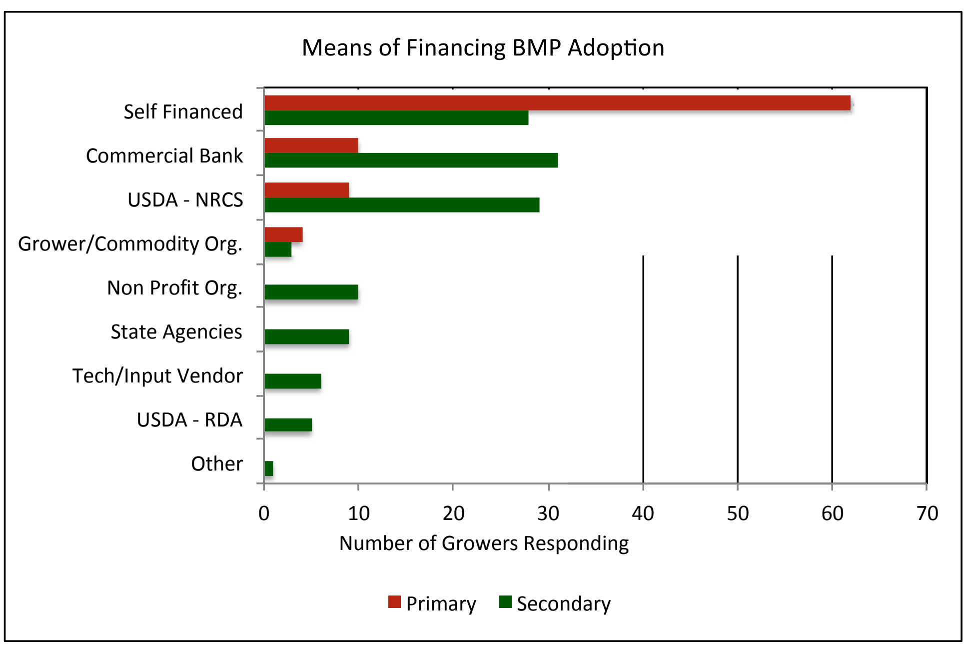
Financing of BMP

An overwhelming percentage of the growers we surveyed self-finance implementation of new BMP. This is among the most surprising findings of our research and because, as we shall see, the cost of new BMP is the leading obstacle to adoption, has important implications for encouraging wider adoption of these practices. Commercial banks and NRCS were distant second choices among financing options, as shown in Chart 5. Latino growers, however, had a somewhat stronger preference for NRCS funding of BMP adoption.

In the focus groups, growers indicated that they expect a very quick return on their investment in BMP, typically within one or two growing cycles. Many suggested that tax credits to offset the cost of BMP adoption would provide an additional incentive for implementation. They have a slight preference for low- or no-cost financing of BMP projects over government cost sharing payments.

Another surprise was that about 30 percent of growers were not aware of NRCS programs such as the Environmental Quality Incentives Program (EQIP), which has invested billions of dollars, primarily in BMP that improve water quality. Of the growers who do participate in USDA financial assistance programs, nearly half had mixed things to say about their experiences. Even more growers, approximately 60 percent, were not familiar with Resource Conservation Districts, how they are organized and what technical information and assistance they provide.

Chart 5



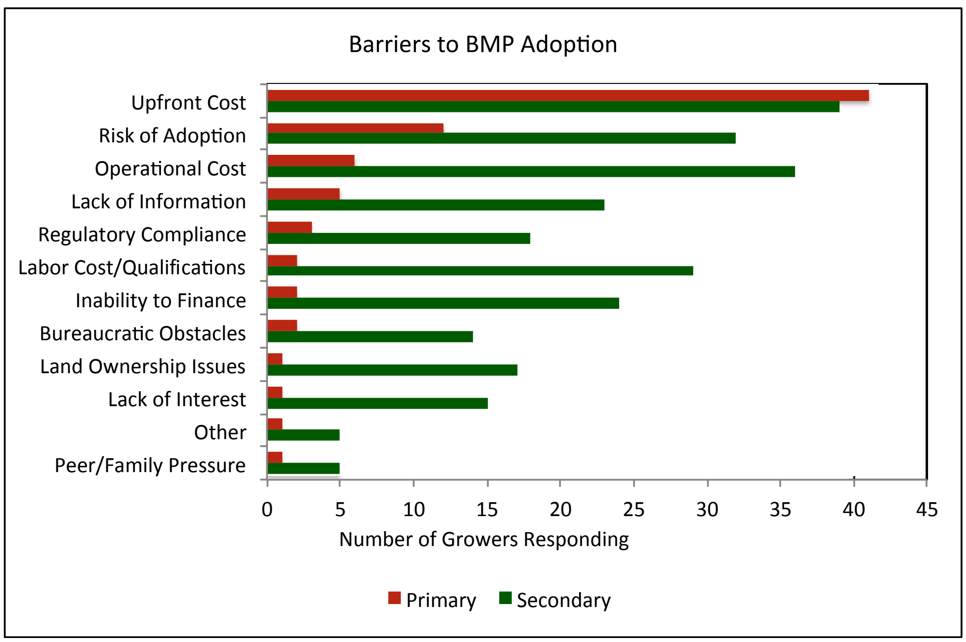
Barriers to BMP Adoption

Capital Cost of Adoption

One of the most important things we asked growers was what barriers or obstacles make them reluctant to adopt new BMP. As Chart 6 shows, the capital costs associated with adopting new irrigation or nutrient BMP were by far considered to be the primary barrier to adoption by growers in every region.

Most growers also said they were hesitant to assume new debt, which is confirmed by the large numbers who self-finance new BMP projects. One grower summed it up this way, “Our margins are small and whatever practice we implement needs to pay out.” The old axiom that “time is money” holds true as growers described this barrier in greater detail. They often said that they don’t have the time to do the initial work of educating themselves about a new BMP. One of the reasons they cite is the time now required to meet the reporting requirements of regulators and supply chain buyers.

Chart 6



Other Cost Factors

Other costs such as labor and the inability to finance projects were much less frequently identified as barriers, except by Latino growers for whom they appear to be more significant. One grower described a typical management issue: “Deprogramming or re-programming our work force can be a barrier. When we’ve had problems, it was often with irrigation management. We train workers but they may not fully understand changes, for example changing from pipe to drip.” Another grower said that he had to hire another full-time employee to help with implementation and continued use of a new irrigation management BMP.

Risk of Adoption

The second most frequently identified barrier to BMP adoption was the risk of a loss of crop yield and, hence, income. When this issue was discussed in the focus groups, it became apparent that the element of risk had many facets. One typical response was, "I operate at a tight margin. My biggest risk is losing efficiency. If I try something and it loses yield, it could break a season." But the concept of risk also extended to impacts on crop quality, the economics of production and the inability to incorporate the BMP across the farming operation, i.e. in a variety of growing conditions, crop rotations, etc. As one grower put it, "Our biggest focus is on the crop. Quality is very important. We need to do tests and trials on any new BMP first."

For tree and vine crops, the adverse effects of a new BMP may not show up immediately. An almond grower on the West side of the San Joaquin Valley observed that, "Permanent crops are different. They could be affected two to three years out. I have tried different things like deficit irrigation and it hurt me in the past. Extension first endorsed the practice, then came back later and said not to use it." Such insights demonstrate a need for a multi-pronged approach to mitigate risk. This is discussed in the next section.

Growers view risk from a variety of different perspectives. The following grower observations illustrate this: A Sonoma diversified vegetable grower told us, "I bear the full risk of adoption, so I need robust information. I participate in test programs, but a risk safety net would help." A Central Coast strawberry grower said, "Our biggest focus is risk to the quality and quantity of production. When looking at a new practice we always do trials." A San Joaquin Valley grower added, "You have to trial things extensively. In implementation, it takes gradual scaling up." A Kern County grower said, "If little cost, but information intensive – risk [coming from a lack of information] becomes a bigger factor." Second only to the barrier of upfront cost for growers who financed their projects themselves or through a commercial lender, was risk, while those that worked with USDA-NRCS programs did not view risk as a barrier. As one Sacramento Valley walnut grower summarized working with NRCS, "Having a conservation plan is important. I would suggest everyone get one. You can always change it. You have to have it if you are going to participate in these programs. It didn't cost me anything to do it but time. Setting up the plan was not that hard. Growers will probably realize they're doing more correctly than they realized."

At all the focus group discussions growers elaborated on another theme common to the wide spread adoption of new technologies, such as irrigation and nutrient BMP. That is the commercialization "valley of death" or the barriers to scaling up that which is well demonstrated on a small research and demonstration scale to full commercial scale. This phenomenon can take place across a sector, or within an individual grower's operation. As highlighted in previous grower comments, many growers appreciate the value of partnering with Farm Advisors and other technical professionals in conducting small-scale field trials on-farm where farmers can become familiar with new technologies (BMP). The barrier then becomes the ability to overcome the risk of scaling up the BMP from the field trial to a commercial scale.

Many growers who have adopted BMP have managed the risk through a gradual process of scaling-up. They will participate with farm advisors in field trials of a BMP, then try the BMP on a portion of one of their own fields and, assuming that works well, finally apply it to the entire field. Once a BMP has been demonstrated to work well in that field over a variety of growing conditions, a grower is more likely to consider applying it to other fields. There was general agreement that each field is different, requiring intimate knowledge. As one Central Coast grower summed it up, "Trials are critical. I'm not going to try things on a large scale until I'm pretty sure it's a sound investment. I'll try larger and larger trials before I take a leap. I want really low risk before I try it on a larger scale. I need to know the ground, know the product/application and know the crop. I put it all together and then I might get to that 100% confidence level."

The grower-cooperator may be comfortable in scaling up the BMP in the field where the trials took place, but may perceive the risk as too great when applying the BMP to the same crop in other fields with somewhat different growing conditions. The same phenomenon exists when scaling up a BMP from a hand full of early adopters to a majority of growers, or from one crop to another. A variety of tools is needed to support the scaling up process encountered by growers once they have made the decision to adopt a new BMP.

Lack of Information

Risk often manifests itself through the lack of information that growers trust and, hence, their confidence in the performance of a new BMP. This was the third most cited primary barrier to BMP adoption. In every focus group growers expressed the desire for easier access to more and better information. A Kern County grower put it, "I feel we're getting to point where industry has surpassed the science. Industry is begging for more science." One grower response to the lack of information and the risk it entails is to try new BMP on a small scale. Another grower summed it up this way, "Each new BMP must be implemented and fine tuned field by field, well by well, rootstock by rootstock."

Bureaucratic and Regulatory Concerns

Difficulty or the inability to obtain a needed permit, conflict with other existing regulations, conflict with buyer imposed requirements, and time required to meet regulatory requirements all were mentioned as barriers to adopting new BMP. This often became a venting session on the part of growers, many of whom appreciated the need for sensible regulations, as they expressed frustration with conflicting requirements, changing requirements, and the time taken away from more productive activities.

About a quarter of the growers we surveyed expressed concern over the access of regulatory agencies to their private business information, and even more were concerned with the amount of time needed for regulatory reporting. Some growers do not want government involved in their farming operation at all. In fact, several expressed concern that government assistance supported the weaker, less efficient producers to the detriment of the more competitive growers. Others were unhappy with the process they had to endure to have BMP projects approved, but found the benefits were worth the effort. Still others found the process frustrating to the point of abandoning the effort. Criticisms included not meeting eligibility requirements, rigidity in the project design requirements, completing the process only to be denied funding and having to reapply only to be rejected again. The following section on adoption assistance discusses suggested improvements.

In every focus group, growers expressed a fear that the voluntary adoption of BMP by some could lead to it becoming a universal requirement through either government regulation or supply chain buyer standards. Growers on the North and Central Coasts were especially concerned about conflicts between food safety and water quality regulations that call for different and incompatible practices, i.e., field edge vegetative buffers to filter runoff v. leaving field edges completely bare to discourage rodent infestation.

From the focus group discussions, it was clear that most growers are willing to adopt new irrigation and nutrient BMP if, in their own minds, they were able. However, they were not willing to adopt BMP if mandated by regulators whose decisions the growers believe are not well founded. Growers largely recognized the need for regulations, and that at this point environmental regulatory compliance was not driving BMP adoption decisions on their farms. They acknowledged their responsibility to protect natural resources for their own benefit and for the benefit of society and the environment. To reiterate the comments of a grower on the Central Coast, “Farmers are now the ‘bad guys,’ but it wasn’t always that way. We’re blamed for water quality and supply issues, air quality issues. But you can’t argue you are doing the right thing unless you are doing the right thing. So we need to get beyond what has been done, need to be proactive, innovative, progressive. We need to be able to prove you are using resources wisely, not impacting water quality in excessively negative ways. We can do that smartly, need to be able to show you are doing everything you can. It will protect viability of farming in the long term.” Some did acknowledge that regulations (and buyer demands) may become a stronger driver in the future. They recognize their responsibility to protect the environment, but fear that the economic costs will be too great and that they may not be able to meet regulatory requirements, no matter the cost. But virtually all felt that if scientifically and economically defensible regulations are put in place, they can and are willing to meet them. The growers participating in every focus group commented that if regulators would take the time to understand farming, to partner with them to improve the environment, not just monitor and report pollution levels, that real progress can be made. These comments were made both in the context of food safety regulations and water quality regulations. Growers especially on the North Coast and on the Central Coast were quite concerned with the conflicts imposed upon them in trying to meet both sets of standards.

As growers recognize that they are rightfully accountable for protecting and improving the environmental resources upon which they and their neighbors depend, that rather than being targeted as the “bad actors” they would prefer to be acknowledged for the work they do and the improvements they’ve made, recognizing the need to document their efforts and continue to show improvement. One grower in the Sacramento Valley put it this way, “In order to adopt the BMP it would be good to have support with regard to public acceptance, recognition, etc. If you can have a document in the marketplace outlining what you’re doing and the public accepts this, then that helps a lot."

Based on grower comments, we believe that regulators and supply chain buyers can better support BMP adoption if they:

- Work to harmonize conflicting regulations using a “net environmental benefit” framework
- Recognize the inherent differences in regulating non-point sources of pollution and the need for new research and demonstration efforts to deal with inherent uncertainty.
- Establish regulations based on the best science available, and provide for a defined useful life of the regulation so that investment in the BMP can be fully recovered.
- Provide for a reasonable time and flexibility in meeting new regulations so that the grower learning curve can be accommodated and the appropriate BMP can be tailored and implemented according to the specific farming conditions.
- Minimize monitoring and reporting requirements so that more time is available to innovate – to research and implement new BMP.
- Work to efficiently verify BMP performance to reduce reporting requirements while assuring environmental improvement.
- Collaborate with research, extension, technology providers (vendors) and technical assistance providers to better support grower efforts to adopt new BMP.
- Tailor financial support programs so that implementing partners are not unduly burdened with unreasonable performance and liability requirements.
- Establish an accountability program for environmental regulators to assure consistent and uniform application of regulatory authority by individual regulators that includes training and transparency protocols.

Rented Land

Only one grower indicated that not owning the land he farmed was the primary barrier to irrigation and nutrient management BMP adoption. However, land ownership issues were identified as a secondary barrier on a par with bureaucratic and regulatory obstacles. A significant number of growers, including many Hispanics, noted that they were tenant farmers who would not make an investment in BMP on their rented land or could not get the landowner to participate with them on a project. Some indicated that if they had longer leases or support from their landlord, they would be more inclined to adopt irrigation and nutrient BMP that require significant capital expenditures.

Types of Assistance Available to Growers for BMP Adoption

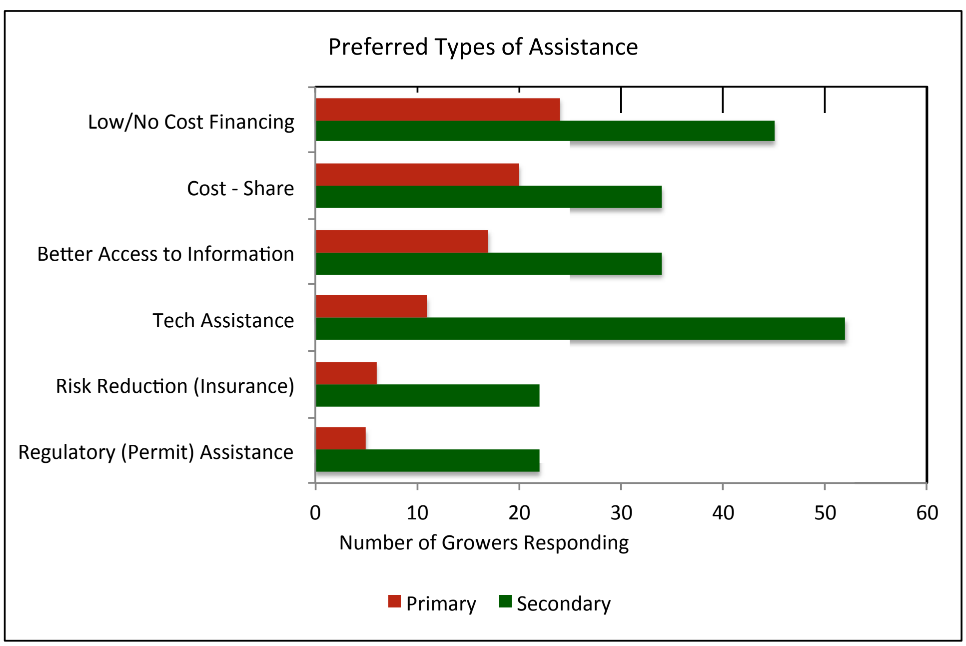
Assistance in various forms can help growers overcome the barriers to BMP adoption. Among these are financial assistance, technical assistance and risk management tools.

Growers had mixed opinions about government financing programs. Many were not aware of their availability. Some were patient in dealing with the bureaucratic process of getting assistance, while others were less so. Among those who knew about them and had received assistance, both cost-share programs such as EQIP and low- and no-cost loans were popular. The combination of technical and financial assistance provided by programs such as EQIP was valued by most growers who had direct experience with these programs.

Technical information and assistance also proved popular among growers. Many growers felt that adopting a new BMP based on good information, with on-going technical assistance, is an effective way to reduce the risk of adoption and conversely, assure a quick return on their investment.

Growers were interested in, but somewhat skeptical of a crop insurance approach to mitigating the risk of lower crop yields or quality. Many were unfamiliar with crop insurance, except for weather-related impacts, and view it as a form of government subsidy. When it was discussed in greater depth, however, many could see the potential value of a yield/income assurance program – such as that provided by AFT's BMP Challenge – for a limited period of time (one to three years) to enable them to gain experience with BMP at a commercial scale.

Chart 7



While Latino growers did not identify risk of adoption as a primary barrier to trying a new BMP, they did most frequently identify risk reduction insurance as a preferred adoption assistance strategy. Secondary forms of assistance preferred by Latino growers included low- and no-cost financing and technical assistance. This result may indicate that these growers value the technical assistance provided by NRCS and RCDs over the cost-sharing offered under their programs.

Financial Assistance

The form of assistance for BMP adoption most favored by growers was financial assistance. Grower recommendations included:

- Greater access to low or no cost financing.
- Not specifically asked in the survey, but mentioned quite often by focus group participants was providing tax credits for adopting new BMP.
- Expansion of cost-sharing of up-front expenses such as that provided under EQIP, AWIP and other NRCS programs. Increased funding and expansion of eligibility criteria were suggested.
- An issue mentioned by RCD staff and other local partners that are providing support for BMP adoption to growers was some of the onerous requirements of California state cost share programs for water quality improvement that either limit grower participation or confer undue financial liability to the RCDs or other partners if funded projects do not perform as anticipated.

Information

Growers want more information. They want easier access to it. They want it to be more timely. They want it tailored to their own farming operation. They want to be able to trust it. Many, but not all, are willing to share information. In fact, one grower observed that, “Proprietary information screws the little guy. We need more public information.” Most growers now rely on the Internet for information and want to see better coordination of web-based information. Sources of information maintain websites, but often those sites are poorly organized, not up to date, and rarely cross-linked to other information sources. Growers want but cannot usually find easy access to Web-based information. Integrating and maintaining up-to-date web-based information on a crop and region specific basis would be invaluable. Build upon existing sources of technical assistance including from universities and cooperative extension, government agencies including Resource Conservation Districts, the private sector including vendors and crop consultants, and other growers and commodity organizations.

Grower comments can be summarized as follows:

- Most growers want to expand the capacity of Cooperative Extension. They want to see more Farm Advisors in their specific region with more specific expertise doing more extension work. Many participate in field trials with Farm Advisors and view them as beneficial.

- Most growers valued their crop consultants, but expressed some concern if they are affiliated with vendors of specific products. Many saw an increasing role for independent crop consultants such as Certified Crop Advisors, especially as new environmental regulations and reporting requirements emerge.
- Growers familiar with NRCS programs wanted to see expansion of NRCS technical assistance. While most growers who had participated in NRCS programs such as EQIP (Environmental Quality Incentive Program) expressed frustration with one or more elements of the sign-up process, most wanted to see it and other NRCS conservation programs expanded. They appreciated the working relationship that NRCS maintains with landowners.
- Growers in areas with active Resource Conservation Districts valued the role and function of RCDs to foster collaboration among landowners, provide technical assistance, and coordinate efforts with NRCS and other government agencies. To strengthen and expand RCD functions, some growers recommended that efforts should be made to build on successful RCDs. This could be done by building collaborations among RCDs on a regional basis. Another suggestion was to provide resources so that active RCDs can mentor capacity building for less active RCDs.
- Commodity organizations such as the Almond Board of California and the California Association of Winegrape Growers were mentioned as good sources of information and technical assistance by several growers. They valued the research funded by these organizations. They also valued the technical assistance they provide through their grower self-assessment workbooks, and sponsored field days.
- Most growers do collaborate. Along those lines, many growers recommended that new methods be developed to extend reliable information to growers and for sharing that information. Growers cited examples such as mobile irrigation labs, grower self-assessment workbooks, field days as proven mechanisms to share information and to build lines of collaboration. Many growers suggested that such tools could be made more routinely available and better coordinated.

Risk Reduction

Growers want to reduce risk of lower crop yields or quality associated with the adoption of new BMP. After cost, risk was the most significant barrier to BMP adoption they identified. While their primary strategy to reduce risk is to acquire information, another strategy they found attractive was to provide a financial “safety net” in the form of indemnification against income loss due to reduced crop yield and/or quality or increased production costs when adopting a new BMP. Such an approach was considered more attractive when combined with technical assistance.

Market Recognition

A few growers did mention that there was the potential of market recognition for BMP adoption. Such recognition could take several forms. Comments included:

- By documenting the use of BMP and measuring and reporting their performance, growers could benefit by:
  - Monetary compensation in the market place from the buyer or consumer using a certification and labeling program
  - Improving the economic performance (efficiency) of their farming operation
  - Consumer recognition that growers are doing the right thing
  - Ease of meeting regulatory requirements and buyer demands
- Develop Ecosystem Services Markets to increase economic attractiveness
- Develop and implement methods to quantify environmental benefits that result from adoption of a BMP
- Monetize those benefits through pollutant trading programs, emission reduction markets, and other mechanisms.
- Keep reporting, monitoring and other transaction costs to a minimum.

Conclusions and Recommendations

Conclusions

California specialty crop growers are interested in improving environmental quality. They are willing to entertain the adoption of new beneficial management practices to make more efficient use of water and reduce water pollution. But the primary motivation of most growers is understandably their bottom line as influenced by production costs, and by crop yield and quality. If BMP are to become more widely adopted, several concerns related to economic return must be addressed.

Increased production costs offer two challenges. The first is whether growers can afford to make the investment, given that most of them now self-finance new BMP and that growers themselves consider the capital costs of implementing new irrigation and nutrient management practices to be the highest barrier to BMP adoption. Complicating this issue is the reluctance of some growers to assume any additional debt or to accept government funding for BMP because of privacy, paperwork and regulatory concerns. The second challenge is whether growers can earn a positive return on their investment in BMP within a relatively short period of time, as they themselves insist. Inasmuch as irrigation and nutrient management BMP offer the potential to reduce the costs of both water and fertilizer, they offer growers hope that they can, indeed, recoup their investment in new practices. A positive return is also more likely if the marketplace recognizes and rewards the environmental benefits resulting from the adoption of BMP by growers.

However, even if these challenges are met, there remains the question of how the implementation of BMP will affect crop yield and quality, which can also affect their economic return. If growers are to embrace new BMP, they must be assured that the risk that crop yield and quality will not be negatively affected is minimal, or at least manageable. There are several ways such risk can be minimized. Since these approaches are not mutually exclusive, they can and should all be pursued where appropriate. The first way to minimize risk is to increase growers' confidence in their knowledge about how to implement the practice so as to assure that crop yield and quality are unaffected or improved. This can be achieved through technical information and assistance provided by a variety of expert sources. But growers must first be aware that these sources exist – many are not – and they must have confidence in the source of information itself.

Another knowledge-based way to minimize risk is by conducting small-scale field trials and, if they prove successful, by scaling up their implementation. Exposure to the experience of other producers who have achieved positive outcomes by adopting a new practice can also reassure growers that risks are minimal, provided there are enough cases to demonstrate that a practice will work under a variety of conditions.

Finally, the risk of BMP adoption can be minimized by programs such as AFT's BMP Challenge, which offer indemnification for any economic loss attributable to proper adoption of the practices. This approach should not be considered a means of permanent support, but rather as a temporary safety net to enable growers to experiment with new BMP until they gain confidence in their management skills and how BMP affects their crops.

Recommendations

Based on what we have learned from specialty crop growers through our survey and focus groups, we believe that a significant expansion of irrigation and nutrient management BMP adoption will require a broad-gauged, coordinated effort to address all of the key challenges growers face in considering whether to adopt new practices. We recommend that the California Department of Food & Agriculture, the USDA Natural Resources Conservation Service, the California Association of Resource Conservation Districts, specialty crop grower associations such as Western Growers Association and the California Grape & Tree Fruit League, and other interested parties come together to discuss the findings of this report and begin to develop a comprehensive strategy for helping growers meet the challenges they must overcome to gain confidence in BMP adoption. Among the elements of such a strategy that deserve consideration are:

Financial Assistance

Maintain and, if possible, increase current funding levels for the Environmental Quality Incentives program (EQIP) and other BMP cost-share programs in the next federal Farm Bill, while streamlining the application process and making the programs accessible to a wider range of growers.

Consider federal and state income tax credits for qualified private investments in BMP.

Information & Technical Assistance

Better coordinate the services of information and technical assistance providers to provide a comprehensive suite of tools for BMP adoption and implementation

Assess and improve the effectiveness of information and technical assistance delivery to growers based on where they fall along the adoption continuum and where they are in the actual process of adopting BMP.

Increase information and technical assistance capacity by maintaining funding levels in the federal Farm Bill, expanding Certified Crop Advisor certification, the CDFA Fertilizer Research and Education Program and University of California Cooperative Extension

Market Recognition

The CDFA Environmental Farming Act Science Advisory Panel could include the adoption of irrigation and nutrient management BMP among the strategies eligible for incentives for on-farm ecosystem services.

The Stewardship Index for Specialty Crops or some other collaborative body could convene growers, buyers and consumers to identify and implement market mechanisms that reward growers for early BMP adoption.

Risk Management

Develop a pilot program for specialty crops similar to the BMP Challenge that combines support for technical assistance with indemnification for loss of crop yield or quality. Such a program should include a risk assessment to determine future premium rates and a means of quantitatively measuring the environmental benefits of BMP adoption.
Government & Regulation

Begin a dialogue among water quality regulators, agricultural producers, information and technical service providers and policy experts to identify ways that an improved regulatory system could encourage and support irrigation and nutrient BMP adoption.

"Selling" BMP to Growers

The proponents of environmentally beneficial management practices must recognize that, when all is said and done, they are there to sell something to the grower. They must effectively demonstrate that what they are selling will benefit the grower – that it is worth the money, fits into the existing farming operation and is simple to use. Much of the challenge of "selling" the BMP product is effectively communicating with the grower. To do so, a concerted, coordinated strategy by the BMP adoption support community is needed. These "sellers" should work together to tailor the "sales pitch" to effectively communicate with individual growers. The ultimate goal is to exceed their expectations. For if we do, they will exceed ours.

Appendix 1 – The Grower Survey

Survey to Assess Growers' Needs When Adopting New Management Practices

Introduction

American Farmland Trust is conducting a survey of growers to better understand how to improve support to growers who want or need to adopt Beneficial Management Practices (BMP). The focus is on irrigation water and nutrient management. Results of the survey will be reported with recommendations that identify the methods that will work best for growers. This survey is funded through a 2010 Specialty Crop Block Grant from the California Department of Food and Agriculture.

Your responses to this survey will be kept strictly confidential.

Focus Group Location: ________________________

What do you grow? Check all that apply. Mark the top three by acreage, 1, 2, 3.

Stone fruits and nuts	Citrus
Grapes	Leafy greens
Tomatoes	Cucurbits
Brassicas	Strawberries
Grain and forages	Pome fruits
Root and tuber crops	Other crops (specify)_____________________

Based on your primary crop, when did you last implement a new irrigation or nutrient management practice?

Last year	2 to 4 years ago	5 or more years ago

If so, what was the practice? ____

Are you considering adopting a new irrigation and/or nutrient management practice in the near future?

Yes	No	Maybe

What are the reasons that motivate you to adopt new irrigation or nutrient management practices? Check all that apply. Mark the top three by their importance to you, 1, 2, 3.

Reduce cost	Improve competitiveness
Reduce labor	Improve the environment
Regulatory compliance	Interest to innovate
Increase crop yield/quality	Peer or family pressure
Market access (e.g. buyer demand)	Other (specify) __________________

When you decide to implement a new irrigation or nutrient management practice, where do you seek technical assistance? Please check all that apply. Please mark the top three by their usefulness to you, 1, 2, 3.

Other growers	Grower/Commodity organization
USDA-NRCS	Technology/Input vendor
Non-profit organization	University/UCCE
Crop consultant	RCDs

Other (please specify) ____

When you decide to implement a new irrigation or nutrient management practice, how do you finance it? Please check all that apply. Please mark the top three by their importance to you, 1, 2, 3.

Self financed	Grower/Commodity organization
Commercial bank	Technology/Input vendor
Non-profit organization	USDA - NRCS
State agencies	USDA – RDA

Other (please specify) ____

Have you used/participated in USDA programs such as EQIP?

Yes No

If yes, which program(s) and for what project? __________________________________
____

If not, why not? ____
____

What barriers to the adoption of new irrigation or nutrient management practices have you encountered? Please check all that apply. Please mark the top three by their importance to you, 1, 2, 3.

Upfront capital cost	Risk of adoption (e.g. yield loss)
Labor cost or qualifications	Peer or family pressure
Operational costs	Lack of interest
Inability to finance	Lack of information
Regulatory compliance (permitting)	Land ownership issues
Bureaucratic obstacles (red tape)	Other: ___________________
Conflicting buyer requirements	

Which of the following would better assist you in adopting new irrigation or nutrient management practices? Please check all that apply. Please mark the top three by their likely effectiveness, 1, 2, 3.

Low/no cost financing	Cost-share
Better access to information	Risk reduction (crop insurance)

Technical assistance Regulatory (permit) assistance
Other____

For the next 1 – 3 years, which are the resources management issues are of greatest concern to you? Please list the top 3 in order of importance to you.

Water supply
Water quality
Air quality
Biodiversity
Soil quality
Energy use
Pest management
Labor cost/availability
Other_________________

Relative to other growers, when are you more likely to adopt a new BMP?

Earlier than most
About the same time as most
Later than most
Depends

Any additional comments you'd like to make? Please provide them below.

Optional:
May we contact you to learn more about your views? Yes No

Contact information:
Name ______________________________
Mailing address ______________________________
Telephone ______________________________
Email address ______________________________

Your responses to this survey will be kept strictly confidential.

Thank you for your participation.

Benchmark - Pre-campaign Coverage

October 1, 2009 thru September 30, 2010

Date	Title	Author	Publication	Circulation
10/1/2009	Evaluating Pesticide Risk	Corinne Ramey	NY Times	951,063
10/2/2009	Which Organic Label Should You Trust?	Dr. Mercola	Food Consumer	
10/5/2009	Pesticide Suspected in Restaurant Salsa		UPI	
10/12/2009	Is Healthy, Home-made Baby Food Just Pulp Fiction	Anna Shepard	London Times Online	
10/16/2009	Pesticide Residue Results Hould be Harnessed by the Fresh Produce		Freshinfo	
11/3/2009	Pesticides: Produce's Clean and Dirty Dozen	Caitlin Hillyard	WTOP	
11/3/2009	Does an Organic Label Really Make a Difference	Eve Vasquez	Red and Black	
11/2/2009	Mercury in Seafood is #1 Consumer Food Safety Concern		PR Newswire	
12/3/2009	How Not to Eat Pesticides for Dinner	Michael Roizen, MD and	Idaho Statesman	52,444
12/3/2009	There's No Such thing as a Chemical Free Lunch	Julie Guthman	SF Chronicle-Opinion	241,330
12/10/2009	The 7 Foods Experts Won't Eat	Liz Vaccariello	Prevention	2,900,193
1/7/2010	Buy Organic Without Busting Your Budget	Terri Bennett	Greensboro News & Record	67,625
1/19/2010	Chemicals Coat Apples Decades After Alar Scare	Shannon Dininny	Associated Press	
1/20/2010	20 Years After the Alar Scare		Omaha World Herald	152,522
2/1/2010	Environmental Toxins and Learning Disorders	Donna Mitzberg	NewJersey.com	
2/1/2010	How to Buy Organic on a Budget	Terri Bennett	McClatchy Newspapers	
2/2/2010	Was, Pesticides, Pathogens: Quick Tips to Prep Your Produce	Jennifer Lance	EcoChilds Play	
2/3/2010	Going Organic	Leanne Ely	Warren Sentinel (Virginia)	4,000
2/5/2010	20 New Anticancer Rules	David Servan-Schreiber, MD,	Huffington Post	
2/18/2010	Eating Safely is as Important as Eating Healthy	Martha Stweart	Boston Globe	232,432
2/26/2010	12 Foods That Are Worth the Organic Splurge	Sarah McColl	Shine (Yahoo homepage)	
3/2/2010	How to Remove Pesticides from Produce with Inexpensive Home Ingredients	Heidi Fagley	Natural News	
3/3/2010	Smart Living: When Does it Pay to Buy Organic?		WKYC-TV Cleveland	
3/3/2010	Buying Organic	Jessica Tanenbaum	Healthy Living	70,000
3/8/2010	Fat Epidemic Linked to Chemicals Run Amok	Stephen Perrine	MSNBC	75,492,000
3/16/2010	Shocking Reasons to go Organic	Matt Bean	CBS News/Mens Health	
3/18/2010	Focus Organic Research on Pesticides, Not Phytonutrients		Mother Nature Network	
3/18/2010	Fresh Produce often Contaminated with Pesticides	David Gutierrez	Natural News	
3/18/2010	Trying to Save Money? 15 Foods you Don't Need to Buy Organic	Brierley Wright, MS, RD	Eating Well Magazine	350,000
3/22/2010	How Contaminated is Your Produce?	Danielle Rose	NewJersey.com	

Benchmark - Pre-campaign Coverage
October 1, 2009 thru September 30, 2010

Date	Title	Author	Publication	Circulation
3/24/2010	Is Organic Better? Making Sense of Organic Choices	Julie Deardorff	Chicago Tribune	452,145
3/24/2010	10 Most Toxic Fruits and Vegetables	Cameron Scott	San Francisco Chronicle	241,330
3/25/2010	Protecting Children From Pesticides: The EPA Needs to Get Back to Work	Gina Solomon	NRDC	
4/9/2010	Low on Cash? These Organic Foods are Still a Must	Katherine J. Chen	Earth911.com	
4/12/2010	Is Organic Worth it?	Christy Strawser	Detroit Free Press	252,017
4/12/2010	Fear of Pesticides Persuades Consumers to go Organic	Susan Salisbury	Palm Beach Post	122,611
4/13/2010	Growing Concern Over Marketing Tainted Beef	Peter Eisler	USA Today	1,826,622
4/19/2010	Wash, Trim Pesticide Residue	Joy Taylor	Des Moines Register	113,597
4/22/2010	Food Label Jargon Demystifies	Katie Lee	CBS News	
4/22/2010	Reduce Your Body's Toxic Load by Consuming Fewer Pesticides	Dr. Walter Crinnion	Huffington Post	
4/23/2010	ESFA Evaluates Possible Risks from the Pesticide Chlormequat in Grapes		FlexNews	
4/28/2010	Organic Foods: You Are What You Eat	Diann Green	Florida Bradenton Herald	41,491
4/28/2010	Avoiding Pesticides - New Dirty Dozen List		Environmental Working Group	
4/28/2010	Dr. Andrew Weil: Which Fruits and Veggies to Buy Organic	Valerie Reiss	Fresh Living	
4/29/2010	Hidden Pesticides	Kevin Yarr	CBC Canada	
5/3/2010	Organic Food Buying Cheat Sheet	Whitson Gordon	lifehacker.com	
5/3/2010	The New Dirty Dozen		Yahoo	
5/4/2010	Produce May Retain Pesticides After Washing	Amy Held	WTOP	
5/4/2010	Differing Views on Organic Food and its Health Benefits	Dr. Ananya Mandal, MD	Medical News	
5/6/2010	New Alarm Bells About Chemicals and Cancer	Nicholas D. Kristof	New York Times	951,063
5/7/2010	Organic Foods Reduce Environmental Risks		PR Newswire - Organic Trade Association	
5/7/2010	US Facing Grievous Harm From Chemicals in Air, Food, Water	Lyndsey Layton	Washington Post	578,482
5/7/2010	US Panel Criticized as Overstating Cancer Risks	Denise Grady	New York Times	
5/10/2010	Do Chemicals Cause Cancer?	Cameron Scott	San Francisco Chronicle	241,330
5/11/2010	Avoid the Dirty Dozen and Avoid Pesticide Residue	Kaye Spector	The Plains Dealer	267,888
5/11/2010	Keep Pesticides off Your Plate	Danielle Koagel	Eat, Drink and Be	
5/13/2010	Beyond the Dirty Dozen: What Foods Have Most Pesticides	Monica Reinagel, MS, LD/N	Nutrition Data	

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October 1, 2009 thru September 30, 2010

Date	Title	Author	Publication	Circulation
5/13/2010	Cultivated Blueberries Land on the Dirty Dozen List	Avery Yale Kamila	Portland Press Herald (Maine)	60,821
5/13/2010	Organic Food: Dear Mr. President, Go Organic	Walter Crinnion	Huffington Post	
5/17/2010	Study Links Pesticides to ADHD in Children	Thomas H. Maugh II	Los Angeles Times	616,606
5/17/2010	Can Pesticides Cause ADHD?	Andrea Canning and Jennifer Pereira	ABC News	
5/17/2010	Research Links Pesticides with ADHD in Children	Mary Clare Jalonick	Associated Press	
5/17/2010	Pesticides in Kids Linked to ADHD	JoNel Aleccia	MSNBC	75,492,000
5/18/2010	Study: Common Pesticides Linked to ADHD	Julie Deardorff	Chicago Tribune	452,145
5/18/2010	Pesticides Tied to ADHD in Children in US Study		Reuters	
5/18/2010	Pesticides Tied to Hyperactivity in Children	Andrew Moseman	CBS News	
5/18/2010	Do Pesticides Cause Hyperactivity?	Cameron Scott	San Francisco Chronicle	241,330
5/18/2010	Lean About Most and Least Contaminated Produce		KTVU - Oakland	
5/19/2010	Pesticide Linked to High Risk of ADHD in Children	David Liu	Food Consumer	
5/19/2010	ADHD Linked to Pesticides		Gourmet Retailer	20,000
5/19/2010	Organic Produce to Buy or Not to Buy?	Sarah Jackson	Everett Herald	15,000
5/19/2010	Research Suggest that Pesticide Exposure May Foster ADHD	Jed Shlackman	San Francisco Chronicle	241,330
5/19/2010	Scientist Link ADHD to Pesticides	Jessica Berman	Voice of America	
5/19/2010	ADHD Gets Wider Linkage to Pesticide		Omaha World Herald	152,522
5/20/2010	Keeping Your Produce Safe	Michael O'Connor	Omaha World Herald	152,522
5/20/2010	What to Eat and What to Avoid	Travis Walter Donovan	Huffington Post	
5/21/2010	Pesticides Cause ADHD? What?	Dr. Stephanie Sarkis	Psychology Today	307,079
5/25/2010	ADHD Linked to Pesticides? Here's the Facts	Laura Tommaso, MD	San Francisco Chronicle	241,330
5/25/2010	Better Buy Organic: Update on Pesticides on Food		JustMeans	
5/25/2010	You Never Know Who's Handled Your Produce, So Wash, Wash, Wash	Landon Hall	Orange County Register	196,684
5/27/2010	Pesticides Commonly Found on Berries and Other Fruits May Contribute to ADHD	Joel Fuhman, MD	San Francisco Chronicle	241,330
5/27/2010	Study Finds Supplements Contain Contaminants	Gardiner Harris	New York Times	951,063
6/1/2010	Dirty Dozen Produce Carries More Pesticide Residue, Group Says	Danielle Dellorto	CNN	
6/1/2010	Hidden Hazards in Fruits and Veggies	Carolyn Butler	Washington Post - Editorial	578,482

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Date	Title	Author	Publication	Circulation
6/2/2010	The Dirty Dozen: Fruits and Veggies Potentially Packed with Pesticides	Celeste M. Ball	WGN-TV Chicago	
6/2/2010	12 Most Pesticide Contaminated Fruits and Vegetables		Gawker	
6/2/2010	Organic Growth: A food Business Success Story	Barry Estabrook	The Atlantic	471,548
6/3/2010	Celery Tops New Pesticide Contamination List	Monica Eng	Chicago Tribune	452,145
6/3/2010	Non-Organic Celery Packed with 67 Pesticides	Gerald Pugliese	Organic Authority	
6/3/2010	Organic U-Pick Offer Pesticide-Free Fun for Chicagoans	Monica Eng	Chicago Tribune	452,145
6/3/2010	Blueberries and Kale Placed on Most Toxic List	Walter Crinnion	Huffington Post	
6/4/2010	Celery Tops List of Pesticide Contaminated Produce		Los Angeles Times - Editorial	616,606
6/7/2010	How to Choose Safe From Pesticide Fruits and Vegetables	Kathleen Blanchard, RN	eMax Health	
6/7/2010	CNN Features "Toxic America"		Pesticide Action Network	
6/15/2010	Good for You? Choose Veggies that are Pesticide Free	Charity Vogel	The Buffalo News	162,213
6/21/2010	Are Organic Foods Healthier?	Walter Crinnion	Huffington Post	
6/22/2010	When to Buy Organic Produce	Elaine Hastings	Florida News Press	77,676
6/25/2010	American Cancer Society Runs with the Money and Away from the Cure	Tony Isaacs	Natural News	
6/28/2010	Survey: Pesticide Contamination Link Won't Change Habits	Amanda Lilly	McClatchy Tribune News	
6/29/2010	Best Shopping Tip for Organic Foods	Denise Dador	KABC	
7/8/2010	Wash Well for Safer Produce	Landon Hall	Orange County Register	196,684
7/15/2010	Conventionally Grown Produce Can Have Residual Pesticides	Meridith Byrd	Victoria Advocate	30,143
7/15/2010	Cleveland Research Shows Link for ADHD, Pesticides	Clif Cleaveland	Chattanooga Times Free Press	76,526
7/15/2010	New Alliance for Food and Farming Website Reports "Dirty Dozen List" Misleads Consumers		Business Wire	
7/15/2010	Chemical Agriculture Group Says, Shut Up and Eat Your Pesticides		Environmental Working Group	
7/16/2010	Dirty Dozen List Misleading, Farmers Say		CNN	
7/16/2010	The 12 Dirtiest Fruits & Vegetables	Josie Glausiusz	Prevention	2,900,193
7/16/2010	New Scientific Report Shoots Down EWG's Dirty Dozen List	Jim Prevor	Perishable Pundit	
7/16/2010	Hold the Mayo, Extra Pesticides	Donald Carr	Huffington Post - Editorial	

Benchmark - Pre-campaign Coverage
October 1, 2009 thru September 30, 2010

Date	Title	Author	Publication	Circulation
7/16/2010	Panel: Environmental Working Group Plany Dirty with List	Tom Karst	The Packer	13,060
7/16/2010	Eat Your Pesticides	Ken Cook	Food Consumer - Editorial	
7/16/2010	The Best Defense Requires a Good Offence	Bryan Silbermann	The Packer - Editorial	13,060
7/19/2010	Healthy Foods Could be Doing More Harm Then Good	Danielle Snipes	WKYC-TV Cleveland	
7/19/2010	Growers Take on the Dirty Dozen List	Bob Hoff	Aginfo Net	
7/20/2010	Organic Choices	Christina Park	KFSN-TV (Fresno)	
7/21/2010	Big Ag Group Launches Pro-Pesticide Campaign	Becky Striepe	Eat, Drink Better	
7/21/2010	Industry Tired of EWG's Smear Tactics	Jim Prevor	Perishable Pundit	
7/22/2010	Big Ag Blames Pesticide Critics for US Health Problems	Cameron Scott	The Thin Greenline	241,330
7/22/2010	Why You Can't Lose Those Last 10 Pounds	Stephen Perrine and Heather Hurlock	Shine (Yahoo homepage)	
7/26/2010	Buy Organic Food: Pesticide Dirty Dozen	Toni Brayer, MD	Opposing Views	
7/26/2010	The Most Important Foods to Buy Organic		Environmental Magazine	
7/29/2010	Dietician's Book a Guide for Cancer Survivors	Bruce Fessier	The Desert Sun	46,063
7/30/2010	The Best Fruits and Vegetables to Buy Organic		CBS 11	
7/30/2010	Details on the Dirty Dozen	Anastasia Bodnar	Biofortified	
8/9/2010	What are the Most Important Foods to Buy Organic		Environmental Magazine	
8/10/2010	Settlement in Pesticide Residue Case		Western Farm Press	
8/10/2010	Tips for Fuying Organic Food		ABC 7 (Chicago)	
8/12/2010	Could Pesticides Cause ADHD	Heather Turgeon	Babble	
8/13/2010	Cheat Sheet for Buying Fruits and Veggies	Susan Perry	MinnPost	
8/16/2010	Risk to Kids from Toxic Pesticides May be Underestimated, Study Finds	tom Laskawy	Grist Magazine	
8/17/2010	Pesticide in Your Child's Lunchbox		JustMeans	
8/17/2010	The Dirty (with Pesticides) Dozen	Rich Heffern	National Catholic Reporter	45,000
8/18/2010	Study: Pesticides May Double ADHD Risk	Neil Katz	CBS News	
8/19/2010	More Evidence Links Pesticides to Hyperactivity	Thomas H. Maugh II	LA Times	616,606
8/19/2010	Researchers: Pregnant Women Should Eat Organic	Cameron Scott	The Thin Greenline	241,330
8/19/2010	A Link Between Pesticides and Attention Disorders?	Laura Blue	Time	
8/19/2010	ADHD: Misdiagnosis Rampant? Pesticides a Possible Cause	Christine Mathias	Salon	
8/20/2010	10 Dirty (Plus 5 Clean) Fruits and Veggies		Huffington Post	

Benchmark - Pre-campaign Coverage
October 1, 2009 thru September 30, 2010

Date	Title	Author	Publication	Circulation
8/23/2010	ADHD Risk in Babies Exposed to Pesticides	Paul Robertson	International Federation of Gynecology and Obstetricts	
8/23/2010	Pesticide Exposure in the Womb Increases ADHD Risk	Nancy Shute	US News and World Report	
8/26/2010	Are We Buying Fruits and Vegetables Dangerous Toxins?	Debbie Nicholson	Allvoices	
8/27/2010	Pesticide Exposure Linked to Attention Problems in Children	Katherine Krampol	Epoch Times	5,857
8/31/2010	What You Should Know About Pesticides on Fruits and Veggies	Vilie Farah	Helium	
9/21/2010	Pesticides Co's Get Tax Dollars to Attack Critics		Environmental Working Group	
9/22/2010	Organic Food: Eating with a Conscience Guide to Organic Food Choices Protective of the Environment and Farmworkers		Beyond Pesticides	
9/23/2010	Group Aiming to "Change Public Perception" on Pesticides Gets Grant	Susanne Rust	California Watch	
9/23/2010	California Funds Pesticides PR Blitz	Cameron Scott	The Thin Greenline	
9/24/2010	Grants to Tout Pesticides Bugs Environmentalists	Jill Replogle	FairWarning.com	
9/24/2010	Produce and Pesticides: What You Need to Know		Dr. Oz Show	
9/28/2010	Could Organic Produce be the New Ritalin?	Walter Crinnion	Huffington Post	
9/28/2010	Simple Steps Can Limit Risk of Cancer	Ranit Mishori	Washington Post	578,482
9/28/2010	Raising a Real Food Baby	Jeffery Lindenmuth	Huffington Post	
9/28/2010	Produce Industry Response to Dr. Oz Show			
9/29/2010	Taxpayers Funding Pro-Pesticide PR Campaign	Donald Carr	Huffington Post	
9/30/2010	Oz Pesticide Warning Untrue, Says Produce Industry	Dan Flynn	Food Safety News	
9/30/2010	Pay No Attention to Dr. Oz	Tom Karst	The Packer	13,060
9/30/2010	Industry Fires Off Letter Fefuting Safety Warnings by Dr. Oz	Joan Murphy	Produce News	12,898
9/30/2010	Produce Industry Takes Issue with Oz on Pesticides		Progresive Grocer	39,398
9/30/2010	Debunking "Dirty Dozen" Claims		Growing Produce	
9/30/2010	Dirty Dozen List Surfaces Again	Tom Karst	The Packer	13,060
			Total Articles = 160; None carrying message	

Date	Title	Author	Publication	Circulation	Msg
10/1/2010	Chemical Pesticides Linked to ADHD in Children	David Gutierrez	Natural News		
10/4/2010	Oz Pesticide Warning Untrue Says Produce Industry		Fresh Plaza		
10/5/2010	A Soap and Water Rinse Gets Produce Cleanest	Anahad O'Connor	NY Times - Opinion	951,063	x
10/5/2010	More Than 50 Groups Challenge Government Grant to Pro-pesticide PR Campaign		EWG - Press Release		x
10/5/2010	Organic Apples are Your Best Bet	Michael Roizen, MD & Mehmet Oz, MD	The Cleveland Plain Dealer	267,888	
10/6/2010	California Asked to Pull Pesticides and Produce Grant		Associated Press		x
10/7/2010	It's All About the Kids	Tom Karst	The Packer	13,060	
10/7/2010	US Spends $180K to Promote Pesticide Residue on Food	Adam Morganstern	Huffington Post		x
10/8/2010	50 Groups Sign On to Fight Pro-Pesticide Campaign		Growing a Green Family		x
10/8/2010	CA Urged to Resind Grant for Produce PR	Helena Bottemiller	Food Safety News		x
10/8/2010	Pesticide Face Off: Two Watchdog Groups Fight for the Soul of Fruits and Veggies	Megan Bedard	Take Part		x
10/11/2010	Industry Front Group Gets Taxpayer Money to Convince You to Eat Pesticide Laden Food	Jill Richardson	AlterNet		x
10/11/2010	Toxicity and Your Child: What Every Parent Needs to Know About	Megan Rostollan	Natural News		
10/11/2010	Trying to Understand Our Chemical Exposure	Jill U. Adams	LA Times	616,606	
10/12/2010	Organic Protest is Anti-Consumer		The Packer	13,060	x
10/12/2010	Q&A with Bryan Silbermann, Produce Marketing Association	Tom Karst	The Packer	13,060	x
10/13/2010	Industry Front Group Gets Taxpayer Money to Convince You to Eat Pesticide Laden Food		AlterNet		x
10/13/2010	When Fear Wins: Fallout From the "Dirty Dozen" List	Steve Savage	Red, Green & Blue		x
10/14/2010	Repeal the $180,000 Grant Awarded to Promote Pesticides	Nicole Makins	Changes.com		x
10/14/2010	What to Buy Organic	Carolyn McTighe	Toronto Sun	195,683	
10/15/2010	The Truth About Pesticides: What Are They Afraid Of?	Bryan Silbermann	Produce Marketing Association		x
10/19/2010	Are Organic Foods Really Worth the Cost?	Lisa Cleary	NBC Washington		
10/20/2010	Pesticide Politics	James McWilliams	NY Times - Opinion	951,063	x
10/20/2010	Safety of Fruits and Vegetables	Bryan Silbermann	The Hill	20,944	x
10/21/2010	Newletter From EWG: Outrageous	Ken Cook	Food Consumer		x
10/21/2010	Pesticides Taint One-Fifth of Kids' Food	Emily Barrett	Environmental Health News		

Date	Title	Author	Publication	Circulation	Msg
10/21/2010	Stop Using Tax Dollars for Big Agro's Pro Pesticide Campaign		Nat. Health Remedies and Strategies		x
10/22/2010	Researchers Take a Cue From Geomics to Decipher Environmental Exposures Link to Disease	Katherine Harmon	Scientific American	599,840	
10/22/2010	The Fear Mongering Industry Fights the Facts		Center for Consumer Freedom		x
10/25/2010	One Quarter of the Foods Kids Eat Contain Pesticides	Sarah Parson	Changes.com		x
10/25/2010	Want Some Bug Killer With That?	Elaine Shannon	Huffington Post		x
10/27/2010	Shame on USDA for Supporting Big Industry Attack on Consumer Watchdog Group	Wendy Gordon	OnEarth Magazine	150,000	x
10/28/2010	How to Lower Your Pesticide Consumption		BebePure		
10/28/2010	Shoppers Guide: Pesticides		GW Food Justice Alliance		x
10/28/2010	Voice of Reason on Pesticides	Kathy Means	PMA From Field to Fork		x
10/29/2010	Why Do We Need to Eat a Variety of Foods?	Sunny Day	Sunny's Day		
11/2/2010	Food Safety - What's On Your Plate?		HealthWorldNet.com		
11/3/2010	5 Scary Cancer Questions Answered	Lucy Danziger	Self Magazine	1,516,075	
11/4/2010	Choosing Organic	Dr. Joanna Dolgoff	The Balancing Act.com		
11/4/2010	Organic Foods: The Meaning Behine the Label	Megan Rupp	The University Daily Kansan		
11/4/2010	When Big Ag Attacks: Government-Sponsored Pesticide Progaganda	Barry Estabrook	The Atlantic	471,548	x
11/4/2010	Alliance for Food and Farming Issues New Report to Illustrate the Safety of Fruits and Vegetables		Business Wire		x
11/8/2010	Is It Genes? Is It Me? A Mother's Maze Through ADHD	Katherine Ellison	LA Times - Opinion	616,606	
11/8/2010	Most Pesticide Laden Fruits and Veggies List Under Attack	Kiera Butler	MotherJones.com		x
11/8/2010	Want Some Pesticides With That Apple?	Sandy Bauers	Philidelphia Inquirer	356,189	
11/9/2010	The Truth About Pesticide Residues - There's an App for That	John Heath	AgriTalk		x
11/9/2010	Pesticides in Your Veggies? Yes, But Agribusiness Backed Groups Says No Worries		EnviroLink.com		x
11/10/2010	New Study Puts Pesticide Data into Perspective	Tom Karst	The Packer	13,060	x
11/10/2010	USDA - Please Stick to Good Science	Susan Schneider	AgricultureLaw		x
11/11/2010	Organic Food Under Attack?	Jill Ettinger	Organic Authority		x

Date	Title	Author	Publication	Circulation	Msg
11/11/2010	Pesticides and Produce: What You Need to Know	Kirby Brooks	Think Green, Live Clean		
11/12/2010	Negative Messages Shape Consumer Opinion	Don Schrack	The Packer	13,060	x
11/15/2010	Alliance for Food and Farming Releases Safe Produce Calculator		The Grower	22,055	x
11/16/2010	Five Organic Groceries That Aren't Worth Your Money	Jane Porter	WTSP-TV Tampa		
11/17/2010	Epidemics Galore, The Proof is in The Population	Julie McGinnis, MS, RD	Allergy Kids		
12/1/2010	Putting Pesticide Residues in Perspective	Jannette E. Warnert	Ag & Nat. Resourses, Univ. of CA		x
12/3/2010	Top 12 Toxic Fruits and Vegetables		The Truth of Life		
12/6/2010	Organic Foods Taking Root in the Bay Area	Kevin Wiatrowski	Tampa Tribune	145,045	
12/16/2010	Everyday Exposures to Toxic Chemicals: Is Your Family Safe	Dr. Nalini Chilkov	Huffington Post		
12/20/2010	Smart Spending When Buying Organic Foods		CBS 4 Miami		
12/21/2010	Is Organic Always the Best Pick When it comes to Buying Food	Elizabeth Weise	USA Today	1,826,622	
1/13/2011	Gen X Mom Sarah Talks How and Why of Organic Produce, Dirty Dozen	Tom Karst	The Packer	13,060	x
1/14/2011	Nearly All Pregnant Women Harbor Potentially Harmful Chemicals	Jennifer LaRue Huget	Washington Post	578,482	
1/18/2011	The 12 Most Pesticide Ridden Fruits and Veggies		Health and Healthcare		
1/18/2011	Toxic Fruits and Veggies? The Dirty Dozen to Avoid		Organictoxicfree.com		
1/21/2011	Seven foods So Unsafe Even Farmers Won't Eat Them		Revolution Broadcasting.com		
1/31/2011	USDA Announces Public Meeting: Seeks Comments on Positions of Pesticide Residues Committee of Codex		USDA Press Release		
2/1/2011	The Invisible Surgeon General	Dr. Henry Miller	LA Times	616,606	
2/2/2011	The Best and Worst Vegetables to Eat	Dr. Joseph Mercola	Huffington Post		
2/4/2011	The Clean Fifteen		CelebrityDiets.org		
2/15/2011	Myth-busting, Fresh Produce Style	Produce Marketing Association	Progressive Grocer	39,398	x
2/15/2011	Organic Weight Loss for Women		International Business Times		

Date	Title	Author	Publication	Circulation	Msg
2/15/2011	When is it Worth Buying Organic?		LearnVest.com		
2/22/2011	10 Dirty Fruits and Veggies	Ashley Macha	Health.com		
2/23/2011	Pesticides on Fruit and Veggies are Wrecking Men's Fertility	Fiona Macrae	Daily Mail (UK)		
2/25/2011	The Clean 15: Foods You Don't Need to Buy Organic	Sally Deneen	WalletPop.com		
2/28/2011	Female Mice Disabled by Parents' Pesticide Intake	Lynn Markham	Bay View Compass (WI)		
3/10/2011	Produce's Dirty Dozen	Shanna Maleeff	The Daily PT		
3/14/2011	Reducing Your Pesticide Consumption	Ken Cook	Organic Valley		
3/15/2011	Pest Problems	Jenna Telesca	Supermarket News	32,233	x
3/15/2011	Which Produce is Best Bought Organic?	Kara Yorio	NorthJersey.com		
3/15/2011	Ditching Diet Soda	Joy Bauer	Today Show		x
3/21/2011	Organic Food, Is it Worth It?	Eleanor Goldberg	Patch.com		
3/28/2011	20 Organic Foods That Are Actually Worse for You		AmazingFacts.com		
3/28/2011	Should You Always Buy Organic?	Deepak Chopra, MD, Alexander Tsisrus, VisualMD.com	Huffington Post		
3/30/2011	Fruits and Veggies are Good For You (I Thought)		IDigFitness.com		
3/31/2011	11 Things Your Should Buy Organic	Sara Reistad-Long	Health.com		
3/31/2011	When to Go Organic and When Not to Bother	Deanna Embury	Licious Living		
	(Oct. 1, 2010 thru Mar. 31, 2011)		**(88 Articles posted with 39 carrying messaging)**		
4/8/2011	Organic vs Nonorganic: What Fruits and Veggies Should You Buy?	Darcy Bonfils	ABC News		
4/11/2011	Keeping Her a Kid as Long as Possible	Liz Szabo	USA Today	1,826,622	
4/14/2011	Avoid Pesticides by Eating Organic	Sarah Saltzman	RedandBlack.com (Univ. of GA)		
4/14/2011	Produce Debate: Fresh vs Frozen	Amy Howell Hirt	Cincinnati Enquirer		
4/19/2011	Tips on How to Buy Food That's Better for You and the Earth	Casey Blake	Asheville Citizen-Times	34,803	
4/21/2011	Prenatal Pesticide Exposure Linked to Lower IQ	Angela Haupt	US News and World Reports		
4/21/2011	Pesticide Exposure in Womb Affect IQ	Tara Parker Pope	NY Times - Blog		
4/21/2011	Pesticide Exposure in Womb Linked to Lower IQ	Brenda Goodman	WebMD		
4/22/2011	Top 15 Least Contaminated Fruits, Vegetables	Enjoli Francis	ABC World News		

Date	Title	Author	Publication	Circulation	Msg
4/28/2011	Choosing Organic Produce: EWG's Dirty Dozen List	Rob Endelman	TheDeliciousTruth.com		
4/28/2011	Fighting Back Against the Frauds at the EWG		Shaw's Ego-Logic.com		
4/29/2011	Industry Seeks USDA Support with Pesticide Residue Report	Tom Karst	The Packer	13,060	
5/2/2011	Alliance for Food and Farming Holds Webinar on Safe Fruits and Veggies	Alliance for Food and Farming	Business Wire		x
5/2/2011	Do You Really Want to Eat That?	Karen Coates	The Faster Times		
5/2/2011	Group Plans Seminar on Pesticide Perceptions	Tom Karst	The Packer	13060	x
5/4/2011	Coming: Dirty Dozen of Organic Produce?	Tom Karst	The Packer	13060	
5/4/2011	Maybe Think Twice Before Buying Strawberries from California	Jeannie Moulton	Eat, Drink Better		
5/4/2011	The Pesticide Shoppers Guide		Foodnews.org		
5/4/2011	Pesticides, Bugs and Toxins, Oh My! What's Lurking in Your Food?	Catherine Pearson	Huffington Post		
5/6/2011	Girls' Early Puberty: What Causes It, and How to Avoid It	Joel Fuhrman, MD	Huffington Post		
5/9/2011	Produce Magic Eliminates Pesticides From Produce	Debra Atlas	Record-Searchlight		
5/12/2011	Alliance for Food and Farming Launches Industry Alert System		FreshPlaza		x
5/12/2011	Alliance Offers Alerts on Produce Media Stories	Mike Hornick	The Packer	13,060	x
5/16/2011	Produce Industry Presses USDA on Pesticide Report	Lyndsey Layton	Washington Post		x
5/16/2011	Produce Industry Wants Americans to Eat Their Pesticide-Laden Veggies	Sarah Laskow	Grist Magazine		x
5/16/2011	Their Spray Rigs in a Twist	Ken Cook	Huffington Post		
5/17/2011	Big Ag Doesn't Want You to Care About Pesticides	Tom Laskawy	Grist Magazine		
5/17/2011	Eat Local, Eat Clean, Avoiding the Dirty Dozen	Alicia Kelley Raymond	Napa Valley Register		
5/17/2011	EWG, Top Scientist Urge Administration to Release New Pesticide Residue Data	Environmental Working Group	Press Release		x
5/17/2011	USDA Plans to Release Pesticide Data This Week	Tom Karst	The Packer	13,060	
5/18/2011	Cleansers Are the Rage, But Do They Work?	Laura Casey	Contra Costa Times		
5/18/2011	Pesticide Campaign Gives Web Update	Jenna Telesca	Supermarket News		x
5/18/2011	Produce Industry Says Quit Complaining About Pesticides	Megan Bedard	Take Part		x
5/18/2011	Safe Fruits and Veggies Campaign in Full Swing	Brian Sparks	Growing Produce		x

Date	Title	Author	Publication	Circulation	Msg
5/18/2011	USDA Slow to Release Pesticide Residue Data		The Daily Green		
5/18/2011	USDA: Stop Funding Disinformation!	Ken Cook	Newsroom America		x
5/19/2011	Scientists Say USDA Pesticide Data is Late		Food Safety News		
5/19/2011	System Responds to Negative Claims	Cecilia Parsons	Capital Ag Press		x
5/19/2011	Yes, You Can Afford, Shop Frugally and Ethically	Stella Louise	Save at Savings.com		
5/20/2011	EWG supporters Urge USDA to Stop Funding Pro-pesticide Campaign with Taypayer Dollars		CommonDreams.org		x
5/23/2011	14 Foods to Buy Organic	Joanna Dolgoff, MD	Huffington Post		
5/23/2011	Fighting The Good Fight		The Packer - Opinion		x
5/23/2011	Let's Work Together to Cut Pesticide Residues	Chuck Benbrook	The Packer - Opinion		x
5/24/2011	Physicians, Scientists Call for More Pesticide Testing on Kids' Favorite Fruits and Veggies		Lexology.com		
5/25/2011	Administration Releases Long Overdue Pesticide Data		EWG - Press Release		x
5/25/2011	Alliance for Food and Farming Urges Consumers to Learn More About the Safety of Their Food		AFF - Press Release		x
5/25/2011	Foods That You Adsolutely Should Go Organic For	Joanna Dolgoff, MD	LowCarbDiet.com		
5/25/2011	Pesticides You Eat Shouldn't Be Measured, Says Food Industry	Emily Main	Rodale.com		x
5/25/2011	USDA Releases 2009 Annual Summary for Pesticide Data Program		FreshPlaza		
5/25/2011	USDA Releases 2009 Annual Summary for Pesticide Data Program		USDA Press Release		
5/25/2011	USDA's Pesticide Data Program Report Five Months Late	Rob Endelman	The Delicious Truth		x
2/26/2011	Ask Liz: Pesticides on Produce	Liz Crenshaw & Katie Roberts	NBC Washington		
5/26/2011	Is Organic Always Better?	Becky Ackerman	Technorati.com		
5/26/2011	USDA Releases Annual Pesticide Summary		Food Safety News		x
5/26/2011	USDA: Overall Pesticide Residues Below EPA Limits	Tom Karst	The Packer		x
5/27/2011	USDA Releases Annual Pesticide Report	Joan Murphy	Produce News		x
5/27/2011	USDA Stop Funding Pro-Pesticide Groups		Care2.com		x
6/1/2011	Produce Industry Seeks to Soothe Fears on Pesticides	Monica Eng	Chicago Tribune		x
6/1/2011	Produce Industry Seeks to Soothe Fears on Pesticides	Monica Eng	Miami Herald		x

Date	Title	Author	Publication	Circulation	Msg
6/1/2011	Testing Turns Up Unapproved Pesticides in Cilantro	Monica Eng	Chicago Tribune		
6/2/2011	How Clean is Your Produce: Health Officials Name the Dirtiest Fruits and Vegetables	Monetta Harr	Jackson Citizen Patriot		
6/6/2011	Finding Common Ground	Brian Sparks	Growing Produce		x
6/7/2011	Best Friends Forever? Produce Growers and Pesticide Makers Deepen Their Bond	Ken Cook	EWG-Huffington Post		x
6/9/2011	How Safe is Half My Plate?	Alliance for Food and Farming	Press Release		x
6/9/2011	EWG Shoud Disavow "Dirty Dozen" and Money Grubbing Tactics	Tom Karst	The Packer		x
6/10/2011	Family Farmers Say Son't Let "Dirty Dozen" Allegations Keep You From Fresh Fruit	Western Growers	Business Wire		x
6/13/2011	98% of Apples Have Pesticide Residues, USA	Christian Nordqvust	Medical News Today		
6/13/2011	Alliance for Food and Farming Responds to "Dirty Dozen" List Release	Alliance for Food and Farming	Business Wire		x
6/13/2011	Apples Just Got Dirtier	Robin Shreeves	Mother Nature Network		
6/13/2011	Apples Top 2011 Dirty Dozen List, Says Group		CNN (blog)		
6/13/2011	Apples Top List of Produce Contaminated With Pesticides	Janice Lloyde	USA Today		
6/13/2011	Dirty Dozen: The 12 Fruits and Vegetables with the Most Pesticides		Huffington Post		x
6/13/2011	For Pesticides: Apples are Worst, Onions the Best	Scott Hensley	NPR		
6/13/2011	My Dirty Dozen List	Steve Savage	Sustaniablog.com		
6/13/2011	Pesticide Residues Taint Apples	Scott Kilman	Wall Street Journal		
6/13/2011	The Delicious Dozen: 12 Healthly Reasons to Eat an Apple a Day	US Apple Association	PR Newswire		
6/13/2011	The New Dirty Dozen List of Produce		Yahoo News		
6/14/2011	Apples Are Top Food with Most Pesticides	Daniel J. DeNoon	WebMD		
6/14/2011	Apples Knock Celery Off of the Top of the Dirty Dozen Produce List	Denise Reynolds, RD	eMax Health		
6/14/2011	Apples Top Dirty Dozen List	Tom Karst	The Packer		x
6/14/2011	Apples Top Dirty Dozen List	Angels Haupt	US News and World Reports		
6/14/2011	Apples Top Group's Most Contaminated List	Fran Jeffries	Atlanta Journal Constitution		

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6/14/2011	Apples Top List For Pesticide Contimination	Barry Bagnato	CBS News		x
6/14/2011	Dirty Dozen List of Produce and Pesticides Released Today	Monica Eng	Chicago Tribune		x
6/14/2011	Don't let EWG Diminish Your Quality of Life!	Steve Savage	Sustaniablog.com		
6/14/2011	Enviro Group's Report: Apples Most Contaminated with Residues	Jeremy P. Jacobs	Greenwire		x
6/14/2011	Just in Time for Summer…..	Josephine Marcoty	Minnesota Star Tribune		x
6/14/2011	Pesticide Laden Produce: Apples and Celery Top the List	Ashlie Rodgriguez	LA Times		x
6/14/2011	Pesticides in Fruits and Vegetables: Are They Really Healthy?	Alyssa Newcomb	ABC News		x
6/15/2011	Is the EWG's Dirty Doxzen List Misleading?	Lisa Barger	This Week in Alternative Medicine		x
6/15/2011	Apples Lead EWG's Dirty Dozen List	Mary Rothschild	Food Safety News		
6/15/2011	Environmental Working Groups Dirty Dozen	Marion Nestle	Food Politics		
6/15/2011	Top 12 toxic Fruits and Vegetables	Melissa Breyer	Care2.com		
6/15/2011	Poison Apples Bad for Consumers, Snow White	Tom Philpott	MotherJones.com		x
6/15/2011	Apples Can be Tainted With Pesticides - But You Still Need Your Fruits and Vegetables	Bryan Walsh	Time (blog)		x
6/15/2011	Don't Like Pesticides? Better Avoid These Fruits and Veggies	Cameron Scott	The Thin Greenline		
6/15/2011	An Apple a Day Dirty With Pesticides, Study Shows	Jeb Phillips	Columbus Dispatch		x
6/15/2011	Dirty or Not, You Still Need to Eat Your Fruits and Vegetables	Meridith Melnick	Time		x
6/15/2011	Washington Apple Commission Defends Pesticide Use	Dan Mitchinson	KIRO-FM		x
6/15/2011	USDA Pesticide Data Shows Startling Differences in Produce Residue Levels	Organic Trade Assoc.	Press Release		
6/15/2011	Apples May Top Pesticide List, But Everyone Agrees on One Point	Marissa Cevallos	LA Times		x
6/15/2011	Apples Are Dirty, But Cabbage and Corn Are Clean	Jonathan Kauffman	SF Weekly (blog)		
6/15/2011	How Much Pesticide is in The Apples We Eat?	Landon Hall	Orange County Register		
6/16/2011	An Apple a Day is Full of Pesticides		Babble.com		
6/16/2011	E.coli Traced to Sprouts From Organic Farm	Gilbert Ross	Financial Post		
6/16/2011	Farmers Frustrated at EWG Distortion of Food Facts		Western Farm Press		

Date	Title	Author	Publication	Circulation	Msg
6/17/2011	Apples Are Not to be Feared	Tracy Warner	Wenatchee World		
6/17/2011	Apples Found to Contain the Most Pesticide Residue	Samantha Bonar	LA Times (blog)		
6/17/2011	If Eating Two Apples a Day is Going to Kill Me, So Be It	Dennis Wyatt	Manteca Bulletin		
6/17/2011	Industry Should Take Control of Pesticide Debate	Bryan Silbermann/Matt McInerney	The Packer - Opinion		x
6/17/2011	Should I Avoid the Dirty Dozen	Dr. Melina Jampolis	CNN Health		
6/17/2011	The Dirtiest and Cleanest Fruits and Vegetables	Nick Eaton	Seattle Post Inteligencer		
6/17/2011	Twelve Fruits and Vegetables That are Covered in Pesticides	Robert Johnson	Business Insider		
6/17/2011	West Virginia Department of Ag Downplays Apple Pesticide Report	Veronica Nett	West Virginia Gazette		
6/17/2011	What Foods Top the Dirty Dozen List?	Rachel Fox, RD	Eat, Drink Better		
6/20/2011	Affording Organics	Kelli Grant	CBS News		
6/20/2011	Apples Top Dirty Dozen List, But Growers Say Results Are Misleading	Leslie Cole	The Oregonian		x
6/20/2011	CropLife America Releases Dirty Dozen Report	CropLife America	Farm Chemicals International		
6/20/2011	Dirty Dozen Solving the Pesticide Problem	Julia Dubois	A Healthier Michigan		x
6/20/2011	Farmers Question the Dirty Dozen	Connor Ramsey	The Pinnacle		x
6/20/2011	Organic Foods Can Fit Into Modest Budget	Carol Gunter	The Augusta Chronicle		
6/21/2011	Dirty Dozen Debate	Kelly April	Chicago Tribune		x
6/21/2011	12 Fruits and Vegetables with Higest Level of Pesticides	Jaclyn Brunfield	Green Parenting		x
6/22/2011	Organic Fruits: Are You In or Not?	Landon Hall	Orange County Register		
6/22/2011	Is the Clean 15 Just as Toxic as the Dirty Dozen?	Tom Philpott	MotherJones.com		
6/22/2011	Helping Shoppers Stay Clean	Sandy Almendarez	Natural Products Marketplace (blog)		
6/22/2011	Fruits and Veggies Get Clean Bill of Health as Activist Whine	Richard Cornett	Western Farm Press - Editorial		
6/22/2011	Dirty Dozen: How Much Pesticide is in Our Fruit?	Landon Hall	Orange County Register		x
6/22/2011	Clean Fifteen Just as Toxic as Dirty Dozen for Farm Workers	Jef Nield	TreeHugger.com		
6/22/2011	Berry Happy the Local Blues Are In	David Hagendorn	Washington Post		x
6/22/2011	Apples Receive Top Honors on Dirty Dozen List	Deirdre Imus	Fox News		

Date	Title	Author	Publication	Circulation	Msg
6/22/2011	Apples Highest in Pesticides on Groups Dirty Dozen List	Susan Salisbury	Palm Beach Post		x
6/23/2011	Apples, Celery Top Pesticide Watch List	Linda Doell	WalletPop.com		
6/23/2011	Fruits, Veggies on Dirty Dozen List Are Worth Buying Organic	Natalie Mikles	Tulsa World		
6/23/2011	Health Watch: The Dirty Dozen	Beth Galvin	MyFoxAtlanta		x
6/23/2011	Safe Fruits and Veggies	Scott Christie	Fresh Cut Magazine		x
6/23/2011	What's Behind Organic and Biodynamic Wines	Scott Greenberg	Washington Examiner		
6/24/2011	Report List Worst, Cleanest Fruit for Pesticide Residue, But Does it Matter?	Matt Vande Bunte	Grand Rapids Press		x
6/27/2011	Apple Picking Data Leaves Bad Taste	Je Schwarcz	Montreal Gazette - Editorial		x
6/27/2011	Even Organic Industry Should Denounce Dirty Dozen	Greg Johnson	The Packer - Opinion		
6/27/2011	Fruits & Veggies You May Want to Consider Buying Organic	Leslie Sims	ABC15 - Phoenix		
6/27/2011	Getting Down and Dirty with Pesticide Residue and the Dirty Dozen		BestFoodFacts.org		x
6/27/2011	How Concerned Should We Be About Pesticides	Tami Gustafson, RD	Seattle Post Inteligencer		
6/27/2011	Which Foods Have the Most Pesticides? EWG Releases a List	Sandy Bauers	Philadelphia Inquirer		
6/28/2011	EWG Gets Far Bigger Subsidy Than Farmers	Harry Cline	Western Farm Press-blog		
6/28/2011	Publicity Stun Aims to Scare More Than Inform		Truth About Trade & Technology		x
7/5/2011	Group Lists the Fruits and Vegetables That Have the Most Pesticides		Kansas City Star		
7/5/2011	Website's Pesticide Residue Calculator Helps Allay Consumers' Fears	Vicky Boyd	The Grower Magazine		x
7/6/2011	What Would Grover Norquist Say?	Andrew Hug	Environmental Working Group		x
7/6/2011	Pesticides in Produce: When to Buy Organic	Janet Rausa Fuller	Chicago Sun Times		x
7/6/2011	Meet the Food Industry Front Groups That Push For Carcinogens in Your food	Jill Richardson	AlterNet		x
7/6/2011	As More Farmers go Organic, Consumers Ask, What Does Organic Really Mean?	Lauren C. Zupkus	Asbury Park Press		
7/7/2011	Is Your Family Eating Dirty Produce?	Shelby Barone	Orange County Register		

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7/7/2011	Industry Education Efforts Moderate the Damage, But the Media Can't Resist EWG's Annual dirty Dozen Stunt	Jim Prevor	Perishable Pundit		x
7/12/2011	The Benefits of Organic Food - For Less	Manuel Villacorta, RD	Huffington Post		
7/14/2011	The Dirty Dozen Rides Again	Dave Stockdale	SF Chronicle		x
7/14/2011	Pesticides by the Pound	Steve Laws	Sherwood Gazette		
7/18/2011	Pets Join in on the Organic Food Trend	Jeannine Stein	LA Times		
7/19/2011	First Blog Post: What Others Are Saying	Alliance for Food and Farming	SafeFruitsandVeggies.com		x
7/20/2011	Apples Get Rotten Press Coverage	Jack Dini	Canada Free Press		
7/20/2011	Media Misstatements and Inaccuracies Perpetuated by Dirty dozen Authors	Alliance for Food and Farming	SafeFruitsandVeggies.com		x
7/22/2011	Pesticides Bug Me! CCOF Releases Campaign Site and Design Competition		CisionsWire		
7/22/2011	15 Reasons Not to Buy Organic	Mandy Major	Women's Day		
7/26/2011	Thomson-Reuters NPR Health Poll		Thomson-Reuters		
7/27/2011	Organic Food for Thought		San Antonio Express News		x
7/29/2011	Shoppers Have a Problem with Pesticides	Alex Fromuzis and Dawn Undurraga	Environmental Working Group		x
8/1/2011	Best Bets if a Budget Curbs Your Organic Food Picks	Lisa Wallace	SF Chronicle		x
8/1/2011	Pesticides vs Organic Farming Methods Make Environmental News	Lorraine Savage	HighBeam.com (blog)		x
8/8/2011	EWG: The Endlessly Wrong Group		The Center for Consumer Freedom		
8/12/2011	Environmental Working Groups Dirty Dozen List Debunked	Greg Conko	OpenMarket.org		
8/12/2011	Environmental Working Groups Dirty Dozen Scaremongering Exposed	Ronald Bailey	Reason.com		
8/12/2011	Food Scientist Debunk Dirty Dozen List		Food Product Design		
8/12/2011	Reign of Error	Geni Wren	Drovers		
8/12/2011	Was UC Davis Dirty Dozen Study Supported by Pesticide Industry?	Ben Norris	Top Secret Writers		

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8/15/2011	All Consuming: Critics Dispute List of Dirty Dozen Fruits, Vegetables	Susan Salisbury	Palm Beach Post		x
8/15/2011	Organic Fanatics Get a Black Eye		Blogger News Network		
8/16/2011	EWG's Dirty Dozen List Still Kicking up Dirt on EWG	Harry Cline	Western Farm Press		x
8/24/2011	Pesticide Residues on Produce	Mary Saucier Choate, MS, RD, LD	Co-op Food Stores Newsletter		x
8/30/2011	California DPR Expands Pesticide Residue Monitoring		Western Farm Press		
8/31/2011	California: Few Pesticide Residues in Produce		Associated Press		
8/31/2011	Pesticidee Concerns May Actually Harm Us	Emily Sohn	Discovery News		
9/1/2011	Can't Eat Organic? Here's How to Lower the Chemical Bacteria of Your Food	Sven Gustafson	A Healthier Michigan		
9/1/2011	Pesticide Concerns Put Lower Income Populations at Risk		General Health Channel		
9/2/2011	Apples Now Standard in McDonalds Happy Meals, But How Nutritious is This Fruit?	Jennifer LaRue Huget	Washington Post		
9/6/2011	Dirty Dozen? Apples Good for Your Health Despite Pesticide Warnings, Experts Say	Carrie Johnson Weimar	Health Science Center News & Communications		
9/13/2011	Alliance for Food and Farming Report Confirms Trend Towards Use of Environmentally Friendly and Reduced Risk Pesticides	Alliance for Food and Farming	Business Wire		
9/20/2011	Organic: Is it Worth It?	Danielle Hayes	Tonawanda News (New York)		
9/20/2011	The Cost of Eating Organic	Jill Keppeler	Tonawanda News (New York)		
9/21/2011	An EAT CLEANER Apple a Day Will Keep the Doctor Away	Eat Cleaner	PRNewswire		
9/21/2011	An Interview With PMA's Silbermann	Matthew Enis	Supermarket News		x
9/23/2011	Organic Foods: Higher in Price, Not Health	James Gherardi	ABC Channel 13 (Lynchburg, VA)		
9/26/2011	Can We Trust the Benefits of Organic Foods?	Marta Montenegro	Fox News Latino		
9/26/2011	Don't Let Dirty Dozen Scare You	Rachel Niefeld, RD	Poughkeepsie Journal		
9/29/2011	Cleaning Up the Dirty Dozen	Jeff Stier and Henry I. Miller	Forbes (blog)		
	(Apr. 1, 2011 thru Sept. 30, 2011)		**(194 Articles posted w/ 77 carrying messaging)**		
10/3/2011	Taking Steps on Food Chemicals	Marion Nestle	SF Chronicle		
10/4/2011	Activists' Dangerous "Dirty Dozen" Drama Debunked; Media Dozen	Jeff Stier	Amy Ridenour's National Center Blog		

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10/5/2011	Detox Your Produce with Brush, Water	Oz, MD			
10/6/2011	Lists Help Produce Consumers Know How to Choose Wisely	Janice Hackert	University of Missouri		
10/7/2011	Organic Sound Like a Good Idea; How to Tell if it's Not	Christina Fitzgerald	Chicago Daily Herald		
10/11/2011	Organic Misinformation is Counterintutive	Christina Bushway	The Packer		
10/13/2011	Eco Meets the Economy	Steven Kurutz	NY Times		
10/14/2011	Review: Reducing Pesticides in Your Food		Meaningful Western Life		
10/17/2011	Pesticides Are Good for You	Michele Simon	Food Safety News		
10/18/2011	Organic vs Non-organic: Choosing Produce Based on Pesticide Exposure	Dana Rebik	KCPQ-TV (Seattle)		
10/19/2011	Environmental Group to Rate the Safety of 10,000 Foods	Meridith Melnick	Time		
10/21/2011	Pesticides Are Good for You	Michele Simon	Grist Magazine		
10/25/2011	Pesticide Hacks Attack Popular Shopper's Guide	Alex Fromuzis	Huffington Post		
11/3/2011	A Fish Test to Make Food Safer		PhysOrg.com		
11/3/2011	Organic Produce and the Dirty Dozen to Avoid	Abbey Gibb	KGW.com		
11/7/2011	EWG's Dirty Dozen: A Produce Guide		Wellsphere		
11/9/2011	Farmed Fish Fed Vegetable Matter May Have Residual Pesticides		Science Daily		
11/21/2011	Pesticides in Your Produce? KLS Puts Utah Fruit to the Test	Richard Piatt	KLS News (Salt Lake City)		
11/22/2011	Dirty Dozen Pesticide List: Why it Matters to Eat Organic	Jessica Hoffman	Seattle Post Inteligencer		
11/22/2011	Recent Reports Help Consumers Reduce Pesticide Exposure and Improve Nutrition	The Organic Center	eNews Forest Park		
11/22/2011	Shopping for Real Food on a Budget	Nancy Deville	Huffington Post		
11/30/2011	Stand Up to Pesticides	Rachel Lincoln Sarnoff	Huffington Post		
12/8/2011	Do You Pay More for Organic? You Might be Paying For Pesticides	Wency Leung	Globe & Mail		
12/8/2011	Pesticides Found in Canadian Organic Produce		CBC.ca		
12/14/2011	There's No Escaping Pesticide Residue, Claim Organic Leaders		Better Farming		
12/28/2011	10 Foods With the Highest Pesticide Residues	Lauren Gordon	The Daily Meal		
1/3/2012	Want to Lose Unwanted Pounds?	Cynthia Phillips	Patch.com		
1/4/2012	Seven Ways to Detoxify Your Life	Terri Bennett	Charlotte Observer		

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1/9/2012	Doing Right by Your Diet	Karen Weintraub	Boston Globe		
1/10/2012	FDA Steps Up Testing for Fungicide in Orange Junce	Mary Claire Jalonick	Associated Press		
1/12/2012	Coca-Cola Says it Alerted FDA About Fungicide		Associated Press		
1/12/2012	FDA Halts Orange Juice Imports to Test for Pesticides		Bloomberg		
1/12/2012	Is Organic Produce Worth the Extra Money? Only in Some Cases, Experts Say	Acata Felton	Peninsula Press (CA Bay Area)		
1/13/2012	Tainted Juice Episode Calls FDA Capabilities Into Question	Elizabeth Weise	USA Today		
1/16/2012	Apple Juice Made in America? Think Again	Christina Rexrode	Associated Press		
1/16/2012	Fungicide Found in Orange Juice allowed in Other Food	Susan Salisbury	Palm Beach Post		
1/16/2012	Health Children, Safe Homes, a Winning Combination	Mary Elizabeth Dallas	HealthDay News		
1/16/2012	To Buy or Not to Buy: Organic it the Question	Arlene Miller	Don't Eat Dirt		
1/17/2012	Three Orange Juice Samples Tested for Fungicide Are Negative		LA Times		
1/19/2012	Is Organic Really Better for Your Family?	Shelby Barone	OC Register		
1/20/2012	OJ Screening a Regulatory Issue, Not a Health One	Kristina Fiore	MedPage Today		
1/20/2012	Orange Juice Shows Us the Toxic Side of International Trade	Dr. Gary Ginsberg	Huffington Post		
1/20/2012	Q & A: Carbendazim and Orange Juice		Food Safety News		
1/23/2012	FDA: Orange Juice Recall Wasn't Warranted	Dina ElBoghdady	Washington Post		
1/25/2012	List of Pesticide Free Foods Released		FreshPlaza		
1/25/2012	Strawberries Pesticide-Laden, Pineapples Better: An App to Find the Best	David Minsky	Miami New Times (blog)		
1/30/2012	Should You Buy Organic? 12 Most Contaminated Foods	Katalin Rodriguez	ChicagoNow		
2/3/2012	FDA Confirms Fungicide in Orange Juice	Mary Claire Jalonick	Associated Press		
2/3/2012	FDA Finds Low Levels of Fungicide in Orange Juice Concentrate	Matt Stevens	LA Times		
2/3/2012	Is Your Orange Juice Safe? FDA Says Carbendazim Causes No Safety Concern	Jim Avila, Kevin Dolak, Carrie Gann	ABC News		
2/6/2012	Weekend Wisdom: The Dirty Dozen		MyPlate2Yours.com		
2/13/2012	Soapy Milk, Toxic Apples: Food Safety in India		Reuters		
2/21/2012	Beat the System: When to Buy Organic	Eric Harryman	Fox40 News (Sacramento)		
2/21/2012	Organic vs Non-Organic Foods	Erin Hawley	First Coast News (Jacksonville, FL)		

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2/21/2012	Pesticides	Environmental Working Group	Newsroom America.com		x
2/22/2012	Organic Foods Available to Suit Every Budget	Environmental Nutrition Newsletter	Chicago Tribune		
2/22/2012	Action: Encourage the USDA to Stand Up for Consumer Interest, Not Cave to Pesticide Lobby	Environmental Working Group	EcoWatch		x
2/23/2012	FDA Says Brazil's Orange Juice is Safe, But Still Illegal	Dan Charles	NPR		
2/23/2012	Policy Plate: Room for Debate and the Pesticide Bullies	Don Carr	Environmental Working Group		x
2/27/2012	DPA Online Bulletin		CA Dept of Pest Reg.		
2/28/2012	Pesticide Exposure in Food Affects Children's Intelligence: Study	Sarah Damian	Food Integrity Campaign		
2/29/2012	Ignore "Dirty" EWG Rhetoric : Eat Fruits and Veggies	Dr. Carl Winter	Western Farm Press		x
3/5/2012	Ask the Diet Doctor: The Truth About Organic Foods	Mike Roussell, PhD	Shape Magazine		
3/5/2012	Follow the Dirty Dozen with the Clean Fifteen	Betsy Wild	Cleanwithbetsy.com		
3/5/2012	Mondays Medical Myth: Organic Food is More Nutritious	Clare Collins	The Conversation (N. Zealand)		
3/5/2012	Organically Speaking: Your Supermarket Guide to Buying Organic	Diane Hendriks	ABC News		
3/5/2012	Science Reporting on Organic Food is Out to Lunch	Joshua Gilder	US News and World Reports		
3/5/2012	Shock: Organic Farmers Use Chemicals Too		Consumer Freedom		
3/7/2012	How Food Safety Knowledge Can Affect Your Health		Milwaukee Journal Sentinel		x
3/8/2012	Save Cash While Shopping Organic		Chicago Tribune		
3/14/2012	Put a Little Spring in Your Diet	Christina Choi	McDill News Service		
3/16/2012	How to Save on Organic Produce	Wendy Donahue	Chicago Tribune		
3/26/2012	Pesticide Residue Risk Recalculated	Dennis Avery	Canada Free Press		
3/26/2012	Review the Environmental Working Group's Dirty Dozen List of Fruits and Vegetables		Practically Green		
	(Oct. 1, 2011 thru Mar. 31, 2012)		**(74 Articles posted with 5 carrying messaging)**		
4/3/2012	Health Advocate Weighs in on US Food Safety	Charles Platkin	Reno Gazette		
4/5/2012	Pesticides May Linked to Slightly Smaller Babies, Shorter Pregnancies	Jenifer Goodwin	Health Day News		

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4/11/2012	7 Simple Ways to Save Money on Healthy Food	Sabah Karimi	Wise Bread		
4/11/2012	Fruits and Vegetable Farmers Talk About Pesticide Use via New Allliance for Food and Farming Site	Alliance for Food and Farming	Perishable News		x
4/11/2012	Is Organic Right For You?	Renee Thompson	Ball State University Daily News		
4/11/2012	Pesticides For Baby's Breakfast?		Babble.com		
4/11/2012	Are Pesticide Sprayers Health Experts? Seriously?	Alex Formuzis	Huffington Post		x
4/13/2012	Expanded Website Content Addresses Consumer Pesticide Concerns	Lee Mannering	xchange.PMA		x
4/18/2012	Searching for the Unassailable Commodity	Tom Karst	The Packer		
4/19/2012	Organic Foods Offer Superior Taste With Less Chemical Residue, Local Experts Say	Kayla Sloan	Kansas State University		
4/20/2012	Alliance for Food and Farming Launch Facebook Page		FreshPlaza		x
4/20/2012	Alliance for Food and Farming Launch Facebook Page		Perishable News		x
4/20/2012	Best Foods to Buy Organic	Judy Greer	Yahoo Homepage		
4/23/2012	Are Pesticides Making You Sick and Fat?	Michelle Schoffro Cook	Care2.com		
4/23/2012	Five Reasons to Eat Organic Apples: Pesticides, Healthy Communities and You	Beth Hoffman	Forbes (blog)		
4/25/2012	"Like" Us if You Want to Stand Up for Safe Fruits and Veggies		California Ag Network		x
4/25/2012	Alliance for Food and Farming Launch Facebook Page		Growing Produce		x
4/27/2012	Alliance Launched Facebook Campaign on Pesticide Residues	Tom Karst	The Packer		x
5/1/2012	Dirty dozen and Clean 15: Best and Worst Foods for Your Wallet and Table	Camille Lamb	Miami New Times (blog)		
5/3/2012	10 Food Rules to Live By	Leah Zerbe and Emily Main	Rodale.com		
5/4/2012	Special Report: Organic Food	Steve McCarron	CBS47 (Fresno)		x
5/8/2012	Chemical Agriculture's Dirty Fight	Alex Formuzis	Huffington Post		x
5/10/2012	Chemical Industry Lobbyists Keep Stronger Oversight Plan at Bay	Michael Hawthorne	Chicago Tribune		x
5/14/2012	More Home Apple Growers Consider Going Organic	Dean Fosdick	Associated Press		
5/15/2012	When Should You Buy Organic?		Fos News		

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5/16/2012	Dirty Dozen and Clean 15		Peel.com		
5/16/2012	EWG Wants You to Eat Your Fruits and Vegetables	Alex Formuzis	Huffington Post		x
5/17/2012	EWG Can't Stop it's Dr. Jekyll Mr. Hyde Act	Tom Karst	The Packer		x
5/21/2012	Food Safety is a Big Concern for North Americans	Dr. Oz and Dr. Rozen	OregonLive.com		
5/22/2012	I Slashed Our Grocery Bill by $200 by Going Organic	Lisa Kling	Yahoo Contributor Network		
5/24/2012	Safe vs Safer	Alex Formuzis	Huffington Post		x
5/25/2012	Alliance for Food and Farming Emphasizes New USDA Report Underscores Impressive Safety Record of Fruits and Vegetables	Alliance for Food and Farming	Business Wire		x
5/25/2012	USDA Pesticide Data Program Annual Summary	Kathy Wills	Food Poisoning Bulletin		
5/25/2012	USDA Pesticide Residues Not a Food Safety Concern	Tom Karst	The Packer		x
5/29/2012	USDA Report Says Pesticide Residues Aren't a Food Safety Concern		Food Safety News		x
5/29/2012	USDA Report Says Pesticide Residues Aren't a Food Safety Concern	S. Rutledge	StopFoodborneIllness.org		x
5/30/2012	Alliance for Food and Farming Shows Parents the Safety of Fruits and Veggies	Alliance for Food and Farming	Market Watch		x
5/30/2012	Alliance for Food and Farming Shows Parents the Safety of Fruits and Veggies	Alliance for Food and Farming	Business Wire		x
5/30/2012	Alliance for Food and Farming Shows Parents the Safety of Fruits and Veggies	Alliance for Food and Farming	EON News		x
5/30/2012	Alliance for Food and Farming Emphasizes New USDA Report Underscores Impressive Safety Record of Fruits and Vegetables		Grocery Headquarters		x
5/30/2012	Alliance for Food and Farming Emphasizes New USDA Report Underscores Impressive Safety Record of Fruits and Vegetables		Perishable News		x
6/1/2012	Alliance for Food and Farming Shows Parents the Safety of Fruits and Veggies		Fruit Grower News		x
6/1/2012	Pesticide Residue Levels Remain Low	Robert Vosburgh	Supermarket News		
6/4/2012	What Pesticides Are on Your Foods?		Kansas City InfoZine		

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6/5/2012	Nieghbors Report Sickness After Pesticides Applied Nearby	Rachel Cook	Bakersfield Californian		
6/5/2012	Possible Pesticide Exposure Leave Four Residents Sick	Kiesha Courtney	Bakersfield Now		
6/7/2012	UC Riverside Calculations Help Demonstrate Food Safety		UC Riverside		x
6/8/2012	Eat Your Fruits and Vegetables: They're Essential to a Healthy Diet	Dr. Carl Keen	Food Safety News		x
6/12/2012	What Consumers Think About Pesticide Residues	Phil Lempert	The Lempert Report		x
6/12/2012	What Pesticides Are on Your Foods?		Scientific Daily		
6/13/2012	Is Organic Food Worth the Extra Cost?	Natalie Kane	WCCO-TV (Minneapolis)		
6/14/2012	Is Organic Worth the Extra Green?	Lyn Dowling	Florida Today		
6/15/2012	How Do I Learn About What Pesticides May Be On My Food?		Environmental Magazine		
6/19/2012	Apples Again Top Dirty Dozen List for Pesticides	Kathleen Doheny	WebMD		x
6/19/2012	Decision Points: Organic Versus Conventional Produce		Fox News		x
6/19/2012	Dirtiest, Cleanest Produce in Your Kitchen		CNN/ABC 15 Phoenix		
6/19/2012	Dirty Dozen: EWG Reveals List of Pesticide-Heavy Fruits and Veggies		Huffington Post		x
6/19/2012	EWG's 2012 Shopper's Guide Released	Robin Shreeves	Mother Nature Network		
6/19/2012	EWG Releases 2012 Shopper's Guide to Pesticides in Produce		Environmental Working Group		
6/19/2012	Farmer Group Calls on EWG to Cease Publishing Dirty Dozen List	Alliance for Food and FarmingBusiness Wire	Alliance for Food and Farming		x
6/19/2012	Is the Produce You Eat Covered in Pesticides?		Chicagoist		
6/19/2012	Lots of Confusion When it Comes to Pesticides	Phil Lempert	Chicago Sun Times		x
6/19/2012	New Dirty Dozen List, See the Most Pesticide Contaminated Foods	Kelly George	Atlanta Examiner		
6/19/2012	Pesticide Residue Rankings: Apples and Celery Worst, Onions and Corn Best	Helena Bottemiller	Food Safety News		x
6/19/2012	Pesticides in Produce: EWG's Dirty Dozen List		CBS News		
6/19/2012	Shopper's Delight: Here's What to Buy Organic	Twilight Greenaway	Grist Magazine		x
6/19/2012	Terrifying Toxic Fruit List Will Change the Way You Eat	Jeanne Sager	The Stir.com		

Date	Title	Author	Publication	Circulation	Msg
6/19/2012	The 2012 Dirty Dozen Plus and the Clean 15: When Buying Organic Does (and Doesn't) Make Sense	Lylah M. Alphonse	Yahoo Shine		x
6/16/2012	Updated Rankings for Pesticide Levels in Produce	Ian C. Campbell	The Oregonian		
6/19/2012	Watch Out for the 2012 Dirty Dozen		CNN/KMGH Denver		
6/19/2012	Watch Out for the 2012 Dirty Dozen	Jessica Dabrowski	CNN/Fox 8 Cleveland		
6/19/2012	Watch Out for the 2012 Dirty Dozen	Marina Csomor	CNN		
6/19/2012	Survey: Dirty Dozen List Harms Consumption	Tom Karst	The Packer		x
6/19/2012	Dirty Dozen List Unhealthy Group Says	Mitch Lies	Capital Ag Press		x
6/19/2012	14 Pesticide Covered Foods That Will Change the Way You Shop	Dina Spector	Business Insider		
6/19/2012	2012 Dirty Dozen Updates: The 12 Fruits and Vegetables Highest in Toxic Pesticides	Briana Rognlin	BlissTree.com		
6/19/2012	Alliance for Food and Farming Give Consumers 12 Reasons Not to Use the Dirty Dozen List	Alliance for Food and Farming	Business Wire		x
6/19/2012	Apples and Celery top List of Food Most Contaminated by Pesticides	Sushma Subramanian	Everyday Health		
6/19/2012	Apples Top Pesticide Dirty Dozen List		Healthcare Today		
6/19/2012	Apples Top the Dirty Dozen Plus List	Steve Laws	Portland Tribune		
6/19/2012	Dirty Dozen List Unhealthy, Group Says	Mitch Lies	Capital Press		x
6/19/2012	Environmental Working Group Releases 2012 Shopper's Guide to Pesticides in Produce		eNews Forest Park		
6/19/2012	EWG Stirs Controversy with Consumer Guide on Dirty Fruits and Vegetables		Agri-Pulse		x
6/19/2012	New Dirty Dozen: Apples, Celery Most Pesticide Contaminated, Mushrooms Okay	Camille Lamb	Miami New Times (blog)		
6/19/2012	Ontario Family Physicians Warn of Pesticide Dangers		Canada Newswire		
6/19/2012	Pesticides in Produce, Baby Food and Tap Water, Oh My!	Susan Damian	Food Integrity Campaign		
6/19/2012	Report: Food Safety Concerns Lower Fruit and Vegetable Consumption		VendingMarketWatch.com		x
6/19/2012	Survey: Dirty Dozen List Harms Consumption	Tom Karst	The Packer		x
6/19/2012	The Dirty Dozen: Eco Group Reveals List of Pesticide Heavy Fruits and Veggies	Robin Shreeves	Mother Nature Network		

Date	Title	Author	Publication	Circulation	Msg
6/19/2012	Why You Shouldn't Panic About Pesticide in Produce	Jon Hamilton	NPR		x
6/19/2012	Will an Apple a Day Really Keep the Doctor Away? It Depends	Eliana Dockerman	Time (blog)		x
6/19/2012	EWG Dirty Dozen List Lack Scientific Validity	Alliance for Food and Farming	Western Farm Press		x
6/21/2012	Are Pesticides Safe? It Depends Who You Trust?	Beth Hoffman	Forbes (blog)		x
6/21/2012	Consumers Are Being Misled About Pesticides in Produce		Food Product Design		x
6/21/2012	Do You Worry About Pesticides in Produce?	Robyn Flipse	HealthGoesStrong.com		
6/21/2012	Does Produce Wash Remove Pesticides?	Robin Shreeves	Mother Nature Network		
6/21/2012	Farmer's Markets Tout Healthy Food	Joe Burns	KTVZ (Oregon)		
6/21/2012	Farmers Say Report Scares People Away From Veggies	Georgina Gustin	St. Louis Post Dispatch		x
6/21/2012	How The USDA Unwittingly Aids EWG's Pesticide Disinformation Campaign	Steve Savage	Sustaniablog.com		
6/21/2012	Organic Foods Debate Lives On	Lyn Dowling	Desert Sun		
6/21/2012	Pesticides in Produce List: Sweet Corn Versus Peaches	Candy Sagon	AARP		
6/21/2012	Pesticides: The Dirty Dozen of Fresh Fruits and Vegetables	Shawn Radcliffe	Men's Health		
6/21/2012	PMA Applauds Efforts of the Alliance for Food and Farming		Grocery Headquarters		x
6/21/2012	Twelve (or so) Things You Need to Stock	Pamela Riemenschneider	Produce Retailer		
6/22/2012	When to Buy Organic: EWG Releases New Dirty Dozen		Delish.com		
6/25/2012	12 Fruits and Veggies High in Contamination	Veronica Robinson	WTOP (DC area)		
6/25/2012	Alliance Efforts Muffle Dirty Dozen Drumbeat	Tom Karst	The Packer		x
6/25/2012	Alliance for Food and Farming Give Consumers 12 Reasons Not to Use the Dirty Dozen List	Alliance for Food and Farming	Foursquare.net		x
6/25/2012	Dangerous Chemicals Lurking in Our Daily Lives		Fox & Friends (Fox News)		
6/25/2012	Why Your Stress-out List Just Got Shorter	Lynn Andriani	Oprah.com		
6/26/2012	Eating Organically: The EWG's 2012 Dirty Dozen List		EmpowHer		
6/27/2012	Healthy Hollywood: Try it on Tuesday - Avoid Veggies Dirty Dozen	Terri MacLeod	Access Hollywood		
6/27/2012	New Dirty Dozen List is Announced: Pro Pesticide Groups are Outraged	Max Goldberg	LivingMaxWell		x

Date	Title	Author	Publication	Circulation	Msg
6/27/2012	PMA Calles for End to Dirty Dozen List		Supermarket News		x
6/28/2012	12 Reasons to Reject EWG's Dirty Dozen	Alliance for Food and Farming	Western Farm Press		x
6/28/2012	Apples Declared the Dirtiest Fruit	Nicole German, RD, LD	Dietblog		
6/29/2012	CropLife America Takes Umbrage with Dirty dozen List	Matthew J Grassi	CropLife America		
6/29/2012	Does Your Produce Contain High Levels of Pesticides?	EMSL	PR Newswire		
7/1/2012	Dirty Dozen Clean 15 Lists Raises Consumer Awareness	Susan Salisbury	Palm Beach Post		x
7/5/2012	People Don't Want to Eat Pesticides	Alex Formuzis (Maria Rodale)	Huffington Post		x
7/5/2012	Two New Reports on Pesticides in Foods, From Different Prospectives	Marion Nestle	The Atlantic		x
7/10/2012	How to Keep Your Kids Toxin Free	Dr. Chris Oglive	Patch.com		
7/10/2012	Is Organic Food to Costly?	Stephanie Kemp-Jackson	Globe & Mail		x
7/10/2012	Natural Organic Items Grab Bigger Share in Supermarkets	Dana Hunsinger Benbow	Indianapolis Star		
7/10/2012	Why Your Organic Veggies Need Food Fingerprinting	Samantha Neary	Triple Pundit		
7/11/2012	5 Suprising Indreidents Allowed in Organic Food	Tom Philpott	Mother Jones		
7/11/2012	Dirty Dozen Clean 15 Lists Raises Consumer Awareness	Susan Salisbury	Palm Beach Post		x
7/11/2012	EWG Resorts to Begging for Cash Online	Harry Cline	Western Farm Press		x
7/11/2012	How the NY Times Went Too Far in Slamming Big Organic	Tom Philpott	Mother Jones		
7/11/2012	Poisonous Advice From the EWG	Angela Logomasini	Right Side News		
7/13/2012	Organic Farming vs Industrial Ag: Which Method Wins?	Becky Striepe	Care2.com		
7/13/2012	What's Big Food Doing in the Organic Business?	Jan Cho	Care2.com		
7/20/2012	Critics of Dirty Dozen List Await Reply		FreshPlaza		x
7/20/2012	Make a Fresh Start With Organic Produce	Amy Sowder	News-Press (Florida)		
7/24/2012	Pesticide in Foods: Regulations, Risk, Reality	Food Seminars International			
7/26/2012	EWG's Answers to the Alliance for Food and Farming	Alex Formuzis	Huffington Post		x
7/27/2012	Good News From EWG? Say It is So	Tom Karst	The Packer		x
8/1/2012	Lists Shed Light on When to Buy Organic	Kathryn Roethel	SF Gate		
8/6/2012	The Dangerous Demonization of Our Food	Angela Logomasini	Fox News		x
8/13/2012	Consumer Reports Receives $2 Million Grant for Food Safety Study	Glen Collins	NY Times - Blog		
8/14/2012	Should I Be Buying Organic?	Georgia Clark-Albert	BDN Maine		

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8/15/2012	Not All Organic Products Are Created Healthy	Dr. Daemon Jones	EmpowHer		
8/20/2012	Wash Your Organic Produce, No, Really	Kiera Butler	Mother Jones		
8/21/2012	New Guide Identifies Cheapest Clean Foods	Dan Shapley	The Daily Green		
8/22/2012	A New Guide to Good, Cheap and Low Pesticide Food	Jennifer LaRue Huget	Washington Post		
8/22/2012	Cheap, Healthy Food Tips Offered by EWG for Eating on a Tight Budget		Huffington Post		
8/22/2012	How to Buy Healthy Food on a Tight Budget	Jacque Wilson	CNN		
8/24/2012	A Shopping Guide for Nutritous Food on a Budget	Mary MacVean	LA Times		
8/24/2012	Ag at Large: Report Erases Pesticide Stigma	Don Curlee	Western Farm Press		x
8/28/2012	5 Ways to Save While Buying Organic	Jessica Hoffman	Seattle Post Inteligencer (blog)		
8/28/2012	Organic Doesn't Mean Better	Bill Croustore	Daily American		
8/30/2012	Alliance for Food and Farming Seeks Dirty Dozen Champions	Alliance for Food and Farming	Perishable News		x
8/31/2012	Alliance for Food and Farming Seeks Dirty Dozen Champions	Alliance for Food and Farming	FreshPlaza		x
8/31/2012	Dirty Dozen Champions Sought	Tom Karst	The Packer		x
9/5/2012	Alliance for Food and Farming Seeks Dirty Dozen Champions	Alliance for Food and Farming	KMJNow		x
9/5/2012	Five Ways the Stanford Study Sells Organics Short	Tom Philpott	Mother Jones		
9/5/2012	Organic a Waste of Money? Depends on Your Reason for Buying it	Rene Lynch	LA Times (editorial)		
9/5/2012	Organic Food Isn't More Nutritious, But That’s Not the Point	Brian Fung	The Atlantic		
9/5/2012	Organic Food Not Safer or Nutritionally Superior to Conventional Foods	Christian Nordqvust	Medical News Today		
9/5/2012	Organic Food Still Not Proven Safer, Study Suggest	Alex Rodriguez	Miami New Times (blog)		
9/5/2012	Organic Food Versus Conventional Food	Kenneth Chang	NY Times		
9/5/2012	Organics Headlines Miss the Boat an Pesticides, Antibiotic Resistance, Humaness	Ryan Sutton	The Bad Deal		
9/5/2012	Study on Benefits of Organic Foods is Misleading, Consumer Group Argues	Michelle Castillo	CBS News		
9/5/2012	The Case for Organic Food		LA Times - Editorial		

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9/6/2012	Alliance for Food and Farming Weighs in on Produce Safety	John Heath	The Packer		x
9/6/2012	How Do We Measure Organic Label's Value?		The Herald-Sun		
9/6/2012	Is Organic Food Worth It?		Baltimore Sun - Editorial		
9/6/2012	Organic Food Offers Health and Safety Advantages	Mark A. Kastel	Cornucopia Institute		
9/6/2012	Should You Buy Organic?	Natalie Wolchover	LiveScience.com		
9/6/2012	The Organic Fable	Roger Cohen	NY Times - Editorial		
9/7/2012	Casting Doubt on Organic Food	Maya Rodale	Huffington Post		
9/7/2012	Focusing on What is Local, Not Just Organic	Jeff Gordnier	NY Times (blog)		
9/7/2012	Organic Duel - Scientist vs Scientist (Providing Balance)		Food Consumer		
9/7/2012	Organic Industry Crafts Counterattack to Threat From Study	Bill Briggs	MSNBC		
9/7/2012	Stanford Scientist Shockingly Reckless on Health Risk and Organics	Frances Moore-Lappe	Huffington Post		
9/7/2012	When it Comes to Buying Organic: Science and Beliefs Don't Always Mesh	April Fulton	NPR		
9/10/2012	15 Foods You Don't Have to Buy Organic		Environmental Media Association		
9/10/2012	Organic Food Takes a Semi-hit to It's Image		SF Chronicle - Editorial		
9/10/2012	Organic Study Misses Point Completely	David Decher	SJ Mercury - Editorial		
9/10/2012	Update: Organic Produce Heathier? Not Necessarily	Tom Karst	The Packer		x
9/10/2012	Your Chance to Speak on Behalf of Safe Produce	Brian Sparks	Growing Produce		x
9/11/2012	Buying Organic is a Personal Choice	Marion Nestle	NY Times - Editorial		
9/11/2012	Do You Really Need to Buy Organic to Avoid Pesticide Residues?	Steve Savage	Science.2.0.com		
9/11/2012	Focus on the Right Kind of Organic Farming	Raj Patel	NY Times - Opinion		
9/11/2012	Healthy Food Doesn't Mean Organic	Dr. Aaron Carrol	CNN - Editorial		
9/11/2012	Organics Are Healthier For You	Nora Pouillon	Washington Post (blog)		
9/11/2012	Organics May Not be Healthier, Study Says		WholeFoods Magazine		
9/11/2012	Stanford Organic Food Study Amidst Pushback, Co-authors Acknowledges Limitations		Huffington Post		
9/11/2012	Study Examins Benefits of Organic Foods	Deirdre Imus	Fox News		
9/11/2012	Why I'm Still Buying Organic Food For My Family	Charity Curley Mathews	Huffington Post		

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9/12/2012	Food For the Wealthy, Not For the Poor	Bjorn Lomberg	NY Times - Editorial		
9/12/2012	Organic Food Study Misses the Point	Heather Pilatic	Huffington Post		
9/12/2012	Organic Produce Defended at Farmers Market	Howard Yune	Napa Valley Register		
9/13/2012	Is Organic Food an Elitist Scam?	Chris Bostock	Creative Loafing		
9/13/2012	Lots of Chatter, Anger Over Stanford Organic Food Study	Rosie Mestel	LA Times		
9/13/2012	Mass Media Agree: Organic Food is No Healthier Then Food With Pesticides		Living Green Magazine		
9/13/2012	Re-Doubling My Commitment to Organic Food	Dawn Undurrage	Environmental Working Group		
9/13/2012	The Organic Food Lie	Dr. Jonny Bowden	Huffington Post		
9/14/2012	Flap Over Organic Food Study: Interview with the Journal Editor	Rosie Mestel	LA Times		
9/14/2012	Stanford Organic Study: Have Faulity Methods, Political Motivations, Threaten Kids' Health?	Lynn Peeples	Huffington Post		
9/17/2012	Organic Foods Are Worth the Cost: Whole Foods CEO	Bernice Napach	Daily Ticker		
9/17/2012	Stanford Study Unlikely to Slow Momentum of Marin's Organic Food Movement	Richard Halstead	Marin Independent Journal		
9/18/2012	Debunking the Debunkers of Organic Food	Michael Yudell	Philly Inquirer (blog)		
9/18/2012	The Environmental Footprint of Organic vs Conventional Food	Brian Palmer	Washington Post		
9/18/2012	Why Organic?	Coach Mark Smallwood	Huffington Post		
9/21/2012	Organic Foods, Does it Really Matter?	Scott Rollins, MD	Grand Junction Free Press		
9/21/2012	Why Buy Organic? It's the Pesticides, Stupid	Betty Herbert	Santa Cruz Sentinel - Editorial		
9/24/2012	Are Lower Pesticide Residues a Good Reason to Buy Organic? Probably Not	Christie Wilcox	Scientific American - Science Sushi Blog		
9/24/2012	Organic Food: No Need to Fret		Boston Globe - Editorial		
9/24/2012	Read, Learn, Choose, But Eat More Fruits and Veggies With Confidence	Alliance for Food and FarmingPRWeb			x
9/26/2012	Be Aware of Toxins, Even in Organic Foods	Dr. Victor S. Sierpina	The Daily News (Galvaston)		
9/26/2012	Let's Ask the Right Questions About Organics and Health	Karen Levy	Huffington Post		
9/26/2012	Organic Trade Boards Pesticide Claim Backed by Ad Wachdog	Julia Glotz	The Grocer		

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9/26/2012	Organically, Locally or Conventionally Grown Produce, Which is Better?	Joan Saige Blake	Boston.com		x
9/26/2012	Pesticides Are Pesticides, Even if Thery're Organic	Center for Consumer Freedom	Canada Free Press		
9/26/2012	Read, Learn, Choose, But Eat More Fruits and Veggies With Confidence	Alliance for Food and Farming	SF Chronicle		x
9/26/2012	Study Claims Organic Food Has No Health Advantages	Levon Minassian	Daily Californian		
9/27/2012	Return of the Organic Fable	Roger Cohen	NY Times - Editorial		
	(Apr. 1, 2012 thru Sept. 30, 2012)		**(218 Articles posted with 75 carrying messaging)**		
10/1/2012	Organic Illusion	Blake Hurst	The American		
10/2/2012	GM, Conventional and Organic Food Safety	Garhard Adam	Science 2.0		
10/2/2012	Website Provides Science Based Safety Information for Consumers		Produce News		x
10/4/2012	Dr. Oz Explores Fattening Food Porn Perils and Organic Food Faves	Joanne Eglash	Yahoo News (blog)		
10/5/2012	Dr. Oz Organic food is Better	Dr. Aleathea Wiggins	Examiner.com		
10/5/2012	Organic or Conventional Fruits and Veggies: The Alliance for Food and Farming Urges Consumers to Listen to Experts Advice and Eat More		PRWeb		x
10/5/2012	Organic or Conventional Fruits and Veggies: The Alliance for Food and Farming Urges Consumers to Listen to Experts Advice and Eat More		Yahoo News (blog)		x
10/8/2012	Alliance Address Dr. Oz Show	Alliance for Food and Farming	Florida Strawberry Growers Assoc		x
10/8/2012	The Top 10 Reasons Why Every Kid Needs Organic Food	Maria Rodale	Huffington Post		
10/9/2012	Does Stanford's Study Have You Seeing Red?	Glenn Braunstein, MD	Huffington Post		
10/11/2012	Benefits vs Risk of Eating Fruits and Vegetables	Produce for Better Health Foundation	Press Release		x
10/12/2012	No Clear Link Between Organic Food, Birth Defect	Amy Norton	Reuters		
10/16/2012	Parsing of Data Led to Mixed Messages on Organic Food's Value	Kenneth Chang	NY Times		
10/16/2012	Study: Health Benefits Outweigh Risk for Produce	Tom Karst	The Packer		x

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10/17/2012	Apples and Oranges on the Organic Food Study	Gary Schwitzer	MedPage Today		
10/17/2012	The Stanford Study's Pesticide Problem	Alex Formuzis	Huffington Post		
10/22/2012	EWG Concern for Specialty Crop Block Grant Contrived	Tom Karst	The Packer		x
10/23/2012	What Pediatricians Might Advise on Organic Food	Mary MacVean	LA Times		
10/23/2012	Should Kids Eat Organic? Docs Say It's Not Necessary	Rachael Rettner	LiveScience.com		
10/23/2012	Pediatricians: Organic Foods May Not Be Better	Michelle Healy	USA Today		
10/23/2012	Organics Provide No Meaningful Nutritional Benefits; Pediatricians Say	Catherine Pearson	Huffington Post		
10/23/2012	Organic or Not Organic: That is the Question	Alexia Severson	HealthLine (blog)		
10/23/2012	Organic Foods Have Fewer Pesticides: Aren’t Necessarily Better, Influential Pediatricians Say	Lindsey Tanner	Associated Press		
10/23/2012	Organic Food No Better Than Conventional for Kids; Pediatricians Say	Linda Carroll	NBC News (Vitals Blog)		
10/23/2012	Docs Say Choose Organic Food to Reduce Kids' Exposure to Pesticides	Nancy Shute	NPR		
10/23/2012	American Academy of Pediatrics' Clinical Report Highlights Benefits of Organic	Organic Trade Assoc.	PR Newswire		
10/24/2012	Report Supports Organic Produce, But Not Milk	Andrea Peterson	Wall Street Journal		
10/24/2012	Pediatricians Raise Doubts About the Benefits of Organic Foods	Tim Devaney	Washington Times		
10/24/2012	Organic Food for Kids: Worth the Price?	Salynn Boyles	WebMD		
10/24/2012	Organic Food for Kids: Buy This Not That	Susanna Kim	ABC News (blog)		
10/24/2012	Crossing Organic Off the Grocery List	Liz Moyer	Wall Street Journal (blog)		
10/24/2012	Another Report Says Organic Food No More Nutritious	Landon Hall	Orange County Register		
10/25/2012	Nutrition First, Organic Second: American Academy of Pediatrics	Corinne Chin	Medill Reports		
10/30/2012	Are Organic Foods Really Worth the Price	Dr. Bill Elliott	Marin Independent Journal		
10/30/2012	Is Organic Food Better? The Jury is Still Out	Jean Luis Santini	AFP		
10/30/2012	New Study Dismisses Benefits of Organic Food		AmericaBlog		
10/30/2012	Organic Does Matter: Pesticides Making US Kids Stupid	Jennifer Lance	Eco Childs Play		
10/31/2012	The Dirty Dozen	Leanne Ely	Daily Herald (Utah)		

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10/31/2012	Is Organic Food Worth It?	Jeff Stier	National Center for Public Policy Research		
10/31/2012	Grim Reapings From the Industrial Food System	Avery Yale Kamila	Portland Press Herald		
11/1/2012	The Aftermath of Stanford's Organic Food Gamechanger	Anita Dukart	Neon Tommy (USC publication)		
11/6/2012	Are Your Fruits and Vegetables Safe	CDPR/CDFA	Press Release		
11/7/2012	Is Organic Agriculture Affluent Narcissisim?	Henry I. Miller & Richard Cornett	Forbes (blog)		
11/7/2012	Leaders from Public Health, Nutrition Environmental Law Join EWG Board	Environmental Working Group	Press Release		
11/8/2012	AAP Fails to Recommend Organic Foods Yet Recognizes Pesticides Are Neurotoxins	Jennifer Lance	Eco Childs Play		
11/8/2012	DPR 2011 Monitoring Show Most Produce Samples Have No Detectable Pesticide Residues	CA Dept of Pesticide Residue	Press Release		
11/8/2012	Most Produce Sampled in CA Had No Detectable Pesticides	Vicky Boyd	The Grower		
11/9/2012	Another Reason to Eat Organic	Cynthia Sass, MPH, RD	Shape Magazine		
11/12/2012	Can Pesticides Make Your Kid Fat?	Rachel Lincoln Sarnoff	Huffington Post		
11/12/2012	Organic Food Products to be Tested for Residues Starting in 2013		RedOrbit		
11/12/2012	Organic Food to be Tested Periodically	Bill Tomson	Wall Street Journal		
11/12/2012	State's Pesticide Residue is Low, Officials Say	Robert Rogriguez	Fresno Bee		
11/14/2012	Organic - Truth or Misconception, It's Big Business	Nate Gaddis	Big Island Now (Hawaii)		
11/14/2012	Study Finds High Exposure to Foodborne Toxins	UC Davis	UC Davis Health System		
11/14/2012	Tests Find Low Pesticide Residue in California	Audrey Asistio	KSEE-TV (Fresno, CA)		
11/15/2012	Organic or Not? Two Pediatricians Weight In	Claire McCarthy, MD & Wendy Sue Swanson, MD	Huffington Post		
11/15/2012	Pesticides Used on Fruits and Vegetables May be Putting Young Children at Risk of Cancer		Daily Mail (UK)		
11/15/2012	Preschool Children Particularly Vulnerable to Foodborne Toxins		News Medical Net		
11/15/2012	Wait a Minute - I Thought Organic was Suppose to be Better?	Marcella Pick, OB, GYN, NP	Huffington Post		

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11/16/2012	Authors Stand by Results of Controversial Organic Food Study	Kamaria Taylor	Stanford Daily		
11/16/2012	Children Ingesting High Levels of Food Toxins: How to Protect	Kathleen Blanchard, RN	eMax Health		
11/16/2012	Top Fruits and Vegetables to Buy Organic	Laura Martin	Asbury Park Press		
11/26/2012	California Finds Few Pesticide Violations	Mike Hornick	The Packer		
11/26/2012	Copper in Organic Foods?	Jack Dini	Supermarket News (blog)		
11/26/2012	Study Shows Children at Risk From Cumulative Exposure to Pesticides	Beyond Pesticides	eNews Forest Park		
11/27/2012	Children Need More Vigilant Avoidance of Pesticide Exposure Say Pediatricians	Denise Reynolds, RD	eMax Health		
12/3/2012	Organic Food Justice for the 99%	Charlotte Vallaeys, MS, MTS	Cornucopia Institute		
12/4/2012	How to Avoid the Chemicals in Our Food	Sonya Lunder and Alex Formuzis	Huffington Post		
12/4/2012	NPMA Responds to AAP's Pesticide Exposure in Children	NPMA	PCT Magazine		
12/6/2012	How Dr. Oz Got it Wrong on Organics	Tom Philpott	MotherJones.com		
12/7/2012	Pesticide Residues on Organic: What Do We Know?	Steve Savage	Science 2.0		
12/11/2012	Dr. Oz Calls Organic Eaters Elite and Promotes Canned Vegetables		Diets in Review.com		
12/11/2012	Organic vs Non-Organic Produce From Joy Bauer		Huffington Post		
12/12/2012	Pesticides Now More Than Ever	Mark Bittman	NY Times - Blog		
12/12/2012	The Dirty Dozen: 12 Fruits, Vegetables to buy Organic	Stacia M. Fleegal	York Daily Record (PA)		
12/13/2012	Mark Bittman's Smart Take on Kids and Pesticides	Tom Philpott	Mother Jones		
12/13/2012	Produce Shopping Without Pesticides	Alan Yu	Psychology Today Magazine		
12/19/2012	Vegetables in Israel Carry Heavy Peaticide Residue		Environmental News Network		
1/7/2013	Dr. Oz is All About TV Ratings, Not Truth	Chuck Robinson	The Packer		x
1/8/2013	Five Ways to Shop Organically on a Budget	Jim Wang	Business Insider		
1/8/2013	Snobby Kids Eat Organic	Catherine McCord	Huffington Post		
1/10/2013	Health Tip: Is Organic Better?		Health Day		
1/14/2013	Don't Eat Your Organic Veggies	Henry I. Miller	New York Post		
1/18/2013	When it Makes Sense to Go Organic	LeeAnn Weintraub	Daily Breeze		

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1/21/2013	Baby Carrots and Chlorine, Does a Viral Message Revel the Truth?	Joel Mackey	Z6Mag		
1/21/2013	Baby Food Made of Organic Blends, Cater to Parents' Inner Foodie	Michael Hill	Associated Press		
1/21/2013	Warnings From a Flabby Mouse	Nicholas D. Kristof	NY Times		
2/8/2013	The Truth About Organic	Carolyna De Laurentis	Huffington Post		
2/13/2013	Is Imported Produce REALLY Organic?		ABC15 (Phoenix)		
2/13/2013	Organic Really Matters	McKinzie Hall, RD	Chicago Tribune		
2/15/2013	Is Organic Produce Really Chemical Free?	Steve Irvin	ABC15 (Phoenix)		
2/21/2013	No Testing procedures in Place to Assure Organic Produce is Chemical Free		ABC10 (San diego)		
2/22/2013	Todays USDA Report Shows Impressive Safety Record of Fruits and Vegetables	Alliance for Food and Farming	Business Wire		x
2/22/2013	USDA Releases 2011 Annual Summary for Pesticide Data Program Report	USDA	USDA.gov		
2/25/2013	USDA Report Shows Impressive Safety Record of Fruits and Vegetables	Alliance for Food and FarmingPerishable News			x
2/26/2013	Don't Fear the PDP		The Packer		x
2/26/2013	Pesticide Data Shows Fresh Produce Safety Record	Tom Karst	The Packer		x
3/1/2013	10 Foods You Shouldn't Buy Organic and 12 You Should	Amanda Geronikos	Money Talks News		
3/4/2013	Is organic Food Really Healthier?		SF Chronicle -(Earth Talk)		
3/4/2013	Pesticide Data Program Shows Little Contamination in 2011		Food Safety News		
3/4/2013	Students Advocate for Organic Food	Dani Kokochak	The News Record (Univ. of Cincinnati)		
3/8/2013	Germany: Supermarket Lettuce Contains Pesticides		FreshPlaza		
3/8/2013	Let's Move Celebrates Three Year Anniversary	Alliance for Food and Farming	Perishable News		x
3/8/2013	Organic Chinese Restaurant Hunger for Accptance	Franh Shyong	LA Times		
3/11/2013	6 tips for Organic Shopping and 3 Pointers for Overall Healthier Food Shopping	Noreen Lovoti	PennLive.com		
3/11/2013	EPA/USDA Food Safety Statements in PDP Report Helpful to Consumers	Marilyn Dolan	Food Safety News		x

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3/12/2013	Eathing Healthy on a Budget	Mike Lee	MyFitnessPal.com		
3/14/2013	Buying Organic is Expensive: Is it Worth the Hype for Your Health?	Mechele R. Dillard	HULIQ		
3/15/2013	Re-Interpreting Data: Turning Positive Food Safety News Into Something Negative	Alliance for Food and Farming	Perishable News		x
3/19/2013	Organic Food is Not Just for Snobs, Dr. Oz: Askk Wal-Mart	Tanya Deckla Cobb	Huffington Post		
3/20/2013	Organic Baby Food Might Not be More Nutritious, But I'm Still Buying It	Nicole Fabian Weber	The Stir (blog)		
3/21/2013	Does Organic Food Matter?	Dr. McKenzie Hall, RD	Detroit News		
3/26/2013	Is There Any Point to Buying Organic Baby Food?	Sarah Miller	Grist Magazine		
3/27/2013	EWG's 2013 Shoppers Guide to Pesticides Coming Soon	Alex Formuzis	Environmental Working Group's Enviroblog		
3/27/2013	Study: Eating Organic Food Associated with Longer Lives (in Flies)	Lindsey Abrams	The Atlantic		
3/28/2013	Is Organic Food Worth the Price?	Jessica Hartman	KTV St. Louis Missouri		
	(Oct. 1, 2012 thru Mar. 30, 2013)		**(116 Articles posted with 15 carrying messaging)**		
4/1/2013	A Loophole for Pesticides Puts Public Health at Risk	Alex Formuzis	Environmental Working Group's Enviroblog		
4/15/2013	Majority of Americans See Organic Label as an Excuse to Charge More	Harris Interactive	PR Newswire		
4/16/2013	Why You Shouldn't Buy Organic	Jayson Lusk	Huffington Post		
4/16/2013	When Buying Organic Produce is Best	Jeni Hall	Monadnock Ledger Transcript		
4/18/2013	Are Organic Foods Worht the Extra Cost?	Jenna Smith	Univ. of Illinois Ext.		
4/18/2013	Are There Less Pesticides in Organic Crops?	James Cooper	HULIQ		
4/18/2013	Is Organic Better? Ask a Fruit Fly	Tara Parker Pope	NY Times		
4/22/2013	Alliance for Food and Farming: Read Actual USDA Pesticide Report, Not Re-Interpretation	Alliance for Food and Farming	Yahoo Finance		x
4/22/2013	Alliance for Food and Farming: Read Actual USDA Pesticide Report, Not Re-Interpretation	Alliance for Food and Farming	Wall Street Journal		x
4/22/2013	Apples Top EWG's Annual Dirty Dozen	Environmental Working Group	Environmental Working Group Press Release		
4/23/2013	2013's Updated Dirty Dozen Produce List	Robin Shreeves	Mother Nature Network		

Date	Title	Author	Publication	Circulation	Msg
4/23/2013	8 in 10 Parents Report Buying Organic		Organic Trade Association-Press Release		
4/23/2013	Apples Top Group's List of Pesticide Carrying Produce	Christopher Doering	Des Moines Register		
4/23/2013	Apples Top List of Pesticide Contaminated Fruit and Veg	Emma Websdale	Blue & Green		
4/23/2013	Dirty Dozen List Again Issued, Refuted	Tom Karst	The Packer		x
4/23/2013	Dirty Dozen Pesticide Laced Fruits and Veggies for 2013, Apples Are Still Number One		Inquistir		
4/23/2013	Dirty Dozen Produce List Called Inaccurate and Alarmist by FDA	Dan Flynn	Food Safety News		
4/23/2013	Dirty Dozen: EWG Releases 2013 List of Most Pesticide Heavy Fruits and Veggies	Sarah Klein	Huffington Post		x
4/23/2013	New Dirty Dozen List of Pesticide Laden produce Just Released	Beth Greenfield	Yahoo Shine		x
4/23/2013	Pesticides in Produce - The Dirty Dozen	Robin Taylor	WPIX.com (NY)		
4/24/2013	Read Actual USDA Report, Not Re-Interpretation		Perishable News		x
4/24/2013	Apples top Dirty Dozen List for Third Year in a Row	Susan Salisbury	Palm Beach Post		x
4/24/2013	A Dozen Reasons: Why Eating Both Conventional and Organic Produce is the Right Choice for Your Family	Alliance for Food and Farming	Perishable News		x
4/24/2013	Apples Top Analyst's Dirty Dozen List	Mike Knowles	FruitNet		
4/24/2013	Food Poisoning: What You Need to Know	Miriam Falco	CNN		
4/24/2013	Industry Groups Say Dirty Dozen Report Lacks Credibility	Joan Murphy	Produce News		x
4/24/2013	New: Dirty Dozen - Clean Fifteen		Ayrshire Farm Journal		
4/24/2013	Which Dirty Dozen Fruits and Vegetables Made the 2013 List?	Rebekah Denn	Seattle Times (blog)		
4/25/2013	14 Fruits and Vegetables with the Most Pesticides		Houston Chronicle		
4/25/2013	2013 Dirty Dozen and Clean 15 Organic Vegetables and Fruit	Jerry Young	Examiner.com		
4/25/2013	A Closer Loot at EWG's 2013 dirty Dozen Food List	Brooklyn Supper	Babble.com		
4/25/2013	An Apple a Day Brings Pesticides Your Way	Rick Paulas	KCET (Los Angeles)		
4/25/2013	Dirty Dozen List Coverage Declines to Negligible Levels		FreshPlaza		x
4/25/2013	Dirty Dozen List Coverage Declines to Negligible Levels	Alliance for Food and Farming	Perishable News		x

Date	Title	Author	Publication	Circulation	Msg
4/25/2013	Dirty dozen Pesticide List Losing Ground to Science	Alliance for Food and Farming	Western Farm Press		x
4/25/2013	Most Americans Regard an Organic Label as Just a Way to Charge More		Science.2.0.com		
4/25/2013	Wash Up: Apples Top the Annual Dirty Dozen List of Pesticide Ridden Crops	James Foley	NatureWorldNews		
4/25/2013	When Should You Buy Organic?	Sean Lee	WWJ News (Chicago)		
4/26/2013	Apples Top Dirtiest Fruit, Pesticides List for Third Year	Alexandra Ward	NewsMax		
4/26/2013	Dirty Dozen List Misleading		FreshPlaza		
4/26/2013	Dirty Dozen Top 12 Fruits and Vegetables with Pesticide Exposure	Justin Caba	Medical Daily		
4/29/2013	Disty Dozen Lives iin Social Media	Pamela Riemenschneider	Produce Retailer		x
4/29/2013	Apples: Why is this Fruit on the EWG's Dirty Dozen List?	Megan Taros	Latin Times		
4/29/2013	EWG's 2013 Shoppers Guide to Produce		Sustainable Sass		
4/29/2013	The Dirty Dozen: Beware of These Foods	Annie Hauser	Weather Channel		
4/30/2013	Check Out the Dirty Dozen List	Suzanne Havala Hobbs	Charlotte Observer		
4/30/2013	Farmers' Group Takes Aim at Dirty Dozen Produce List	Tim Heardon	Capital Press		x
4/30/2013	Organic or Not	Sheah Rarback	Miami Herald		
5/2/2013	Organic or Conventional: The 2013 Dirty Dozen and Clean 15		cancerhawk.com		
5/3/2013	Eat Your Apples in Spite of Scary Media Coverage	Jack Dini	Canada Free Press		
5/6/2013	EWG's 2013 Dirty Dozen		Daily Pea		
5/6/2013	Meet the Dirty Dozen, Produce with the Most Pesticides	Ashleigh Schmitz	Fox News		
5/6/2013	Nutritious Apples, Poisonous Claims	Angela Logomasini	Washington Times		
5/6/2013	Only a Lull in the Fight Against Dirty Dozen	Chuck Robinson	The Packer		x
5/6/2013	Ideologically Contaminated Produce Shopper's Guide Underminds Health	Jeff Stiers & Henry I. Miller	Huffington Post		
5/8/2013	Dirty Dozen List Loses it's Punch	Richard Cornett	Western Farm Press		x
5/8/2013	EWG Expands Dirty Dozen List to Include Leafy Greens and Summer Squash	Locke Hugues	Shape Magazine		x
5/8/2013	EWG Releases Annual Dirty Dozen List of Fruits and Vegetables		CBS 3 Philadelphia		
5/15/2013	Center for Food Safety Lists Food Industry Front Groups	Dan Flynn	Food Safety News		x

Date	Title	Author	Publication	Circulation	Msg
5/15/2013	Dirty Dozen Produce with the Highest Concentration of Pesticides		Fox Business News		
5/15/2013	Is Organic Food All It's Cracked Up to Be?	Jennifer Welsh	Business Insider		
5/16/2013	Debunking the EWG's Dirty Dozen	LaVell Winsor	Farm Futures		x
5/16/2013	Eating Organics is Catching On	Penny Fletcher	The Current		
5/17/2013	Dirty Dozen Message Quietly Lives On	Pamela Riemenschneider	The Packer		
5/17/2013	How Wrong is the Latest Dirty Dozen List?	Steve Savage	Science.2.0.com		
5/17/2013	Why Buy Organic?	Jaime McCutcheon	WCTI-12 (No. Carolina)		
5/22/2013	The Best and Worst Foods for Pesticide Levels	Heather Loney	Global News (Canada)		
5/24/2013	Why Your Apple a Day Better be Organic		Spry Living		
5/28/2013	Pesticides Linked to ADHD, Autisim, IQ Scores Reduction		Sun.Star Vavao (Philippines)		
5/28/2013	Benefits of Organic Foods		Sun.Star Vavao (Philippines)		
5/30/2013	California's Children Face Higher Health Risks From Contaminants in Food Than Adults	Jennifer Wolsenhome	Environmental Health Perspective		
6/5/2013	Is Organic Food Better?	Simone Walters MS,RD	Metro (NY)		
6/6/2013	Piedmont: Chemicals' Impact on Health Problems Detailed in Talk	Maggie Sharpe	San Jose Mercury News		
6/14/2013	Organic vs. Conventional Produce?	Alexandra Economy	Winona Daily News (Minnesota)		
6/17/2013	Would Americans be Better Off Eating a Mostly Organic Diet?		Wall Street Journal		
6/18/2013	High Levels of Pesticides found in Celestial Seasonings Tea	Samantha Bonar	LA Times (blog)		
6/20/2013	Alliance for Food and Farming Takes on Dirty Dozen	Tom Burfield	The Packer		x
6/24/2013	Alliance Outlines Success Against Dirty Dozen List at FPFC Luncheon	Tim Linden	Produce News		x
	(Apr. 1, 2013 thru June 30, 2013)		**(78 Articles posted with 21 carrying messaging)**		
	(Oct. 1, 2010 thru June 30, 2013)		**(768 Articles posted with 232 carrying messaging)**		

PEST MANAGEMENT

CALIFORNIA ALMOND **SUSTAINABILITY PROGRAM**

california almonds

Almond Board of California

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INTRODUCTION — SUSTAINABILITY AND PEST MANAGEMENT

Exposure to the principles of Integrated Pest Management (IPM) is probably the first experience involving sustainability concepts for most California Almond growers. In part, this is because the origin of IPM can be traced to efforts by University of California scientists that began in the 1950s. This is also because IPM is an ecosystem-based approach that emphasizes the balanced use of multiple tactics (nonchemical and chemical) to cost-effectively and safely manage pests.

The California Almond community is known nationwide for dramatic success in adopting IPM and for reducing unnecessary uses of pesticides. Records of pesticide use data reveal a dramatic reduction in the use of pesticides in California Almonds since 1980. This includes fewer dormant sprays of organophosphates, which is significant for ensuring the quality of surface waters.

The Almond Board of California (ABC) has funded University of California research supporting IPM understandings and adoption since 1973 (the first year that ABC funded production research). The initial work involved the management of navel orangeworm. By 1979, the single practice of removing mummy nuts in the winter was shown to reduce damage by navel orangeworm by up to 60%. These and other IPM practices resulting from ABC-funded research are being implemented by almond growers and handlers across the state.

Accordingly, ABC has been named a Champion for Pesticide Environment Stewardship by the U.S. Environmental Protection Agency, and twice has been named an IPM Innovator by the California Department of Pesticide Regulation. With the detection of pesticides in waterways and groundwater, and recent attention attributing pesticide use to poor air quality, a proven record of judicious pesticide use provides California Almond growers with a well-deserved good reputation.

Even with refined IPM systems, pest-related challenges in almonds continue. These include the introduction of new pests; the rapid growth in almond acreage; transitions to new varieties, tree spacing and irrigation systems; annual variations in weather; understanding and integrating the use of new pest control products; and adapting to new regulations and international maximum-residue limits. Fortunately, the familiar IPM cornerstone of careful, regular pest monitoring (scouting) to inform decision making remains crucial for dealing with these and related challenges.

The practices in this module are grouped and presented in an order that is consistent with the IPM approach. That is, preventive practices are characterized first, because prevention is the logical first step for minimizing pest problems. Next are recommended practices for monitoring pests and their symptoms as the basis for deciding if and when to control them. Last, practices are described for the effective and safe use of tactics to control economically damaging pest populations.

ORCHARD ESTABLISHMENT — PREVENTING FUTURE PEST PROBLEMS

1	Was this orchard planted by the current farm owners or managers? ☐ Yes. ☐ No. (Skip to question 26 on page 8.)

	During establishment of this orchard, the following methods were used to *prevent* pest problems:	Not familiar with this	I didn't try it	Used this practice	Not applicable
	SITE PREPARATION				
2	If the previous crop was a perennial, weeds were aggressively controlled for 1–2 years to reduce nematode pests before removing it.	☐	☐	☐	☐
3	Old trees (or other previous crop) were removed and destroyed, and residual roots were removed as deeply as possible from the soil.	☐	☐	☐	☐
4	The site was fallowed or planted with a non-host cover crop for nematodes (e.g., Piper Sudan or safflower) for at least one year.	☐	☐	☐	☐
5	If the site had a significant number of burrowing rodents, the soil was ripped before planting to reduce the population.	☐	☐	☐	☐
6	Before planting, populations of weeds (especially perennials) were reduced by repeated cycles of irrigation, tillage and drying; by postemergent herbicide application followed by cultivation; etc.	☐	☐	☐	☐
7	The site was graded or modified before planting to ensure even drainage and prevent low spots and puddle formation, which can stress trees and/or increase problems with weeds and diseases. If the site is subject to standing water, trees were planted on berms or mounds. (See the Irrigation Management module for detailed information.)	☐	☐	☐	☐
	SAMPLING AND STRATEGY				
8	Prior to planting, the site's micro-climate and crop and pest history were researched to determine potential problems, especially if almonds or related crops (e.g., peaches, plums or cherries) were grown.	☐	☐	☐	☐
9	The soil and, if possible, roots from the previous crop were sampled for nematodes before planting.	☐	☐	☐	☐
10	Integrated pre- and post-plant strategies for managing pests were developed from the crop history and sampling results.	☐	☐	☐	☐

During establishment of this orchard, the following methods were used to *prevent* pest problems:

		Not familiar with this	I didn't try it	Used this practice	Not applicable
	FUMIGATION CONSIDERATIONS				
11	Based on site history (not a replant following almonds or almond relatives; no oak root fungus concerns; etc.) and results from sampling for nematodes, fumigation was not done. ☐ Yes. (Skip to question 17.) ☐ No, the site was fumigated.				
12	The type, rate and method of fumigation were selected according to nematode species and counts, soil diseases present, soil conditions and legal considerations.	☐	☐	☐	
13	What fumigation method was used? ☐ Solid (full coverage) ☐ Strip (tree row) ☐ Spot (planting hole) ☐ GPS-guided spot treatment				
14	Fumigation took place when the soil temperature and moisture were appropriate to maximize efficacy.	☐	☐	☐	☐
15	A thorough review of typically used fumigation methods (e.g., row strip or tree site) was completed, and appropriate safety, quality control and emergency responses are included in written management plans.	☐	☐	☐	
16	When practical, necessary fumigants were applied before or after the peak ozone interval, from May 1 to Oct. 31.	☐	☐	☐	☐
	PLANTING CONSIDERATIONS				
17	When planning for tree spacing, the effects of humidity, canopy architecture, sun exposure, soil conditions and irrigation on pest management were considered.	☐	☐	☐	
18	If this site had problems with root diseases (e.g., oak root fungus) or nematodes, a university-recommended resistant/tolerant rootstock(s) was utilized.	☐	☐	☐	☐
19	Variety selection was based, in part, on disease resistance.	☐	☐	☐	☐
20	Only virus-indexed and certified nematode-free planting materials were used.	☐	☐	☐	☐
21	Orchard rows were planted north to south to optimize sun exposure and reduce the potential for foliar diseases.	☐	☐	☐	☐
22	Effort was taken to ensure tree-graft unions were at least 2 inches above the soil surface to prevent the infection of scions by soil pathogens.	☐	☐	☐	☐
23	Tree guards (e.g., milk cartons) were used to prevent feeding by vertebrate pests on the trunks.	☐	☐	☐	☐
24	For the first few years after planting, extra effort was made to control weeds before they produced seed.	☐	☐	☐	☐
25	Other: ______________________________			☐	

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GENERAL IPM AND PESTICIDE RISK MANAGEMENT — PREVENTION

	For this orchard, the following cultural methods were used to *prevent* pest problems:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	IRRIGATION AND NUTRIENT MANAGEMENT					
26	Irrigation did not result in standing water (e.g., by using shorter but more frequent run times for heavier soils), which can stress trees and promote weeds and diseases. (See the Irrigation Management module for detailed information.)	☐	☐	☐	☐	
27	Irrigation scheduling was adjusted for orchard canopy and/or root development conditions. (E.g., reducing amounts of water applied to trees stunted by nematodes increases water use efficiency and prevents other pest problems.)	☐	☐	☐	☐	
28	To prevent diseases, the irrigation system was designed and installed to avoid wetting trunks and lower leaves.	☐	☐	☐	☐	☐
29	Necessary amounts of nitrogen were properly determined and applied, therefore avoiding excesses and deficiencies in nitrogen that can increase pest problems. (See the Nutrient Management module for detailed information.)	☐	☐	☐	☐	☐
30	Other: ______________________________				☐	

References and more information

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Strand, Larry, editor. 2002. *Integrated Pest Management for Almonds,* Second Edition, Publication 3308. UC Division of Agriculture and Natural Resources, Oakland, CA.

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GENERAL IPM AND PESTICIDE RISK MANAGEMENT — MONITORING AND STRATEGY

	For this orchard, the following methods were used to *decide if and when to control* pests:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
31	Choose the option that best describes the frequency of and who did the scouting for insects, mites and diseases: ☐ A. The orchard was scouted occasionally or not at all. (If no scouting was done, skip to question 38 on page 11.) ☐ B. The orchard was scouted on a regular schedule by someone other than a Pest Control Adviser (PCA). ☐ C. The orchard was scouted on a regular schedule by a PCA.					
32	Written or electronic scouting reports were kept by or provided to the farm owner or staff to inform decision making.	☐	☐	☐	☐	
33	If reports were available, a year-end review of pest levels and trends was completed.	☐	☐	☐	☐	☐
34	Scouting data, university guidelines and practical experience were used to design and implement management strategies for insects, mites and diseases.	☐	☐	☐	☐	
35	Scouting continued after the use of each pest control tactic to verify efficacy and/or resistance issues.	☐	☐	☐	☐	☐
36	Choose the option that best reflects the scouting method used: ☐ A. "Driving by" the orchard (only checking the perimeter). ☐ B. Walking or driving through the orchard. ☐ C. Representative sampling of the orchard (e.g., by adopting university recommendations).					
37	Other: ______________________________				☐	

Records

Many PCAs do not provide written or electronic records to the orchard manager or owner, but it is recommended that you ask them to do so. If you do the scouting, keep records. The use of records aids decision making by revealing trends within and across seasons.

Several companies provide scouting software that can be used on smartphones or other handheld devices to generate records while scouting. Once in electronic form, scouting data can be used to analyze the cost efficacy of your practices — both before and after they take place.

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GENERAL IPM AND PESTICIDE RISK MANAGEMENT — EFFICACY AND SAFETY OF CONTROL

	For this orchard, the following methods were used to *maximize efficacy and minimize risk when controlling* pests:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	PESTICIDE APPLICATION EQUIPMENT					
38	For this orchard, choose the option that best reflects who was *primarily* responsible for applying pesticides: ☐ A. A custom applicator or farm management company. (You may have to answer *Not Applicable* for some of the following questions related to equipment and applications.) ☐ B. The farm owner or staff.					
39	Pesticide application equipment has been calibrated prior to use each year, after every equipment repair or modification, and when changes are made in operating pressure, spray pattern, fan speed, tractor type, tractor wheels, etc.	☐	☐	☐	☐	☐
40	A log of calibration and repairs to pesticide application equipment was maintained to ensure timely maintenance and efficient operation.	☐	☐	☐	☐	☐
41	Sprayer operating manuals have been reviewed, and all applicators have been trained in proper operation.	☐	☐	☐	☐	☐
42	Other: ______________________________				☐	
	AERIAL SPRAYING OF PESTICIDES					
43	Aerial spraying has been used for this orchard. ☐ A. Yes, even if the following did not apply. ☐ B. Yes, but only when impossible to get ground sprayers into the orchard, or to complete ground spraying in the time available (such as when a storm is approaching). ☐ C. No. (Skip to question 46 on page 12.)					
44	Aerial spraying was done using GPS guidance to maximize precision.	☐	☐	☐	☐	☐
45	Other: ______________________________				☐	

Spray drift

Pesticides found in streams and rivers are the cause for several regulations affecting California Almond growers. Until better technology is found, air blast sprayers will be necessary for effective tree protection, especially in mature orchards. Frequent calibration and use of properly functioning low-drift nozzles, as well as proper ground speed, fan speed and pressure, optimize spray efficiency and minimize drift. The use of a target-sensing sprayer that can automatically open and close nozzles to match tree height and presence (i.e., turning off nozzles between trees or when a tree is missing) should be considered. Target-sensing sprayers can reduce spray by 25%. Government cost-share funds have been available for this technology. If interested, check with your county Natural Resources Conservation Service office about available funding.

For this orchard, the following methods were used to *maximize efficacy and minimize risk when controlling* pests:

		Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	AIR BLAST PESTICIDE SPRAYERS					
46	Prior to each air blast application, the weather was checked for current and forecasted wind speed and direction, inversion conditions, temperature and rain.	☐	☐	☐	☐	☐
	Air blast applications only occurred:					
47	when winds were under 10 mph.	☐	☐	☐	☐	☐
48	when winds were between 2 and 8 mph (minimizes drift from inversions and wind).	☐	☐	☐	☐	☐
49	when winds were blowing away from drift-sensitive sites.	☐	☐	☐	☐	☐
50	at ground speeds of 2 mph or less (optimizes coverage).	☐	☐	☐	☐	☐
51	at night or during the coolest part of the day (to avoid vapor drift and for worker safety).	☐	☐	☐	☐	☐
52	when rain was not forecasted for 48 hours *unless* applications just before rainfall were recommended (e.g., for managing diseases) and zero runoff into waterways was expected.	☐	☐	☐	☐	☐
53	Low-drift nozzles were used to optimize spray placement and minimize off-target movement.	☐	☐	☐	☐	☐
54	Sprayer nozzles have been replaced at least once per season, or more frequently if powders or other corrosive materials were used.	☐	☐	☐	☐	☐
55	The spray pattern was adjusted according to the orchard's average tree size and shape (e.g., reducing size of lower nozzles for a mature orchard with a thin lower canopy, or shutting off top nozzles for a young orchard with short trees).	☐	☐	☐	☐	☐
56	When shifting between foliar sprays and dormant or bloom sprays, the fan speed, pressure and/or nozzle type were adjusted for the canopy density.	☐	☐	☐	☐	☐
57	Spray coverage was periodically checked using water-sensitive paper placed in the target zone.	☐	☐	☐	☐	☐
58	Proven drift-control spray additives or drift-reducing sprayers have been used, when possible.	☐	☐	☐	☐	☐
59	To reduce drift, the sprayer was operated at the lowest pressure providing uniform coverage.	☐	☐	☐	☐	☐
	OTHER PESTICIDE SPRAYERS					
60	Sprayer shields or drift guards were used to keep sprays on target (e.g., for weed sprayers).	☐	☐	☐	☐	☐
61	Ultra-low-volume spray equipment or target-sensing sprayers (e.g., SmartSpray® or WeedSeeker® technology) were used to reduce spray volumes or amounts of pesticides.	☐	☐	☐	☐	☐
62	Other: ______________________________				☐	

For this orchard, the following methods were used to *maximize efficacy and minimize risk when controlling* pests:

		Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	ACCOUNTING FOR SENSITIVE SITES					
63	The air blast sprayer was turned off when making row turns and did not resume until the nozzles were adjacent to the first trees.	☐	☐	☐	☐	☐
64	A map of sensitive sites and associated buffer zones within or near the orchard has been created and reviewed with everyone involved in pesticide applications.	☐	☐	☐	☐	☐
65	Spraying near waterways (e.g., creeks or irrigation canals) or other sensitive sites was discontinued when winds blew in the direction of these sites.	☐	☐	☐	☐	☐
66	Outward-facing nozzles on air blast sprayers were turned off when spraying outermost rows adjacent to open spaces (e.g., roads or open fields) or sensitive sites.	☐	☐	☐	☐	☐
67	When operating air blast sprayers next to open or sensitive sites (aquatic areas, residences, schools, etc.), the two rows directly adjacent to these sites were sprayed on the outer side only (i.e., to direct spray into the orchard).	☐	☐	☐	☐	☐
68	If drainage ditches or other aquatic areas exist within or near the orchard, pesticides were not applied within 100 feet upslope of these sites.	☐	☐	☐	☐	☐
69	Other: ______________________________				☐	

Sensitive sites

The term "sensitive sites" refers to areas of human or environmental sensitivity on or near the farm. These include streams, ponds, canals, wellheads, dry wells, drainage or runoff areas, wetlands, homes, schools and workplaces. Making a farm map that identifies sensitive sites and recommended or required buffer zones helps with farm planning, employee training and necessary emergency responses. Free or low-cost online mapping tools can help with farm planning.

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	For this orchard, the following methods were used to *maximize efficacy and minimize risk when controlling* pests:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	ACCOUNTING FOR ENDANGERED SPECIES					
70	The person(s) responsible for pest management could identify endangered or threatened species that may be found in the area, and periodically checked for signs of them.	☐	☐	☐	☐	☐
71	The person(s) responsible for pesticide selection and application regularly checked county, state or federal sources for endangered species updates that may impact pest management options and, if necessary, modified the selection of products or applications accordingly.	☐	☐	☐	☐	☐
72	Other: ____________________				☐	

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INSECT AND MITE PESTS — PREVENTION

	For this orchard, the following methods were used to *prevent* insect and mite problems:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	NAVEL ORANGEWORM (NOW)					
73	To reduce outbreaks of NOW and brown rot, mummy nuts were counted and removed, as needed, during the winter, so that less than two mummies per tree remained by February 1 (less than one mummy per tree for the southern San Joaquin Valley or within 3 miles of pistachio orchards).	☐	☐	☐	☐	☐
74	By March 15, mummy nuts on the ground were destroyed (e.g., by mowing or by verifying there was sufficient moisture to rot them).	☐	☐	☐	☐	☐
75	Timely harvest (harvesting as soon as nuts were dry enough) was completed to reduce nut damage by NOW.	☐	☐	☐	☐	☐
76	Controlled deficit irrigation was used to provide a uniform hullsplit, increase drying on the tree, and facilitate a rapid, timely harvest.	☐	☐	☐	☐	☐
77	Other: ____________________				☐	
	WEB-SPINNING MITES					
78	To reduce outbreaks of mites, dust was reduced on orchard roadways (via dust suppressants, oiling, watering, mulching, vegetative cover, driving slowly, etc.).	☐	☐	☐	☐	☐
79	Efficient irrigation management (see the Irrigation Management module) was practiced to prevent trees from becoming water stressed and to reduce web-spinning mites and their damage.	☐	☐	☐	☐	☐
80	Other: ____________________				☐	
	DAMAGE FROM OTHER INSECTS					
81	Rapid pickup of nuts off the ground was completed to reduce nut damage by ants and other pests.	☐	☐	☐	☐	☐
82	Other: ____________________				☐	

NAVEL ORANGEWORM MANAGEMENT AND MONITORING

Joe Connell, University of California Farm Advisor, Butte County

Management

The original four-point program for naval orangeworm (NOW) management developed by the University of California and the Almond Board of California included winter sanitation, a dormant spray (for peach twig borer control), an in-season spray and a timely harvest. Each can be important to help ensure the delivery of quality almonds.

Winter sanitation is the most critical component of the management strategy for NOW control. Removal of overwintering mummies down to an average of less than two mummy nuts per tree is essential. Often, birds don't do as well as we would like to believe. Make a mummy count in the orchard this winter, and clean the trees if there are too many mummies left. Destroy mummies on the ground by March 15.

Controlling peach twig borer (PTB) is important since NOW often follows PTB into the nuts. If PTB is present, the strategy of using sprays at bloom to control PTB could be substituted for a dormant spray in the NOW program.

An in-season spray at hullsplit can help keep NOW damage low, but it is not as effective as the cultural methods of sanitation and a timely harvest. If winter sanitation is completed effectively, and early harvest is practiced, the in-season spray may not be needed if external sources of infestation are more than one-quarter mile away.

Commence rapid, early harvest once 100% of the Nonpareil nuts at eye level have just begun to split. Nut removal at that time should be at least 99% when the trees are shaken. Anything that delays harvest will increase worm damage. Unexpected rain that slows down Nonpareil harvest or delays the pollinizer harvest will increase damage to soft-shelled pollinizers. Consider on-farm stockpile fumigation along with early harvest to preserve optimum quality.

Monitoring

Black egg traps baited with almond press cake and 10% almond oil are good monitoring tools. Place egg traps in orchards by the first week in April. Use at least four traps per orchard. In large orchards, use an average of one trap per 10 acres. Hang egg traps at head height on the north side of Nonpareil trees 1 to 3 feet inside the drip line.

In sprinkle-irrigated orchards, hang the traps over the sprinkler head to keep the press cake bait dry. These traps are good, and they maintain their attractiveness even after hullsplit.

Check traps twice a week in April and May until the first eggs are found, providing a biofix date. Once a biofix for the first generation is obtained in the spring, the degree-day phenology model can be used to predict the onset of the second to fourth generations. Each time traps are checked, remove the eggs, record the number of eggs, and chart or graph the number of eggs per trap per day.

Insect Life Cycle

There are several approaches to predicting the NOW life cycle. A simple degree-day model using a lower development threshold of 55°F and a horizontal upper development cutoff of 94°F is similar to models used for other insects and works quite well. The horizontal upper cutoff assumes that development continues at a constant rate at temperatures in excess of the upper threshold. This method tends to overestimate NOW development at temperatures over the upper development threshold (i.e., during especially hot summers).

Mean development time for NOW on mummy nuts is 1,056 degree-days, and on new crop nuts is only 723 degree-days, due to improved diet. Mean egg hatch is at 100 degree-days. We know there are three generations each year that have the potential to affect the crop. The first generation takes 1,056 degree-days on mummy nuts, but part of the second, and all of the third generation only take 723 degree-days on new crop nuts after hullsplit begins.

Practical Application

Monitoring with egg traps is useful for two reasons. First, they let you know how much NOW pressure is in the orchard and where it's the worst. Second, once you note when spring egg laying begins, degree-day projections will tell you when worm pressure is likely to increase during harvest and if the crop will be subject to attack by a fourth generation. This can help you determine which blocks to harvest first, or it may provide clues as to whether or not in-season sprays on the Nonpareil or soft-shelled pollinizers are likely to be beneficial.

Usually, the third generation comes in mid- to late August through September, and the fourth generation starts in late September to October and overwinters. When the biofix for the first generation is in May, populations follow this pattern of NOW activity. Although the third generation can do significant crop damage, its impact under these conditions can be minimized with the cultural controls discussed earlier.

When the biofix for the first-generation egg laying is a month earlier (mid-late April) there is more time for the third generation to damage the nuts. In addition, the fourth generation may begin in mid-September instead of in October. Under these conditions, the full impact of the third generation and part of the fourth generation may be felt on the soft-shelled varieties. This is why we have more severe worm problems on late-harvesting soft-shelled pollinizer varieties in years when harvest is delayed.

Using egg traps to monitor NOW activity will help you develop a better appreciation for the severity of worm pressure from year to year. In addition, it can help you anticipate the potential effects of a delayed harvest.

Insect Life Cycle Models (Phenology Models Using Degree-Days):

Although the Internet puts incredible resources at our fingertips, most of us are too busy to spend much time browsing. We usually need specific information quickly.

Web-based degree-day (D°) models are now easy to use and can predict insect life cycles once you provide a start date (the biofix), based on counts from insect traps on your farm. Degree-day projections from your spring biofix can be made using the UC IPM website and weather data from a station close to your location.

Here are simple steps for navigating:

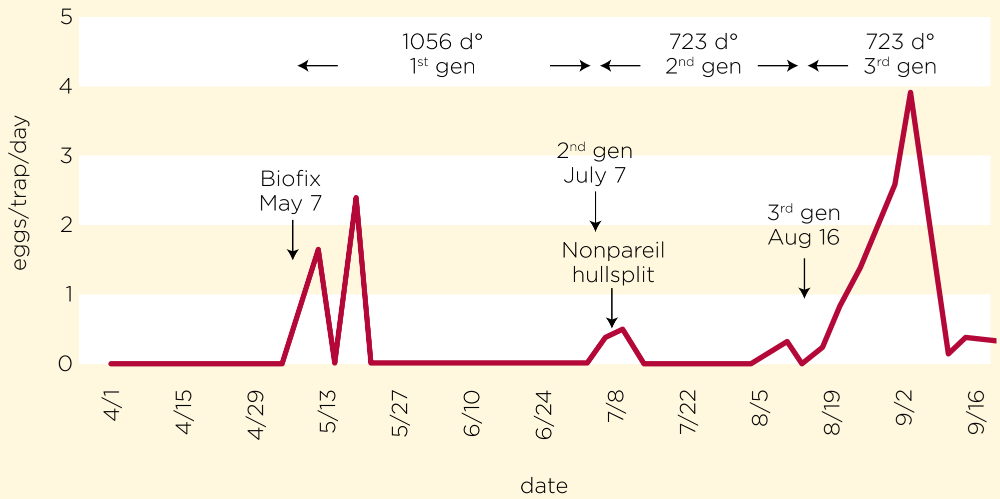
1) Go to the UC IPM website using your browser. http://www.ipm.ucdavis.edu.
2) Once at the website, find “Quick Links” and click on “Weather, models & degree-days.”
3) Under “Pest and plant models,” click on “Navel orangeworm.”
4) Make sure the “crop choice,” almonds, is correct and click on the “Continue” button.
5) Specify the source of temperature data: “Weather station from UC IPM database”; then,
6) Under “Select from stations in which California county?” highlight your county’s name.
7) Fill in the time period:
    a. “Biofix (start date)”: *month date year* < Enter your biofix.
    b. “End date”: *month date year* < Enter the latest date you care about or the end of the growing season. The program will use long-term average temperatures to project degree-days for the remainder of the season.

8) Click on "Continue"; then, select the weather station (from the list of county stations) that you wish to use. For example, click on "Durham.A (CIMIS #12, Durham)"
9) Select the Output file format you prefer. (E.g., select "Formatted report [for viewing or printing].")
10) Click on the "Calculate" button.
11) You're done!
    - You get a NOW degree-day report on your screen. (You can print it by clicking on "File," then "Print" from your browser's menu bar.)
    - The report also shows which temperatures are current (normally up through the date when you ran the model) and which are long-term averages (indicated by an "A" following the temperature).
    - The accumulated-degree-days column is used to identify the dates when each generation should end and the next egg-laying cycle will begin. (For example, after 1,056 degree-days, the first generation should end, and the second-generation egg laying should begin. Then, 723 degree-days after that, the third-generation egg laying should begin.)

If you know the daily maximum and minimum temperatures, you can also read and accumulate NOW degree-days from published charts.

The following graph is an example of how the NOW degree-day model can be useful for anticipating worm pressure at harvest. Monitoring and identifying the spring biofix dates for the major worm pests is an important component of a good pest management program in your orchard.

NAVEL ORANGEWORM D° MODEL



INSECT AND MITE PESTS — MONITORING AND STRATEGY

	For this orchard, the following methods were used to *decide if and when to control* insect and mite pests:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	SAMPLING NUT DAMAGE AT HARVEST					
83	At harvest, an analysis of types of nut rejects (more than a simple grade sheet) was obtained from the handler(s) to determine the pest(s) causing the damage, the efficacy of the year's pest management program, and the plan for the next year.	☐	☐	☐	☐	☐
84	At harvest, farm staff took their own samples of nuts and analyzed them to determine the pest(s) causing the damage, the efficacy of the year's pest management program, and the plan for the next year.	☐	☐	☐	☐	☐
	NAVEL ORANGEWORM (NOW)					
85	Was NOW sprayed in the past year? ☐ No. (Skip to question 89.) ☐ Yes. (Check all combinations of spray timing and monitoring used to ensure efficacy.)					
86	Spring spray was based on egg traps and degree-day calculations and/or timed to coincide with peach twig borer treatment.	☐	☐	☐	☐	
87	Hullsplit spray was based on the percentage of split hulls.	☐	☐	☐	☐	
88	Hullsplit spray was based on egg traps and degree-day calculations.	☐	☐	☐	☐	
	SAN JOSE SCALE (SJS)					
89	Was SJS sprayed in the past year? ☐ No. (Skip to question 94 on page 22.) ☐ Yes. (Check all types of monitoring used to decide if and when to spray.)					
90	Dormant spur monitoring (also detects brown and European red mites).	☐	☐	☐	☐	
91	Monitoring using pheromone traps and degree-day calculations.	☐	☐	☐	☐	
92	Monitoring crawler emergence (e.g., with sticky tape).	☐	☐	☐	☐	
93	SJS parasite activity was also monitored (e.g., on trap cards) to estimate the potential for biological control.	☐	☐	☐	☐	

For this orchard, the following methods were used to *decide if and when to control* insect and mite pests:

#	Method	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	PEACH TWIG BORER (PTB)					
94	Was PTB sprayed in the past year (dormant, bloom or spring sprays)? ☐ No. (Skip to question 98.) ☐ Yes. (Check all types of monitoring used to decide if and when to spray.)					
95	At the previous harvest, nuts were monitored for PTB damage.	☐	☐	☐	☐	
96	Shoot strike monitoring began in April to determine if the number of strikes reached a treatment threshold (generally four or more strikes per tree for mature orchards).	☐	☐	☐	☐	
97	Monitoring using pheromone traps and degree-day calculations.	☐	☐	☐	☐	
	WEB-SPINNING MITES					
98	Hot spots for web-spinning spider mites (e.g., orchard areas along dusty roads) were monitored (generally May to August) to guide control decisions.	☐	☐	☐	☐	☐
99	Mite predators (e.g., predatory mites and six-spotted thrips) were also monitored to estimate the amount of biological control.	☐	☐	☐	☐	☐
	ANTS					
100	The person(s) responsible for pest management was able to identify common ants and distinguish pest from non-pest species.	☐	☐	☐	☐	
101	In mid- or late spring, the number of fire ant and pavement ant colonies per 5,000 square feet was estimated.	☐	☐	☐	☐	☐
	LEAFFOOTED BUGS AND STINKBUGS					
102	Spring and summer monitoring included scouting for nut drop, nut gummosis and signs of other damage from leaffooted bugs and/or stinkbugs.	☐	☐	☐	☐	☐
103	During fall or winter, woodpiles, redwoods, junipers, cypress, eucalyptus, etc. were scouted for aggregations of leaffooted bugs to determine if these overwintering sites should be removed or otherwise managed.	☐	☐	☐	☐	☐
104	Other: ______________________________				☐	

INSECT AND MITE PESTS — EFFICACY AND SAFETY OF CONTROL

For this orchard, the following methods were used to *maximize efficacy and minimize risk when controlling* insects or mites:

		Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
105	How many times have dormant sprays been applied to this orchard in the past five years? ☐ 0 ☐ 1 ☐ 2 ☐ 3 to 4 ☐ 5 (every year)					
106	If a dormant spray was applied in the past year, what material(s) was used? ☐ Oil alone ☐ Oil and copper ☐ Oil and organophosphate ☐ Oil and pyrethroid ☐ Other ____________________					☐
107	When insecticide applications were necessary, the lowest label rates shown to be effective (e.g., by UC IPM guidelines) were used.	☐	☐	☐	☐	☐
108	When insecticides or acaricides were chosen, potential negative effects on beneficial and nontarget organisms were accounted for (e.g., by avoiding broad-spectrum pesticides such as pyrethroids, organophosphates and carbamates).	☐	☐	☐	☐	☐
109	In addition to following required practices on product labels, mode-of-action group numbers for insecticides and acaricides (on labels or in UC Pest Management Guidelines) were recorded and used to guide pesticide rotation/resistance decisions.	☐	☐	☐	☐	☐
110	A mating-disruption program for NOW has been used or attempted for this orchard.	☐	☐	☐	☐	☐
111	Control tactics for web-spinning spider mites included releases of predatory mites or insects to augment natural biological control.	☐	☐	☐	☐	☐
112	Other: ____________________				☐	
	POLLINATOR PROTECTION					
113	Prior to applying new insecticides, impacts to bees and natural enemies were checked (using information from labels and other sources such as the UC IPM website), and the product with the fewest precautions and/or shortest residual was considered for use.	☐	☐	☐	☐	☐
114	Outside of almond bloom, row middles were mowed or otherwise managed to prevent weeds from flowering and, therefore, discourage bees from entering the orchard when insecticide residues may have been present.	☐	☐	☐	☐	☐
115	Other: ____________________				☐	

Resistance Action Committees (RACs)

Pesticide labels often include numbers that designate groups of active ingredients with common "modes of action." Each group similarly affects pest targets (insects, weeds, etc.). Since multiple products can contain the same active ingredient, and multiple active ingredients can have similar modes of action, the group number is useful for planning pesticide rotations. Each branch of the pesticide industry has a Resistance Action Committee (IRAC for insecticides, FRAC for fungicides and HRAC for herbicides) that categorizes active ingredients by these group numbers. Single products (especially fungicides) can contain active ingredients from separate groups. If the pesticide label does not list the number(s), they can be found on the corresponding RAC website (see "References and more information" sections of this module) or by accessing the online UC IPM Pest Management Guidelines for almonds.

EXAMPLES OF BROAD-SPECTRUM INSECTICIDES

INSECTICIDE CLASS	BRAND NAMES
Carbamates	Lannate, Sevin
Organophosphates	Diazinon, Guthion, Lorsban, malathion, Supracide, Imidan
Pyrethroids	Ambush, Asana, Brigade, Danitol, Pounce

EXAMPLES OF NARROW-SPECTRUM INSECTICIDES OR THOSE LESS TOXIC TO NONTARGETS

INSECTICIDE CLASS	BRAND NAMES
Insect growth regulators	Clinch, Confirm, Dimilin, Distance, Esteem, Intrepid, Seize
Microbials *(Bacillus thuringiensis)*	Condor, DiPel, Javelin
Miticides	Acramite, AgriMek, Apollo
Narrow-range oils	Gavicide Oil, Omni Oil, etc.
Naturalytes *(spinosad, spinetoram)*	Entrust, Delegate, Success

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DISEASES — PREVENTION

	For this orchard, the following methods were used to *prevent* diseases:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	PRUNING AND WOUND PREVENTION					
116	Were trees pruned? ☐ Yes. ☐ No. (Skip to question 119.)					
117	Pruning resulted in minimal stub cuts or damaged branch collars, which could be sites for disease entry.	☐	☐	☐	☐	
118	Pruning was completed during dry weather (e.g., immediately after harvest) to minimize open wounds being exposed to rain.	☐	☐	☐	☐	
119	During harvest, good shaker management was practiced to avoid tree wounding and subsequent infection by pathogens.	☐	☐	☐	☐	
120	Field equipment was operated to avoid wounding tree crowns (where the trunk and roots meet).	☐	☐	☐	☐	☐
121	Other: ____________________				☐	

DISEASES — MONITORING AND STRATEGY

	For this orchard, the following methods were used to *decide if and when to control* diseases:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
122	The orchard was monitored for shot hole or rust lesions and fruiting structures in the fall to determine if treatment would be necessary at petal fall. After petal fall, monitoring for fruiting structures continued until weather was not conducive for disease development. (NOTE: Zinc sprays applied as foliar fertilizers in the fall may cause incidental leaf loss, thereby reducing potential infection sites.)	☐	☐	☐	☐	☐
123	During bloom and spring periods, the weather was carefully monitored for temperatures and rainfall favorable for disease development.	☐	☐	☐	☐	
124	Disease symptoms were monitored weekly prior to and during bloom, and throughout spring, until weather was no longer conducive for disease development.	☐	☐	☐	☐	
125	The orchard was scouted during postharvest for nuts or leaves stuck on trees or shoot die-back, which may indicate hull rot or damage from San Jose Scale.	☐	☐	☐	☐	☐
126	Other: ______________________________				☐	

DISEASES — EFFICACY AND SAFETY OF CONTROL

	For this orchard, the following methods were used to *maximize efficacy and minimize risk when controlling* diseases:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
127	To reduce the likelihood of diseases becoming resistant, fungicides were sprayed to ensure full coverage (ground speeds of 2 mph or less, no skipped rows, etc.).	☐	☐	☐	☐	☐
128	In addition to required practices on product labels, the most recent fungicide efficacy and resistance management information was reviewed (e.g., *UC Fungicide Efficacy and Treatment Timing* tables) to guide rotation/resistance decisions.	☐	☐	☐	☐	☐
	POLLINATOR PROTECTION AT BLOOM					
129	As much as possible during bloom, sprays were applied when bees were not working flowers (e.g., when temperatures were below 55°F; or mid-afternoon or later when most pollen was foraged). (NOTE: Spraying blossoms during the morning may reduce pollination.)	☐	☐	☐	☐	☐
130	Prior to positioning hives in the orchard, arrangements were made with the beekeeper(s) about what, if any, advance notice was required about pesticide use while hives were present.	☐	☐	☐	☐	☐
131	Other: ____________________				☐	

BLOOM AND BEES

The California Almond community has attracted media attention in recent years for the large number of beehives that travel to orchards for use in almond blossom, coupled with attention on multiple bee health issues nationwide. To maintain a healthy relationship with your beekeeper(s), cooperation between the grower and beekeeper is essential. The Coalition for Urban/Rural Environmental Stewardship recommends that growers and beekeepers work together to:

- Review the pest management practices in the area before the beehives are delivered.
- Develop a written agreement outlining the crop timing, period for using the hives, and important considerations.
- Clearly define responsibilities for providing supplemental water and food sources and for protecting the hives.
- Place hives away from areas that may be exposed to pesticides toxic to bees during the pollination period.
- Protect water sources from contamination by pesticides.
- Inform neighboring growers and custom applicators operating in the area where hives are located so precautions can be taken when treating nearby fields.
- Remove hives if pesticides toxic to bees will be applied in the immediate vicinity.
- If applications of pesticides toxic to bees near beehives are unavoidable, shield beehives with wet burlap to confine and protect the bees, but ensure that bees are kept cool at all times.
- Post the beekeeper's name and contact information near the hives.

Excerpted from "Pollinators and Pesticide Stewardship," available at www.curesworks.org.

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NEMATODES — PREVENTION

	For this orchard, the following methods were used to *prevent* nematode problems:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
132	Equipment used in orchards infested with nematodes was cleaned of soil and roots before being moved to noninfested areas.	☐	☐	☐	☐	☐
133	Tail water from blocks or orchards infested with nematode pests was not used to irrigate noninfested areas.	☐	☐	☐	☐	☐
134	If cover cropping was done, the plant species used for cover were rotated annually to restrict the growth of nematode populations.	☐	☐	☐	☐	☐
135	Other: ____________________				☐	

NEMATODES — MONITORING AND STRATEGY

	For this orchard, the following methods were used to *decide when and how to manage* nematode problems:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
136	If weak areas of tree growth were evident, root and soil samples were taken from these areas and tested for nematode pests.	☐	☐	☐	☐	☐
137	Other: ____________________				☐	

NEMATODES — EFFICACY AND SAFETY OF CONTROL

	For this orchard, the following cultural methods were used to *minimize damage* from nematodes:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
138	Recommended irrigation, nutrient and soil management practices were followed to promote tree health and vigor, which provided some tolerance to nematodes.	☐	☐	☐	☐	☐
139	Organic matter was added to the soil (e.g., as compost or a cover crop) to enhance root growth and health.	☐	☐	☐	☐	☐
140	Other: ______________________________				☐	

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WEEDS — PREVENTION

	For this orchard, the following methods were used to *prevent* weed problems:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
141	Ground cover (resident or planted) was intentionally grown between orchard rows. ☐ Yes. ☐ No. (Skip to question 145.)					
142	Between-row, resident vegetation was managed to minimize weed colonization of tree rows.	☐	☐	☐	☐	
143	A between-row cover crop was selected, seeded and managed to outcompete weeds and prevent weed colonization of tree rows.	☐	☐	☐	☐	
144	Between-row ground cover was managed (e.g., mowed) before bloom to provide frost protection, remove flowers that could compete with almonds for pollination, and ensure cover was short and even at harvest.	☐	☐	☐	☐	
145	To prevent transferring weeds among orchards, equipment was cleaned after working in weedy areas, especially if herbicide-resistant species were suspected or present.	☐	☐	☐	☐	☐
146	The orchard was irrigated using drip or micro-sprinklers (decreases weed growth in row middles).	☐	☐	☐	☐	☐
147	Other: ______________________________				☐	

WEEDS — MONITORING AND STRATEGY

For this orchard, the following methods were used to *decide if and when to control* weeds:

		Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
148	Weeds were monitored at least twice a year, preferably during the fall after harvest and first rains (for winter annuals and perennials) and during late spring (summer annuals and perennials).	☐	☐	☐	☐	
149	Species and infestation levels were recorded to guide the weed management strategy and type and timing of control(s).	☐	☐	☐	☐	
150	Monitoring included an evaluation after each treatment to identify and manage problems with efficacy, including resistance.	☐	☐	☐	☐	☐
151	Monitoring records included growth stages (seedling or mature) and potential herbicide resistance issues.	☐	☐	☐	☐	☐
152	Groundwater protection areas, nearby surface waters and regulations pertinent to the orchard were known and factored into the weed management strategy.	☐	☐	☐	☐	☐
153	The orchard's soil texture was known and factored into management decisions. (E.g., sandy loams to loamy sands require lower rates of pre-emergent herbicides, and permit more flexible timings for cultivation.)	☐	☐	☐	☐	☐
154	Some annual weeds were tolerated within the tree rows if competition from them was negligible and their presence did not increase rodents or interfere with irrigation or harvest.	☐	☐	☐	☐	☐
155	An integrated weed management strategy was developed (involved multiple control tactics, rotation of herbicides with different modes of action, etc.) that considered monitoring results, past treatments, herbicide resistance and physical characteristics of the orchard and surrounding sensitive areas.	☐	☐	☐	☐	☐
156	Other: ______________________________				☐	

WEEDS — EFFICACY AND SAFETY OF CONTROL

	For this orchard, the following methods were used to *maximize efficacy and minimize risk when controlling* weeds:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
157	Weed control involving cultivation, mowing or flaming did not damage almond roots or trunks or irrigation systems.	☐	☐	☐	☐	☐
158	Potentially adverse environmental effects of nonchemical controls (e.g., soil erosion and/or problematic air emissions associated with cultivation, flaming or mowing) were considered before and during use.	☐	☐	☐	☐	☐
159	Herbicides generally were applied only within the tree rows (not orchard middles).	☐	☐	☐	☐	☐
160	Rates of pre-emergent herbicides were adjusted for soil texture to prevent tree damage and leaching.	☐	☐	☐	☐	☐
161	Herbicides were selected and used to cost-effectively and safely (avoiding off-site movement by drift, runoff, leaching and volatilization) control the majority of weeds and growth stages that were present.	☐	☐	☐	☐	☐
162	Rates of applied postemergent herbicides were decreased by spot-spraying or use of smart sprayers (e.g., SmartSpray® or WeedSeeker® technology).	☐	☐	☐	☐	☐
163	Suspected or identified herbicide-resistant weeds were managed with alternative tactics including cultural practices (such as hoeing small patches when first noticed) and alternating herbicides with different modes of action.	☐	☐	☐	☐	☐
164	Other: ____________________				☐	

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VERTEBRATE PESTS — PREVENTION

	For this orchard, the following methods were used to *prevent* vertebrate problems:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
165	Potential vertebrate shelters (e.g., piles of rocks, unused sprinkler pipe, farm equipment, brush piles or brushy vegetation) have been removed from the orchard and its margins.	☐	☐	☐	☐	☐
166	If the orchard is adjacent to grasslands or other wild areas, a cleared margin was maintained to discourage rodents from entering the orchard.	☐	☐	☐	☐	☐
167	Orchard floors were managed to prevent weeds from getting tall and providing shelter for rodents (especially directly adjacent to almond trees).	☐	☐	☐	☐	☐
168	Other: ____________________				☐	

VERTEBRATE PESTS — MONITORING AND STRATEGY

	For this orchard, the following methods were used to *decide if and when to control* vertebrate pests:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
169	The orchard and its margins were monitored for signs of vertebrate pests (e.g., ground squirrels and gophers) throughout the season.	☐	☐	☐	☐	☐
170	To detect and control problems early, orchards were intensely monitored during the onset of vertebrate activity (e.g., spring).	☐	☐	☐	☐	☐
171	To prevent harm to nontarget species from control tactics, vertebrate pests were accurately identified (e.g., distinguishing ground squirrel burrows from endangered kit fox dens).	☐	☐	☐	☐	☐
172	Other: ____________________				☐	

VERTEBRATE PESTS — EFFICACY AND SAFETY OF CONTROL

	For this orchard, the following methods were used to *maximize efficacy and minimize risk when controlling* vertebrates:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	GOPHERS, GROUND SQUIRRELS AND OTHER SMALL BURROWING VERTEBRATES					
173	Burrowing vertebrate pests were managed without toxic baits or fumigants. ☐ Yes. (Skip to question 178.) ☐ No.					
174	Small populations were managed (where permitted) by trapping alone or in combination with chemicals.	☐	☐	☐	☐	☐
175	Spot treatments were used, when possible.	☐	☐	☐	☐	☐
176	Exclusion devices (e.g., bait stations with small openings) or other methods were used to reduce risks to nontarget species from toxins or traps.	☐	☐	☐	☐	☐
177	For severe or chronic infestations, a treatment plan was developed that accounted for pest species and bait acceptance, toxicity and residual activity, and other considerations about efficacy, worker safety and nontarget effects. (E.g., fumigants can pose high risks to applicators but low risks to nontarget vertebrates; some baits are more effective as broadcast than spot treatments.)	☐	☐	☐	☐	☐
178	Biological control of burrowing vertebrate pests was encouraged by installing nest boxes or perches for predatory birds (e.g., owls or hawks) at orchard margins. ☑	☐	☐	☐	☐	☐
179	If nest boxes or perches were provided, they were periodically maintained and cleaned, which included cleaning the orchard floor under them before harvest.	☐	☐	☐	☐	☐
180	Other: ______________________________				☐	

☑ This practice may also have food safety implications. Consult ABC GAP recommendations for more information.

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POSTHARVEST PEST MANAGEMENT

This practice may also have food safety implications. Consult ABC GAP recommendations for more information.

For this orchard or facility, the following methods were used to *prevent* pests in stockpiles:

	STOCKPILE MANAGEMENT	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
181	This orchard or facility stockpiled nuts (in the orchard or elsewhere): ☐ Yes. ☐ No. (Skip to question 194 on page 42.)					
182	Stockpiles were located on clean (e.g., not treated with manure or other contaminants in the past year), dry soil or concrete where water does not collect.	☐	☐	☐	☐	
183	Stockpiles were oriented north to south to minimize condensation and mold.	☐	☐	☐	☐	
184	For nuts that were stockpiled, their moisture content was determined while on the orchard floor, before or after sweeping.	☐	☐	☐	☐	
185	Nuts were not stockpiled if hull moisture exceeded 13% or kernel moisture exceeded 6%.	☐	☐	☐	☐	☐
186	If stacked with nuts having higher-than-recommended moisture, stockpiles were uncovered during the day, when humidity was lower, and recovered at night.	☐	☐	☐	☐	☐
187	Stockpiles were built with smooth tops to reduce "valleys," where condensation concentrates.	☐	☐	☐	☐	☐
188	Stockpiles were covered with white-on-black tarps to minimize condensation and temperature changes.	☐	☐	☐	☐	☐
189	Other: ______________________________				☐	

	For this orchard or facility, the following methods were used to *maximize efficacy and minimize risk when controlling* pests in stockpiles:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
190	Employees handling stockpiles were trained to properly manage them, including use of safe fumigation practices.	☐	☐	☐	☐	☐
191	Traceability procedures were followed when creating stockpiles.	☐	☐	☐	☐	☐
192	A thorough review of typically used types of fumigation (stockpile fumigation, hull pile fumigation, etc.) has been done, and appropriate safety, quality control and emergency responses are in written management plans.	☐	☐	☐	☐	☐
193	Other: ______________________________				☐	

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POSTHARVEST PEST MANAGEMENT (HULLER/SHELLERS OR PROCESSORS)

The practices in this section apply to facilities for huller/sheller operations or processing plants. In addition to the main work area, facilities include connecting or immediately adjacent rooms, storage areas or surrounding environments that could harbor pests which may infest areas where almonds are processed.

Because pests can transmit human pathogens or other contaminants, practices in this section have food safety implications. Practices here should not be considered a definitive guide for Good Manufacturing Practices (GMPs) for food safety. GMPs for food safety are detailed on the Almond Board of California website (www.almondboard.com).

194	Does this facility operate seasonally or year-round? ☐ Seasonally. (If so, the following questions apply from preseason preparation to postseason wrap-up.) ☐ Year-round.					

POSTHARVEST PEST MANAGEMENT (HULLER/SHELLERS OR PROCESSORS) — PREVENTION

	For this facility, the following methods were used to *prevent* pest problems:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	PROGRAM, POLICIES AND TRAINING					
195	A staff person has been authorized to implement the facility's pest management program, and to serve as the primary point of contact for pest control contractors (if used).	☐	☐	☐	☐	☐
196	The facility has a written and regularly updated employee sanitation, prevention and pest management program that was used to train employees at hiring and by schedule thereafter.	☐	☐	☐	☐	☐
197	Records were kept for employee pest management training.	☐	☐	☐	☐	☐
198	Other: ____________________				☐	

For this facility, the following methods were used to *prevent* pest problems:

		Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	PEST FOOD AND WATER SOURCES					
199	Floors, walls and ceilings were constructed to facilitate cleaning and maintenance.	☐	☐	☐	☐	☐
200	Landscape plants and trees known to serve as food or nesting sites for birds and other pests were not planted or have been removed.	☐	☐	☐	☐	☐
201	Clutter and debris were quickly removed (i.e., daily) from equipment or areas prone to debris (e.g., load levelers, dock areas and conveyor belts), and from less visible or accessible areas (e.g., ledges, cracks and within equipment).	☐	☐	☐	☐	☐
202	Trash bins, dumpsters and other external waste receptacles were on rigid, cleanable surfaces (e.g., concrete pads), which were kept clean.	☐	☐	☐	☐	☐
203	Waste bins and other interior trash receptacles, especially those used for disposing of food or other materials that attract pests, were emptied often (preferably daily) and kept clean (e.g., by removing waste that had collected under trash liners).	☐	☐	☐	☐	☐
204	The facility (interior and exterior) had no standing water, and all sources of water were managed to not attract or harbor pests.	☐	☐	☐	☐	☐
205	No food, beverages, candy, chewing gum, lozenges or similar comestibles were allowed in almond processing areas.	☐	☐	☐	☐	
206	No pets or other animals were allowed inside the facility.	☐	☐	☐	☐	
207	Lunch or snacking areas were separate from almond processing areas.	☐	☐	☐	☐	☐
208	Vending machines were not in buildings where almonds were processed.	☐	☐	☐	☐	☐
209	Food and clothing were removed from employee lockers (if provided) at least weekly.	☐	☐	☐	☐	☐
210	Policies or devices prevented doors and windows from remaining open unnecessarily (especially for bathrooms and other areas of water use).	☐	☐	☐	☐	☐
211	Bins, wagons and other almond storage or transportation equipment were thoroughly cleaned at season's end or when not in regular use.	☐	☐	☐	☐	☐
212	Nuts stored outdoors were covered.	☐	☐	☐	☐	☐
213	Other: ______________________________				☐	

For this facility, the following methods were used to *prevent* pest problems:

#	PEST EXCLUSION TACTICS	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
214	At least twice annually, unnecessary openings, gaps or cracks were identified and sealed to exclude insects, rodents, birds, etc. Necessary openings were screened, curtained or had other exclusion devices, if possible.	☐	☐	☐	☐	☐
215	Floor cracks and/or expansion joints were sealed, as needed, and floors and equipment were frequently swept to prevent the accumulation of almond particles.	☐	☐	☐	☐	☐
216	Areas above and around stored almonds were designed and/or maintained to exclude birds and other pests.	☐	☐	☐	☐	☐
217	Exclusion materials (e.g., nets, needle strips, ledge barriers or gels), traps and/or scaring (hazing) devices (e.g., noisemakers, decoys or lasers) were used to prevent birds from roosting, nesting, fouling or causing other problems in or around the facility.	☐	☐	☐	☐	☐
218	To provide a clear zone for pest inspection around the facility's external perimeter, tall grass and other plants adjacent to the facility were removed.	☐	☐	☐	☐	☐
219	During the off-season (if applicable), the facility was not used to store items, or as a workshop involving items that could harbor pests (e.g., farm equipment).	☐	☐	☐	☐	☐
220	Equipment stored on the facility's grounds was maintained as pest-free, and unused or inoperative equipment was removed.	☐	☐	☐	☐	☐
221	Temperature manipulation or a modified atmosphere was used to control pest development in stored nuts.	☐	☐	☐	☐	☐
222	Hull and/or shell piles were on impervious surfaces to prevent insect reproduction in soil under piles.	☐	☐	☐	☐	☐
223	Other: ______________________________				☐	

POSTHARVEST PEST MANAGEMENT (HULLERS/SHELLERS OR PROCESSORS) — MONITORING AND STRATEGY

	For this facility, the following methods were used to *decide if and when to control* pests:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	MONITORING METHODS					
224	A schematic map was made of the locations of all traps and bait stations for insect and rodent pests.	☐	☐	☐	☐	☐
225	A log was kept of pest management activities, including inspections of each trap and bait station.	☐	☐	☐	☐	☐
226	The log included documentation of maintenance issues found when installing insect pheromone lures.	☐	☐	☐	☐	☐
227	The log was kept electronically (e.g., facilitated by use of a bar code scanner).	☐	☐	☐	☐	☐
228	A method of service verification (e.g., stickers, cards or bar codes) was used for traps and bait stations that required them being opened to record or scan information.	☐	☐	☐	☐	☐
229	Pheromone traps used to capture pests for timing necessary treatments were strategically placed (especially near stockpiles, hull piles, and almond storage and processing areas).	☐	☐	☐	☐	☐
230	Other: ______________________________				☐	
	MONITORING FREQUENCY					
231	Traps and bait stations in external locations were checked at least monthly, and those in internal locations at least weekly (more often during periods of expected high pest pressure).	☐	☐	☐	☐	☐
232	At least monthly, the entire facility was inspected for signs of pests, maintenance needs for pest prevention or exclusion, general clutter and debris.	☐	☐	☐	☐	☐
233	At least quarterly, the pest management program was thoroughly audited to determine necessary revisions.	☐	☐	☐	☐	☐
234	Other: ______________________________				☐	

POSTHARVEST PEST MANAGEMENT (HULLER/SHELLERS OR PROCESSORS) — EFFICACY AND SAFETY OF CONTROL

	For this facility, the following methods were used to *maximize efficacy and minimize risk when controlling* pests:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	HULL/SHELL PILES					
235	As each hull or shell pile was developed, perforated pipe was laid on the surface to facilitate later fumigation, if needed.	☐	☐	☐	☐	☐
236	If hull or shell piles intended for animal use were treated, the products used were labeled for animal feedstock.	☐	☐	☐	☐	☐
237	If hull or shell piles were treated for insects, lower-risk insecticides (e.g., insect growth regulators) were used.	☐	☐	☐	☐	☐
238	Other: ______________________________				☐	
	TRAPS AND BAIT STATIONS					
239	Light traps were installed at each door (preferably on two sides of large doors and the hinge side of personnel doors), and were emptied on a regular schedule.	☐	☐	☐	☐	☐
240	The placement of rodent traps included above-ground locations (e.g., beams and ledges) since some rodents rarely descend to ground level.	☐	☐	☐	☐	☐
241	Multiple-catch traps or glue boards were spaced 20–25 feet apart around the inside of exterior walls. (Note: Bait cannot be used inside facilities where it can contaminate almond products.)	☐	☐	☐	☐	☐
242	Rodent control devices, such as bait stations or multiple-catch traps, were spaced no more than 40 feet apart around the exterior of buildings.	☐	☐	☐	☐	☐
243	Rodent control devices, such as multiple-catch traps, were spaced no more than 100 feet apart around the property perimeter. (Note: As of June 2011, rodenticides are no longer permitted more than 50 feet from a building.)	☐	☐	☐	☐	☐
244	If impossible to install traps or bait stations in protected locations, they were secured inside locked and anchored stations.	☐	☐	☐	☐	☐
245	Potential allergens such as peanut butter were not used in baits and traps.	☐	☐	☐	☐	☐
246	Traps were cleaned and maintained to not attract secondary pests.	☐	☐	☐	☐	☐
247	Other: ______________________________				☐	

	For this facility, the following methods were used to *maximize efficacy and minimize risk when controlling* pests:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	PESTICIDE SAFETY AND EFFICACY					
248	If insecticides were applied, food-processing surfaces were covered or thoroughly cleaned to avoid residues.	☐	☐	☐	☐	☐
249	If insecticides were applied, lower-risk materials (e.g., insect growth regulators or pheromone disrupters) were used when possible.	☐	☐	☐	☐	☐
250	Fogging of any part of the facility was completed only if justified by pest monitoring, and nuts could not be exposed to fogging materials.	☐	☐	☐	☐	☐
251	Relevant international MRL (maximum residue level) information was available and consulted prior to selecting pesticides and application methods.	☐	☐	☐	☐	☐
252	Pesticides and pesticide application equipment were stored separately from oils or products used in food processing and away from food processing areas.	☐	☐	☐	☐	☐
253	Other: ______________________________				☐	

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NOTES

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Introduction – Sustainability and Ecosystem Management

Ecosystem management is encouraged and implemented by agriculturists, communities, governments, businesses, academics and conservation organizations throughout the world. In practice, however, ecosystem management can be challenging to comprehend and effectively apply due to the intricacy and system-level effects of its interrelated processes. Practical ecosystem management in agriculture requires knowledge of ecosystem components and processes and how the processes can be optimized to benefit agricultural productivity and environmental quality.

An ecosystem is the complex of communities of living organisms and the physical environment interacting and functioning together as an ecological unit. Its components are inseparable and interrelated. Realizing the interconnectivity of ecological, social, economic and institutional systems is fundamental to understanding how agriculture and landscapes relate. It is important to realize that agricultural practices affect multiple aspects of the ecosystem and manage accordingly. An ecosystem management approach acknowledges that people are part of and significantly impact ecosystem structure and processes, and depend on and must assume responsibility for their ecological, social and economic systems.

Four fundamental processes affect ecosystem dynamics and environmental quality – the water cycle, the mineral cycle, energy flow and community dynamics. Understanding the basics of each can improve your approach to land stewardship and optimize agricultural productivity.

The Water Cycle

Water enters landscapes as rainfall and is stored in the soil profile, as surface water in ponds, lakes and reservoirs, or as groundwater in aquifers. Water exits landscapes via runoff, evaporation, transpiration and deep percolation through the soil profile into aquifers. In natural and agricultural ecosystems, plants significantly influence water storage and movement. On-site water resources are increased by practices that limit runoff and improve infiltration into and the water-holding capacity of soils. Efficiencies of water use can be optimized by regular maintenance and monitoring of irrigation systems, and by basing irrigation decisions on soil moisture, soil water-holding capacity and crop demand. These practices helps ensure the supply and efficient use of and cycling of water, and help optimize crop productivity.

The Mineral or Nutrient Cycle

The mineral or nutrient cycle is the process by which key elements such as nitrogen (N), phosphorous (P), potassium (K) and other macro- and micro-nutrients move through the living (biotic) and nonliving (abiotic) components of the ecosystem. Ideally, the mineral cycle involves a biologically active soil with adequate aeration and energy flow to sustain a variety of organisms that exchange carbon, nitrogen and oxygen with the atmosphere. Implementing practices that prevent off-site nutrient losses (e.g., buffer strips and hedgerows) and increase nutrient cycling (e.g., cover cropping, compost additions and efficient fertilizer use) make farming operations efficient, productive and environmentally sound.

Energy Flow

The living world runs on solar energy, and energy flow impacts ecosystem structure and functions. Through photosynthesis, plants capture and convert solar to chemical energy (carbohydrates) for their growth and development. Animals depend on energy stored by plants. All life forms rely on energy flow; thus, so does every economy, nation and civilization. Agricultural practices impact energy capture and flow. Executing practices that enhance energy flow helps optimize productivity and the functionality of other ecosystem processes.

Community Dynamics

A community is a subset of the living organisms in an ecosystem. Plant and animal communities constitute the highest levels. The animal community, for example, can be further divided into soil microbial, insect, bird and other communities. Community dynamics refers to how communities interact with each other and the environment and is the most vital of the ecosystem processes. Other processes cannot function appropriately unless plants are present to convert sunlight to useable energy for animals. Biologically diverse communities are never static as species composition, density, age structure and other factors change constantly. Biodiversity is a measure of the variety of plant and animal species in an ecosystem. A diverse assemblage of plants and animals enhances the functioning, stability and productivity of the ecosystem, which increases crop productivity and quality.

In contrast to most other modules, the management practices relevant to orchards in this module should be assessed at the whole-farm level. This is because ecosystem management generally is implemented on and affects larger landscapes. Practices pertinent to hulling/shelling or processing should continue to be assessed at the individual facility level.

We live and farm in a watershed…

A watershed is the area of land where all of the water that is under it, or drains off of it, ends up in the same place.

John Wesley Powell, scientist geographer, put it best when he said that a watershed is "…that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community."*

Watersheds come in all sizes and often cross county and state lines as well as property boundaries. Accordingly, it is important to remember that we live and farm in watersheds, and, thus, are accountable for protecting and wisely using water resources.

Adapted from: http://water.epa.gov/type/watersheds/whatis.cfm.

	For this farm or facility, the following ecosystem management practices and approaches relevant to the general landscape were used:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	GENERAL LANDSCAPE ISSUES					
1	The name and basic characteristics of the ecological region (e.g., Sacramento Valley, Bay/Delta, Sierra Foothills or San Joaquin Valley) within which the farm or facility is located were known.	❑	❑	❑	❑	
2	The watershed within which the farm or facility is located was known.	❑	❑	❑	❑	
3	One (or more) member of the farm or facility was an active member in a local or regional water quality coalition.	❑	❑	❑	❑	❑
4	One (or more) member of the farm or facility participated in a watershed stewardship planning group.	❑	❑	❑	❑	❑
5	Other:				❑	

	For this farm or facility, the following ecosystem management practices and approaches relevant to threatened or endangered species were used:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	THREATENED OR ENDANGERED SPECIES					
6	The threatened and/or endangered species that might inhabit the farm or facility grounds have been identified. ❑ Yes. ❑ No. (Skip to question 11.)					
7	The identified threatened and/or endangered species that might inhabit the farm or facility grounds have been listed.	❑	❑	❑	❑	❑
8	Habitat for any threatened and/or endangered species that exists on the farm or facility property has been identified.	❑	❑	❑	❑	❑
9	The farm or facility property was managed to protect and/or enhance habitat for threatened and endangered species (e.g., Safe Harbor Agreement).	❑	❑	❑	❑	❑
10	Other:				❑	

Endangered Species and Habitat in the Central Valley

To be completed…

What is a Safe Harbor Agreement?

A Safe Harbor Agreement (SHA) is a voluntary arrangement between non-federal landowners and the US Fish and Wildlife Service or National Oceanic and Atmospheric Administration-Fisheries. Primarily, it promotes voluntary management for listed threatened and/or endangered species on non-federal property, while assuring participating landowners that no additional regulatory restrictions will be imposed. The agreements benefit both the targeted species and the landowners, who can farm without worry of additional regulations and associated fines or penalties from noncompliance.

For more information see: http://www.fws.gov/midwest/endangered/permits/enhancement/sha/index.html.

What are ecosystem services?

Ecosystem services are the benefits to humans from the many resources and processes supplied by ecosystems. Services include reducing greenhouse gases, recycling nutrients, providing wildlife habitat and regulating microclimate and local hydrological processes. In some cases, ecosystem services can suppress plant and animal pests via natural enemies, and buffer the offsite movement of sediment, nutrients and pesticides.

It is important to recognize and enhance the services that the ecosystem provides to benefit almond production and environmental quality.

	For this farm or facility, the following ecosystem management practices and approaches relevant to the promotion of biodiversity were used:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	PROMOTION OF BIODIVERSITY					
11	The value (ecosystem services) from ensuring a high level of appropriate biodiversity (e.g., beneficial wildlife, pollinators and pest natural enemies) on the farm or facility property was understood. ❑ Yes. ❑ No. (Skip to question 18.)					
12	Farmed or landscaped areas were managed (e.g., cover crops, low/no tillage, additions of organic matter or landscape plantings) to appropriately increase biodiversity.	❑	❑	❑	❑	❑
13	Areas not farmed or not used for processing were managed to appropriately increase biodiversity, including beneficial wildlife via providing nest (owls and songbirds) and bat boxes, raptor perches, etc.	❑	❑	❑	❑	❑
14	Habitat features on the farm or facility property were connected by vegetated corridors and to adjacent properties to the greatest extent feasible to provide connectivity for beneficial wildlife.	❑	❑	❑	❑	❑
15	Numbers and/or symptoms of desirable animals and plants on the farm or facility property were observed to determine impacts from management.	❑	❑	❑	❑	❑
16	Numbers and/or symptoms of desirable animals and plants on the farm or facility property were measured and recorded to determine impacts from management.	❑	❑	❑	❑	❑
17	Other:				❑	

Songbirds and bats are insectivorous

Even through many adult songbirds eat seeds instead of insects; all adult songbirds feed insects to their young during the nesting season. Bats also consume insects when flying at night. Consequently, using nest and bat boxes to enhance songbird and bat populations can benefit agriculture.

To encourage use of owl boxes, they should be cleaned annually by removing nesting material from the previous year.

	For this farm or facility, the following ecosystem management practices and approaches relevant to conservation easements were used:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	CONSERVATION EASEMENTS					
18	Some or all of the natural areas of the farm or facility property were protected by a natural resources conservation easement.	❑	❑	❑	❑	❑
19	Some area(s) or the enter farm is protected by an agricultural conservation easement.	❑	❑	❑	❑	❑
20	Other:				❑	

Conservation Easements

Natural resource conservation easements are legal agreements that allow landowners to donate or sell some "rights" on portions of their land to a public agency, land trust or conservation organization. In exchange, the landowner agrees to restrict development and farming in natural habitat, and assures the easement land remains protected in perpetuity. A 1996 survey conducted by the National Wetlands Conservation Alliance found that the leading reasons landowners restored wetlands were to provide habitat for wildlife, leave something for future generations, and preserve natural beauty. Only 10% of the surveyed landowners restored wetlands solely for financial profit. This finding applies to habitats besides wetlands. A conservation easement can provide landowners with financial benefits for the protection, enhancement and restoration of natural environments on their properties. Moreover, many easement programs include cash payments for costs associated with habitat restoration and enhancement.

Agricultural conservation easements have the explicit purpose of keeping farmland in production. They resemble natural resource conservation easements, but specifically preserve farmland for farming. Local opportunities may exist for one or both kinds of conservation easements. See http://www.conservation.ca.gov/dirp/cfcp/Pages/Index.aspx for details.

Flowering shrubs and pollinators

Flowering shrubs can be a valuable alternative nutrition source for bees. In fact, a beekeeper reduced rental charges by thousands of dollars for a Firebaugh-area almond grower since the presence of these optional nutrition sources allowed hives to remain in the orchard for more of the season.

	For this farm or facility, the following ecosystem management practices and approaches relevant to upland habitat maintenance and enhancement were used:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	UPLAND HABITAT MAINTENANCE AND ENHANCEMENT					
21	Hedgerows of trees and/or shrubs were maintained on at least some edges of the farm or facility property.	❑	❑	❑	❑	❑
22	Hedgerows of flowering shrubs, such as coyote brush, were maintained along at least some edges of the farm or facility to provide alternative nutrition for native pollinators and pest natural enemies.	❑	❑	❑	❑	❑
23	Vegetation is maintained on the farm or facility that provides pollen and nectar sources for introduced pollinators before and after almond bloom.	❑	❑	❑	❑	❑
24	Vegetation such as grasses, trees or shrubs was maintained along roadsides, ditch-banks, headlands and/or irrigation canals (where feasible) to provide beneficial wildlife habitat and slow and retain water and filter contaminants.	❑	❑	❑	❑	❑
25	Beneficial trees have been maintained that existed before farm or facility establishment and/or were planted after establishment, such as along roadsides, to provide habitat for beneficial wildlife.	❑	❑	❑	❑	❑
26	Other:				❑	

	For this farm or facility, the following ecosystem management practices and approaches relevant to riparian and wetland habitat maintenance and enhancement were used:	Not familiar with this	I haven't tried it	I have tried It	My current practice	Not applicable
	RIPARIAN AND WETLAND HABITAT MAINTENANCE AND ENHANCEMENT					
27	Riparian habitat, swales, vernal pools or water courses were present on the farm or facility property. ❑ Yes. ❑ No. (Skip to question 35.)					
28	Swales were managed with setbacks to preserve them and to prevent rutting by equipment during times of the year when the soil is wet.	❑	❑	❑	❑	❑
29	If vernal pools and/or water courses exist on the farm or facility property, setbacks were in place to minimize disturbance.	❑	❑	❑	❑	❑
30	If water courses exist on the farm or facility property, banks were maintained with resident non-woody vegetation (excluding noxious weeds).	❑	❑	❑	❑	❑
31	If water courses exist on the farm or facility property, banks were vegetated with a mix of grasses, trees and shrubs.	❑	❑	❑	❑	❑
32	Dying trees (unless infested with damaging disease), snags and downed logs were maintained in riparian buffer areas to provide cover, forage and habitat for beneficial species.	❑	❑	❑	❑	❑
33	If water courses exist on the farm or facility property, there was enough canopy cover to adequately shade the stream.	❑	❑	❑	❑	❑
34	Other:				❑	

What is resident vegetation?

Resident vegetation is composed mostly of non-native plants, including weeds. It is important to ensure that resident vegetation growing in riparian areas excludes noxious weeds. Regular monitoring and control actions when necessary can prevent the establishment of noxious weeds.

Resident vegetation provides many of the same ecosystem services as native plants. However, if economically feasible, native plants are preferred in buffer strips, hedgerows, etc., because they are adapted to the area.

Environmental management planning and assistance

To be completed….

The NRCS has resources to help with natural resource conservation for agriculture. This includes guidance and funding for technology and implementing practices, and for doing surveys and management plans. For more details, see http://www.ca.nrcs.usda.gov/programs/ or contact your local NRCS office.

	For this farm or facility, the following ecosystem management practices and approaches relevant to ecosystem management planning were used:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	ECOSYSTEM MANAGEMENT PLANNING					
35	An environmental survey and map of the farm or facility property has been completed and notes sensitive areas (e.g., swales, waterways, trees, habitat for endangered species and other features). ❑ Yes. ❑ No. (Skip questions 36-40.)					
36	An expert, such as staff from the USDA Natural Resources Conservation Service (NRCS), helped complete the survey.	❑	❑	❑	❑	
37	The map was used for purposes of pesticide use reporting.	❑	❑	❑	❑	
38	The map was used for ecosystem management planning.	❑	❑	❑	❑	
39	A written ecosystem/habitat management plan has been completed for the farm or facility that includes goals for production, goals for managing areas not used for farming or processing, and a monitoring protocol to measure improvement over time.	❑	❑	❑	❑	
40	Other:				❑	

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Complementary water quality content to incorporate into existing Pest Management module

	For this orchard, the following methods were used to minimize risks of groundwater contamination from wells:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	WELLS AND GROUNDWATER PROTECTION					
1	Fertigation was done and a backflow prevention device was in place between the point of fertilizer injection and the well to prevent well contamination.					
2	Wellheads were situated or berms or other barriers were in place to prevent surface water from contacting the wellhead and potentially contaminating groundwater.	❑	❑	❑	❑	❑
3	To prevent groundwater contamination, abandoned wells have been properly sealed according to local requirements.	❑	❑	❑	❑	❑
4	Pesticide mixing and loading was done more than 100 feet from the wellhead unless it was protected from contamination by berms or other physical characteristics.	❑	❑	❑	❑	❑
5	For mixing and loading pesticides, either a double-check valve, reduced pressure principle backflow prevention device or an air gap was in place and maintained between the well pump and sprayer tank.	❑	❑	❑	❑	❑
6	A separate water supply tank (nurse tank) was used for mixing pesticides.	❑	❑	❑	❑	❑
7	Safe pesticide storage included storing dry products above liquids, storing pesticides more than 300 feet from the nearest well, storing only undamaged containers, and ensuring the storage area had an impermeable floor and sump to contain leaks.	❑	❑	❑	❑	❑
8	An emergency response plan related to pesticide or fertilizer spills and subsequent exposure was posted in the appropriate location(s) and workers were trained to follow the plan.	❑	❑	❑	❑	❑
9	Other:				❑	

Complementary water and soil quality content to incorporate into existing Nutrient Management module – retitle to Managing and Retaining Nutrients and Soil

	For this orchard, the following practices were used to enhance soil properties and reduce risks of soil and nutrient loss:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	ENHANCING SOIL PROPERTIES AND PREVENTING EROSION AND SURFACE WATER CONTAMINATION					
1	How frequently has the orchard floor received any tillage, not including floating, smoothing or rolling, over the past several years? ❑ None. ❑ Not every year. ❑ Annually or more frequently.					
2	If soil organic matter is low for the orchard, an ongoing program exists to increase it by adding compost, growing cover crops and/or shredding prunings.	❑	❑	❑	❑	❑
3	Orchard equipment was chosen (e.g., ATV instead of tractor) or modified (e.g., via wider or bigger diameter tires, or lower tire pressure) to minimize soil compaction.	❑	❑	❑	❑	❑
4	Farm roads and/or equipment yards and their margins have been graded or engineered, kept in vegetation or otherwise managed to minimize erosion.	❑	❑	❑	❑	❑
5	Down-slope orchard margins, stream banks, or other areas prone to runoff had vegetated buffers, fabric fencing, filter strips, straw bale check dams or water bars, sediment basins and/or other means to slow and retain water and filter contaminants (sediment, nutrients and pesticides).	❑	❑	❑	❑	❑
6	Drainage and erosion prevention systems were cleaned/maintained prior to each rainy season and checked regularly during stormy periods.	❑	❑	❑	❑	❑
7	Culverts were properly sized to accommodate high-flow events and had hardened inlets and outlets or energy dissipaters to reduce erosion.	❑	❑	❑	❑	❑
8	If areas had eroded previously, efforts were made to stabilize (e.g., via geotech fabric or berms) and restore the damaged area.	❑	❑	❑	❑	❑
9	Other:				❑	

You're invited

FREE Almond Grower Workshops!

california almonds
Almond Board of California

Mon. March 4, 2013
Larry E. Reider Education Center
2000 K Street
Bakersfield, CA 93301

Kern County Superintendent of Schools

Tue. March 5, 2013
Visalia Convention Center
303 E. Acequia Avenue
Visalia, CA 93291

VISALIA CONVENTION CENTER

What's in it for you?

1. Submit your self-assessment and learn how to generate a FREE customized farm management report comparing your practices to fellow growers
2. CEU credits
3. Expert presentations by farm advisors and others with Q&A
4. Free snacks and lunch
5. Prizes
6. The opportunity to examine your operation for additional efficiencies
7. Network with other growers
8. Learn the latest recommended and cost-effective farm management techniques
9. Contribute facts to tell the Almond Sustainability Story to buyers, regulators and stakeholders
10. Help ensure that buyers preferentially source California almonds

Agenda

8:00am	Arrival and Sign-in
8:15am	Welcome and Overview
8:45am	Self-Assessment Exercise: Pest Management
10:30am	Presentation: Cost-effective weed monitoring
11:00am	Presentation: Maximizing on-target spray deposition
11:30am	Presentation: NRCS cost-share for conservation practices/technology
12:00pm	Lunch and prize drawing
12:30pm	Adjourn

To register:
Contact Kendall Barton
Almond Board of California
kbarton@almondboard.com
209.343.3245

Please include a name, address, phone number and email for each attendee.

Guest Presenters

March 4, 2013

- Steven Wright • UCCE Farm Advisor, Tulare and Kings Counties
- Brad Higbee • Research Entomologist, Paramount Farming Co.
- Brandon Bates • Natural Resources Conservation Service

March 5, 2013

- Steven Wright • UCCE Farm Advisor, Tulare and Kings Counties
- Joel Siegel • Research Entomologist, USDA ARS
- Genett Carstensen • Natural Resources Conservation Service

SureHarvest — Sustainability from the ground up

CAFF — Community Alliance with Family Farmers

CALIFORNIA ALMOND SUSTAINABILITY PROGRAM™

www.AlmondBoard.com/Growers/Sustainability

You are invited to participate in an Almond Sustainability Workshop. The program is designed by the Almond Board of California and SureHarvest to ensure value for you.

Participating in an Almond Sustainability Workshop helps market your almonds

You attend a workshop and submit your assessment

SureHarvest protects & analyzes the data and you generate a FREE customized report

The Almond Board communicates results to the California Almond industry

Buyers preferentially source California almonds

california almonds
Almond Board of California

Buyers are asking for sustainability. The information from the workshop will help the industry illustrate how almond growers practice environmental stewardship and use resources in a responsible, sustainable and beneficial way.

The California Almond Sustainability Program provides value for you. “Sustainable Agriculture” is not a radically different or business unfriendly farming philosophy. It simply advocates practices that are: Economically Feasible, Environmentally Sound and Socially Equitable. An increasingly important part of sustainable agriculture is Telling Your Story. By participating and submitting self-assessments, the Almond Board can champion your thoughtfulness and achievements in the use of cost-effective, environmentally and socially sound practices to almond buyers, public policy makers and consumers. Through the assessment and presentations, you may also learn about new options for increasing profit and environmental protection. You will be shown how to generate a free sustainability report that compares your practices to those of fellow growers.

We look forward to seeing you at the workshop!

Who should sign up: Almond ranch owners and managers who are interested in learning about the program to assess their use of best practices for irrigation and nutrient management, air quality, energy efficiency, and pest management.

Both growers already participating in the program and those not yet involved should sign up.

For more info:
Contact Kendall Barton
Almond Board of California
kbarton@almondboard.com
209.343.3245

Both workshops include:
- Introduction to the Sustainability Program
- Educational presentations
- Self-assessment activities for the Pest Management module (online* and/or paper-based)
- Lunch
- Prize drawing

*The self-assessment can be completed online. You can bring your personal laptop to use during this portion of the workshop. There will also be laptops available for use at each venue.

www.AlmondBoard.com/Growers/Sustainability

Pest Management and California Almond Growing

The California Almond community has a long history of implementing integrated pest management (IPM) to increase production efficiencies and decrease pesticide risks. Key has been and continues to be the application of University of California research funded by the Almond Board. Pest challenges occur each year, so it is important that almond growers maintain their reputation of using existing and adopting improved cost-effective, environmentally friendly management practices.

Selected statewide results about strengths and opportunities for improvement related to the IPM tenets of prevention, monitoring, and the effective and safe use of control tactics are displayed and discussed below.

Insert one or more relevant photos

Practice	Response	% of orchards ± 95% confidence level	Why not? (% of orchards)		
			Not familiar	Not tried	Have tried
Insect, Mite and Disease Monitoring					
Frequency of and Who Does Insect, Mite & Disease Monitoring	Occasional/None Regular non-PCA Regular by PCA	8.0 17.5 74.5			
Of orchards monitored for insects, mites & diseases…					
Pest monitoring records are retained by farm owner/staff to inform management decisions	Yes No	69.4 ± 7.8 30.6 ± 7.8	1.5	22.4	6.7
Monitoring data, university guidelines & practical experience are used to design & implement management strategies	Yes No	86.1 ± 5.8 13.9 ± 5.8	2.2	8.0	3.6
Navel Orangeworm					
Mummy nuts are counted & removed per recommendations during winter to reduce outbreaks of navel orangeworm & brown rot	Yes No	86.2 ± 5.6 13.8 ± 5.6	2.1	3.4	8.3
Hullsplit sprays for navel orangeworm are based on egg-trap counts & degree-days	Yes No	80.2 ± 3.4 19.8 ± 3.4	0.0	12.3	7.5
Web-spinning Spider Mites					
Control tactics for web-spinning spider mites include releases of predatory mites/insects	Yes No	18.9 ± 4.6 81.1 ± 4.6	3.8	62.9	14.4
Weeds					
Weed species and infestation levels are monitored & recorded to inform the management strategy and type and timing of controls	Yes No	65.7 ± 7.9 34.3 ± 7.9	2.1	24.3	7.9
Monitoring records include growth stages & potential herbicide resistance	Yes No	45.7 ± 8.3 54.3 ± 8.3	2.9	35.7	15.7
Field equipment is cleaned after working weedy areas to prevent transferring weeds among orchards	Yes No	45.8 ± 8.9 54.2 ± 8.9	0.8	36.7	16.7
General Pesticide Risk Management					
Frequency of dormant sprays in past 5 years	0 1-2 3-4 5	39.6 31.2 13.9 15.3			
Pesticide application equipment is calibrated prior to use each year & after equipment repair/modification	Yes No	95.6 ± 3.5 4.4 ± 3.5	0.7	2.2	1.5
Air blast spray patterns are adjusted for average tree size & shape	Yes No	94.8 ± 3.8 5.2 ± 3.8	0.7	0.7	3.7
Air blast spray coverage is periodically checked using water-sensitive paper	Yes No	39.8 ± 8.5 60.2 ± 8.5	3.9	29.7	26.6
Air blast spraying is stopped when making row turns & does not resume until nozzles are adjacent to first trees	Yes No	97.7 ± 2.6 2.3 ± 2.6	0.0	1.5	0.8
Spraying near waterways/other sensitive sites is discontinued when winds blow in their direction	Yes No	93.3 ± 4.8 6.7 ± 4.8	0.0	1.9	4.8
Ultra-low-volume spray equipment or target-sensing sprayers are used to reduce spray volumes or amounts of pesticides	Yes No	30.8 ± 7.9 69.2 ± 7.9	5.4	40.8	23.1

Strengths

- Growers for a majority of orchards employ the key IPM tenet of pest monitoring (92% of orchards regularly monitored) and record-keeping, and use results and expert guidelines to support management decisions.
- As part of optimal navel orangeworm management, growers for a majority of orchards count and remove mummy nuts during winter and base necessary hullsplit sprays on egg-trap counts and degree-days.
- Growers for a majority of orchards decrease pesticide risks by not applying dormant sprays annually (nearly 40% apply no dormant sprays), timely calibration of spray equipment and adjusting spray patterns based on average tree size and shape, and discontinuing sprays during row turns and near sensitive sites when winds blow in their direction.

Opportunities

- Growers can improve operations by ensuring monitoring records include weed growth stages and resistance concerns, and cleaning field equipment after working weedy areas *(more outreach about benefits where appropriate)*.
- Growers can further mitigate pesticide risks and enhance production efficiencies by confirming coverage with water-sensitive paper and considering use of ultra-low spray equipment or target-sensing sprayers *(more outreach by application technologists about benefits)*.

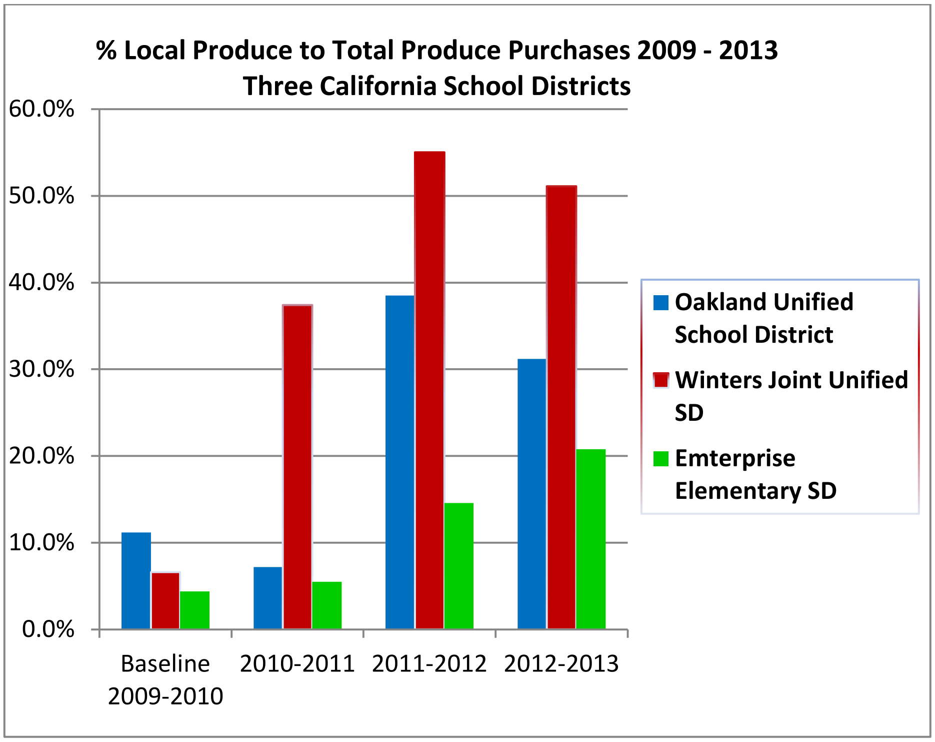
CDFA-SCB 10030 Final Report

Appendix A:

Table 1. Total Produce Expenditures, All Three Districts, Baseline to Year Three

	Baseline 2009-2010	2010-2011	2011-2012	2012-2013	**PERCENT INCREASE Baseline to Year Three**
Oakland Unified School District					
Total amount spent on produce	$793,219	867,401	$1,290,271	$1,363,027	**72%**
Total amount spent on local produce	$ 88,573	$ 62,238	$ 496,460	$ 425,829	**381%**
Percentage local to total	**11.2%**	**7.2%**	**38.5%**	**31.2%**	
Winters Joint Unified SD					
Total amount spent on produce	$ 7,707	$ 11,518	$ 24,760	$ 43,208	**461%**
Total amount spent on local produce	$ 512	$4,313	$ 13,610	$ 22,075	**4212%**
Percentage local to total	**6.6%**	**37.4%**	**55.0%**	**51.1%**	
Ensterprise Elementary SD					
Total amount spent on produce	$79,531	$ 77,688	$ 161,007	$ 177,488	**123%**
Total amount spent on local produce	$3,506	$ 4,264	$ 23,483	$ 36,904	**953%**
Percentage local to total	**4.4%**	**5.5%**	**14.6%**	**20.8%**	

Chart A.



% Local Produce to Total Produce Purchases 2009 - 2013
Three California School Districts
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Baseline 2009-2010
2010-2011
2011-2012
2012-2013
Oakland Unified School District
Winters Joint Unified SD
Emterprise Elementary SD


LEARN. LEAD. SUCCEED.
LPS

Northern & Central California

Farm to School Forum

Thursday June 27th, 2013   9am-3:30pm

ROBERT MONDAVI Institute for Wine & Food Science, Davis, CA

Please RSVP by May 31, 2013 by following this link

http://ucce.ucdavis.edu/survey/survey.cfm?surveynumber=10523

Limited travel stipends available

Join us for an interactive day featuring

- Panel presentations by CA Student Nutrition Services Directors
- School Chef demonstrations & tastings
- Roundtable discussions on Farm to School
- Olive Oil Tasting

This forum is the culmination of a three-year UC Davis Farm to School project with Oakland, Redding (Enterprise), and Winters school districts. It is designed to share insights and best practices from these districts and from other successful farm to school programs.

Co-sponsored by: **Robert Mondavi Institute for Wine and Food Science**
UC Davis Agricultural Sustainability Institute
Funded by: **California Department of Food & Agriculture, Specialty Crop Block Grant**

Northern & Central California Farm to School Forum

Agenda

Thursday June 27th, 2013 9am-3:30pm
Robert Mondavi Institute for Wine & Food Science, Davis, CA

8:30 Arrive and sign in

9:00 WELCOME, INTRODUCTIONS

Gail Feenstra, *Food Systems Coordinator, Agricultural Sustainability Institute*
Tom Tomich, *Director of Agricultural Sustainability Institute*
Clare Hasler-Lewis, *Executive Director, Robert Mondavi Institute for Wine and Food Science*

9:15 FARM TO SCHOOL PANEL

"LIGHTNING TALKS" FOLLOWED BY OPEN DISCUSSION
Featuring CDFA Project Food Service Directors and Invited Food Service Directors
Jennifer LeBarre, *Director Student Nutrition Services, Oakland Unified SD*
Denise Ohm, *Food Service Director, Enterprise Elementary SD*
Cathy Olsen, *Director of Food & Nutrition Services, Winters Joint Unified SD*
Miguel Villareal, *Director of Food & Nutritional Services, Novato Unified SD*
Jamie Smith, *Central Coast School Food Alliance Chef/Consultant*

10:15 – 10:30 *Break*

10:30 – 11:30 SCHOOL CHEF DEMONSTRATIONS

PREPARING CALIFORNIA SPECIALTY CROP RECIPES FOR SCHOOL MEALS
Donnie Barclift, *Chef, Student Nutrition Services, Oakland USD*
Cathy Olsen, *Director, Food &Nutrition Services, Winters JUSD*
Denise Ohm, *Director, Food Services, Enterprise Elementary SD*
Bryan Ehrenholm, *Executive Chef, Nutrition Services, Manteca USD*
Kristy Labourdette, Arturo Topete, and Sande Royval, *Chefs, Davis JUSD*

10:30 – 11:30 SMALL GROUP ROTATIONS

Group A: RMI KITCHEN/CHEF DEMONSTRATION: *Featured chefs prepare recipes with local, seasonal produce*

Group B: RMI GOOD LIFE GARDEN: *Seasonality & Garden-based Learning*
Carol Hillhouse, *Director of UC Davis School Gardening Program*

Group C: RMI SENSORY THEATER: *A Look at UC Davis Dining Services: Farm to Institution Challenges and Successes*
Dani Lee, *Sustainability Manager, UC Davis Dining Services*

11:30 TASTING SPECIALTY CROP RECIPES—RMI Sensory Theater Foyer

12:30 *Lunch & Networking*

12:45 Introduction to Breakout Sessions—RMI Sensory Theater Foyer

1:00 BREAKOUT GROUPS ON HOT TOPICS in FARM TO SCHOOL

- **Results of a nutrition study in three California school districts**
  Sheri Zidenberg-Cherr, *UCCE Specialist, UCD Department of Nutrition*
- **Distribution strategies for working with local farmers and school districts**
  Jana Nairn, *CEO, AgLink*
- **Farm to School and Farm to Institution efforts in the Bay Area**
  Alex Emmott, *Farm to School Supervisor, Oakland USD*
  Ariane Michas, *Regional Food Systems Manager, CAFF*
- **Statewide Farm to School efforts & policy developments**
  Diana Abellera, *Regional Food Systems Director, CAFF*
  Elysia Fong, *Statewide Farm to Fork Coordinator, CDFA/CDE/CDPH*

1:50 *Break*

2:00 OLIVE OIL IN CALIFORNIA SCHOOLS: PRESENTATION & TASTING
Dan Flynn: *Executive Director, UC Davis Olive Center*

2:45 FROM OUR ROOTS TO OUR FRUITS: A GROUP REFLECTION ON FARM TO SCHOOL IN CALIFORNIA
Carol Hillhouse, *Director of UC Davis School Gardening Program*
Collectively, we will take stock of our backgrounds, identify key elements to grow a healthy farm-to-school culture, and envision a 5-year future of Farm to School within our school districts and across California.

3:15 Reception with light snacks

Attachment C-3: Sample Survey Responses to CDFA Farm to School Final Forum

1. **The morning panel presentation by five School Food Service Directors.**
   - Enjoyed hearing what actions have been taken on the Farm to School movement and how each of the directors is making progress in that direction.
   - The sharing of the best practices from various schools was informative and motivating! Great speakers.
   - Great ideas shared by the panel members. I really like the California Thursday idea presented by the Oakland USD director.
   - I like hearing directly from the food service staff. Pluses and minuses are always appreciated.
   - It was helpful to hear about their real experiences.
   - This was the most applicable part for me. Well presented with a balance of information. The directors were able to show what was possible and what the limitations are. This is very important for all parties to understand.

2. Rotation in the RMI kitchen: Chefs preparing their specialty crop recipes.

- It’s always helpful to see recipes in action...the exposure to flavor and conversations with those who prepare the recipes on a regular basis was inspiring.
- It's always good to see the action that precedes presentation and to ask questions of the chefs as they work. Can we publicize their awesome recipes for other food service directors?
- It was nice to see and chat with the chefs about what dishes they were preparing.
- Loved this part of the day! The chefs were all enthusiastic, creative, and provided outstanding "healthy" ideas that could be incorporated into the school meals program. Fantastic way of showcasing those leaders in the field who can role model to the rest.
- Will be adding some of those recipes to my menus!
- I will be using the recipes sampled, they were delicious!
- Great to meet and talk to chef tasked with the challenge of affordably incorporating farm ingredients.
- This was great!!!!!
- Would have been nice if the chefs were a little more talkative, maybe if they had an ambassador to talk up what they were doing or had some key points to share about why they chose that recipe.

3. Rotation in the Good Life Garden: Seasonality and Garden-based Learning

- Nice presentation and a beautiful environment despite the heat. The garden itself gave me lots of ideas for improving the look and groupings of our own school gardens.
- Enjoyed hearing about garden seasonality as it relates to school gardens and planting. Would have liked to have a small tour of the garden that was out there.
- Interesting information provided.

4. Rotation in the Sensory Theater: University Campus Food Systems and Local Procurement.

- Dani did a great job with her presentation and what UCD-Sodexo Dining is undertaking. It would have been intriguing for her to invite Sodexo Colleagues who work on school accounts to speak to the varying degree of the business model and what they learn from one another.
- It was interesting to hear how the University procures those gigantic amounts of food, but my interests are more focused on school gardens as learning environments.
- It was great to hear about how UCD is procuring their food and how they serve their students.

- Interesting to hear how the University policy planned a role in leveraging the change that not all wanted to see happen.

5. Chefs' presentations and the tastings of their specialty crop recipes.

- It was great to get more detail before sampling the dishes
- Delicious!
- It would be great to hear more about how/when these are served in the schools and what the kids' reactions are as well as participation rates for that entree.
- Proof of the pudding is....fantastic! What kid could resist those dishes? I will share all of them with our food services director.
- It gave the food meaning and made the dishes stand out more once each chef was able to present their featured dish.
- Great segment!
- I loved the creativity of the recipes. We will be using some of them.

6. Breakout Sessions~~

1. **Results of nutrition study in three California school districts;**
2. **Distribution strategies for local farmers and school districts;**
3. **Farm to School and Institution on-the-ground efforts in the Bay Area;**
4. **Statewide Farm to School efforts and policy developments.**

- ***#2:*** This was interesting, as I've been wanting to learn about AgLink. I always give the same feedback about these meetings: there is great expertise in the room, from a diverse group of people with a lot of on-the-ground experience. I love it when we get to have conversations that reveal this expertise, rather than having someone up front giving a presentation. It is really tricky to organize but when it is done well, it is super rewarding.
- ***#1:*** It was extremely valuable to me as I devise ways to evaluate the effectiveness of school gardens on how they may change the eating habits of students.
- ***#3:*** Results of the nutrition study: It was great to see what studies have been going on and what foods the students liked and didn't like. This is great since I am in the field of nutrition education and work directly with schools.
- ***#2***: This was all about AgLink, not a more general view that speaks to school districts connecting to local farmers, as I thought it would be.
- ***#4:*** I attended Statewide F2S efforts. Good information exchange.
- ***#3:*** I learned useful information and met interesting people.
- ***#4:*** Good to hear about where things are and what the focus will be. Made some connections here that will be very useful.

7. Olive Oil tasting with Dan Flynn

- This was nice for my own personal experience, but it felt a little out of place with the rest of the content of the day.
- Learned more about olive oil than I ever thought I would know..
- Definitely will think CA when using olive oil now. I would like to use it more in school food.
- I thought it was educational to learn about olive oil, how olives are harvested, and why they taste different. Also, I have been looking for olive oil that is from California which I'm finding that many are imported.

- Interesting but ultimately not very relevant to what the day was about. I felt the subject -- which basically had to do with fraudulent labeling -- was off topic to what the day was trying to accomplish.
- I just loved this! I know more about olive oil now than I knew there was to know. This changed how I'll be buying olive oil!

8. Final Wrap-up Session: From our Roots to our Fruits: Group Reflection on Farm to School in California

- Always a good thing to leave inspired and excited about keeping this movement growing forward into the future! Thank you for hosting this training and for bringing all those great people together.
- Great activity!!
- I'm going to "borrow" the tree concept for strategic planning by our Board.
- People's comments were informative and encouraging. This and the opportunity to talk with people and lunch and between sessions were very useful.
- Loved the tree visual and concept and I liked hearing the "headlines". Only thing was that the worksheet didn't seem to match the questions asked of the groups.
- Great to bring it all together. Fun and engaging way to do it. Brought out a lot of good conversation in the process.

Attachment D: Local Farms Sourcing List
Updated August 23, 2013

Oakland Unified School District, Oakland, CA
Definition of local is tiered: 1st tier is Oakland; 2nd tier is the surrounding 9 county area; third tier is within a 250 mile radius of Oakland
Winters Joint Unified School District, Winters, CA
Definition of local is tiered: 1st tier is Winters; 2nd tier is Yolo/Solano County; 3rd tier is within 300 mile radius of Winters.
Enterprise Elementary School District, Redding, CA
Definition of regional is within a 375 mile radius of Redding, CA

New Farm Contracts *[64 minimum]*
OUSD
- Khaleds
- Kaki Farms
- Ibarra Farm
- Ed Chavez, EGB Farm
- Catalan
- Lou Vue Farm, Lou Tong Thau
- Lu-Mien Village Farm
- Avalos OrganicFarm
- Andres Farm
- Wileman Brothers & Elliott Inc., Cutler, CA, vegs
- Landmark Produce Sales, Victor, CA, English cucumbers
- Naturipe Farms, Watsonville, CA, strawberries
- Five Crowns Marketing, Brawley, CA, Honeydew, cantaloupe
- Naturipe Farms, Delano, CA, blueberries
- English Peas - (Watsonville, CA)
- Apricots - Family Tree Farms (Kettleman City, CA)
- Peaches or Nectarines - Sunwest Fruit Co. (Parlier, CA)
- Capay Organic (9 farmers)
- Veritable Vegetable (10-20 farmers)
- Pacific Rim (5-10 farmers)
- Thumbs Up Produce (6-8 farmers)

WJUSD
- Terra Firma Farm, Winters
- Sparks Ranch, Winters
- Putah Creek Farm, Lew Saetern
- Coco Ranch
- Glenview Farms
- Ahmad Farms
- Capay Canyon Ranch
- Capay Organic/Farm Fresh to You (9 farmers)

EESD
- Happy Valley aggregates from 25 farms: in Butte, Shasta,Tehema, and Yuba counties
    - Orland: 5 farms, Asian Pears, Mandarins, Navel Oranges, Valencia Oranges

- Woodland: 1 farm, Honeydew
- Yuba City: 1 farm, Watermelon, peaches, tomatoes
- Marysville: 1 farm, mandarins
- Live Oak: 1 farm, Fuyu Persimons
- Gridley: 5 farms, Kiwi, Tomatoes, Nectarines, Plums, Peaches, Mandarins
- Chico: 2 farms, Mandarins, watermelon, canteloupe
- Oroville:2 farms, Mandarins, Oranges
- Paradise; 1farm , Apples, Peaches, Pluots
- Corning: 1 farm, Mandarins
- Redding: 2 farms, Cherry Tomatoes, Asian Pears,
- Anderson:3 farms,

Local Farm contracts through the districts' main distributors
[25 vendors minimum, several representing more than one farm per vendor]

OUSD—Fresh Point

- Ratto Brothers
- Taylor Farms, Salinas
- Grimmway, Bakersfield
- Bolthouse, Fresno
- Baloioan Farms, Fresno
- Classic Salad, Watsonville
- Monterey Mushroom, Salinas
- Bee Sweet, Fresno
- Boskavich Farms, Salinas
- Fowler Growers, Fresno
- Farmington Fresh Growers, Stockton/Linden

WJUSD—Produce Express

- Del Rio Farms, mixed veggies/cherry tomatoes, Sacramento
- Apple Hill Farms, Apple Hill, CA (apples sourced also from Camino, CA, Walnut Grove CA)
- Murcott Farms, Live Oak, CA, seedless mandarins
- Grimmway, Bakersfield, carrots
- Brentwood Farm, apricots
- Lodi Cherries
- Watsonville strawberries
- Stockton asparagus
- Faurot Ranch Watsonville, CA mixed baby lettuce
- Newcastle, CA, nectarines

EESD—ProPacific

- Lundberg Family Farms, North Sacramento Valley
- Ratto Brothers, Modesto, CA
- Western Fresh marketing, Gridley, Ca, kiwi
- Wilkerson Packing, Gridley, CA, Satsuma tangerines

Attachment E

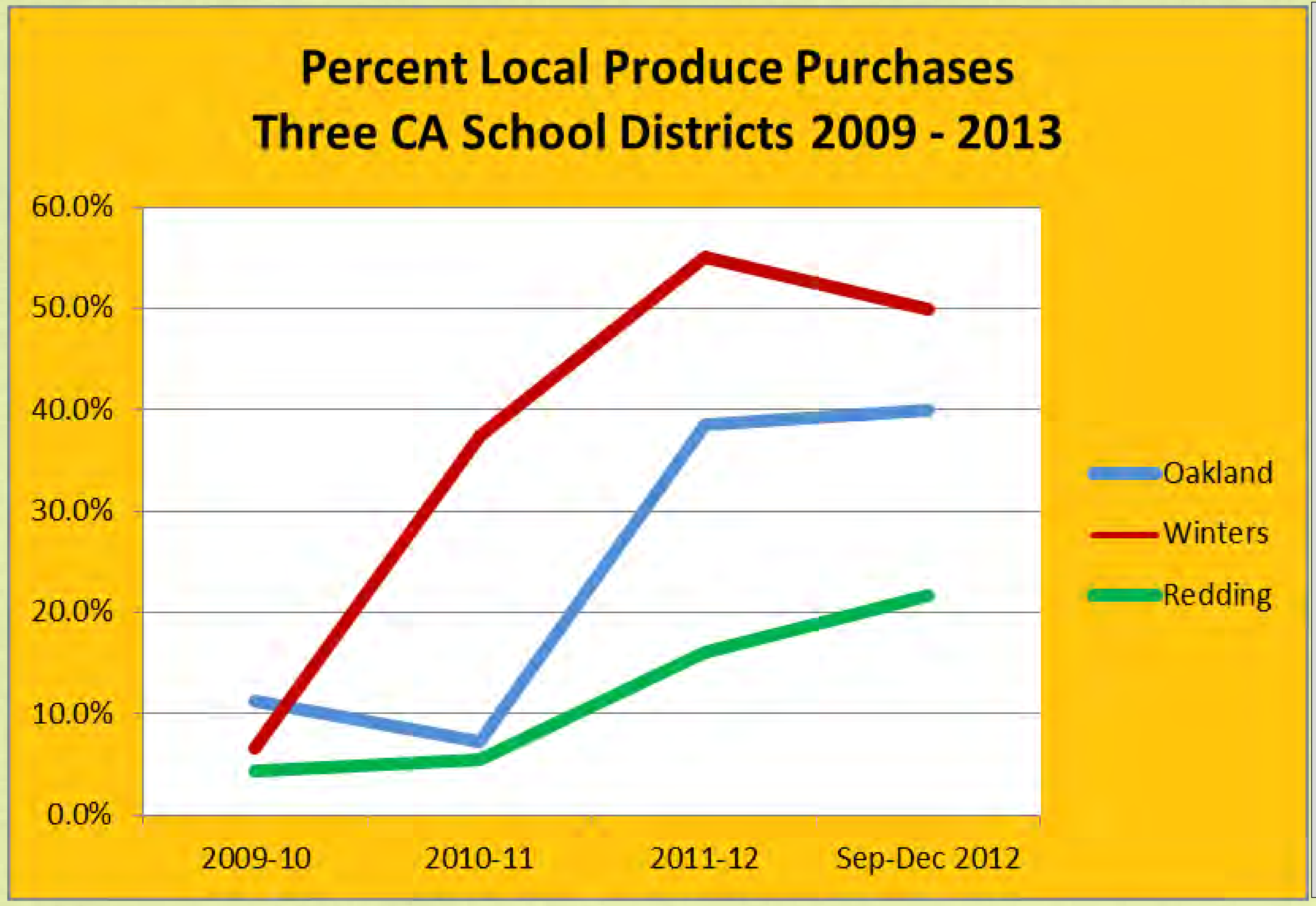
Building Successful Farm to School Models to Enhance Markets for Specialty Crops

Gail Feenstra, Carol Hillhouse, Sheri Zidenberg-Cherr, Jeri Ohmart, Thea Rittenhouse, Rachel Cox Miller, Rachel Scherr, Jacqueline Bergman
UC Sustainable Agriculture Research & Education Program, ASI School Gardening Program, UCD Nutrition Department

Goals:

- Increase procurement and consumption of fresh, seasonal fruits and vegetables in three California school districts.
- Engage Student Nutrition Services Directors and staff in professional development to support expanding farm to school programs.
- Assess changes in food preferences and dietary behaviors of children in participating schools.
- Promote California specialty crops through expanded Farm to School programs.

Project Funded by 2010 CDFA Specialty Crop Block Grant



Impact on Dietary Behavior

Statistically significant* changes from intervention:

Winters Joint Unified School District:

- Increase in vegetable intake*
- Increased identification of select produce items*

Oakland Unified School District:

- Increase in vegetable selection*
- Increased identification of select produce items*

Enterprise Elementary School District:

- Data is under analysis.

❖ ***No significant change in produce preferences***

Conclusion: Farm to School programs can be an important component of school-based interventions.

Oakland USD
Large, Urban

21,000 lunches served daily
68 % Free/Reduced eligibility

Accomplishments

- Increased % local produce purchases from **7.2%** (SY-09/10) to **40%** (Sep-Dec 2012) of total produce.
- Branded Farm to School Program ***Oakland Eats Garden Fresh***
- Expanded school farm stands from 12 to 25 school sites.
- Created new bid language for produce distributors to assure higher purchase of local produce and source identification.
- Hired a district-wide Farm to School Coordinator.

Enterprise ESD, Redding
Medium Urban/Rural

2,600 lunches served daily
70% Free/Reduced eligibility

Accomplishments

- Increased % local produce purchases from **4.4%** (SY-09/10) to **21.6%** (Sep-Dec 2012) of total produce.
- Partnered with small regional distributor, Happy Valley Produce, to purchase local produce for schools.
- Added Nutrition Education as a professional development component to annual Northern CA School Nutrition Assn Food Fair.

Winters Joint USD
Small, Rural

1,630 lunches served daily
65% Free/Reduced eligibility

Accomplishments

- Increased %local produce purchases from **6.6%** (SY-09/10) to **49.9%** (Sep-Dec 2012) of total produce.
- Established school garden at Rominger Elementary School
- Food Service Director and Community Partners organized Bastille Day 2012, a community fundraiser for Winters Farm to School. It raised over $22,700 for Farm to School.

Professional Development—CDFA Specialty Crop Block Grant
Building Successful Farm to School Models

Oakland Unified School District

	WHAT	TO/FOR WHOM	CONTENT
YEAR ONE: 2010-11 ***March 8, 2011***	In-service presentation to Food Service staff and managers of OUSD	Food Service Staff; Jennifer and Ildi identified need to train about fresh fruits and vegetables	Introduction to Farm to School in OUSD and introduction to tasting fresh produce—citrus, identifying key issues and interested audience members. Farm to School resources
March 20-21, 2012	Fresh Fruit/Veg Training in Hayward	Fresh Fruit & Veg Workshop Training series for food service staff and nutrition educators	Farm to School; Promoting fresh F/Vs; Prepping with fresh produce; policy and national updates on school nutrition issues.
YEAR TWO 2011-12 ***August 23, 2012***	Farm to School presentation and Seasonality Tasting	Food Service staff and managers of OUSD	Nutrition Education; Seasonality and introduction to new varieties of fruits and vegetables for use in school lunches.
Fall 2012	Consultation with OUSD District Garden Coordinator, Park Guthrie	OUSD District Garden Coordinator and Castlemont High School Coordinator + students	Discussions on possible directions OUSD school gardens could develop in; meeting with Castlemont High School Coordinator
YEAR THREE 2012-13 ***Fall 2012***	Tour of OUSD Food Service and Farm Stands Gardens	Collaborative effort to share information and lessons learned	Featured demonstrations by OUSD Food Service; meeting Farm Stand volunteers; advising on school garden efforts
April 2013	Visit by Castlemont High School Students to UC Davis campus	Castlemont HS students involved in school garden and environmental design	Toured the Student Farm complex; ate lunch at Segundo Dining Commons (local, fresh, seasonal food); tour by Aggies of Vet School; tour of Environmental Design building; talk by Department Chair.

Winters Joint Unified School District

	WHAT	TO/FOR WHOM	
YEAR ONE 2010-11 ***Fall 2010 (& ongoing)***	Rominger school garden assistance	For WJUSD team wanting to establish a school garden at Rominger Intermediate School. Participants included Principal, Food Service Director, community volunteers, teachers	General information about the logistics involved in establishing a school garden; assistance with finding resources for materials; assistance with grant opportunities for funding garden; Visits to district gardens already established.
Fall 2010-Spring 2011	Winters Farm to School support—several school district & community meetings	For school and community group beginning to establish a farm to school program. Participants as above.	Shared advice and experiences relating to establishing a farm to school program in a district.

YEAR TWO 2011-12 ***Winter 2011***	Herb propagation Workshop Part One at UC Davis Ecological Garden	WJUSD teachers, staff, parents, garden volunteers	Herb Propagation Part I: How to propagate herbs; propagation activities; information about herbs
Spring 2012	Herb propagation Workshop- Part Two at WJUSD School site	WJUSD teachers, staff, parents, garden volunteers, and students; Food Service Director	Planting herbs in Waggoner school garden and sharing activities and curriculum that can be used in conjunction with herbs
YEAR THREE 2012-13 ***Fall, Winter 2012***	Assistance with establishing Rominger School Garden	For students, with teachers, food service director and parent volunteers	Assisted with logistics; spent a weekend putting in irrigation, raised beds, etc.
Spring 2013	Planted out school garden with students	Students, teachers, parent volunteers	Showed students how to plant their starts in the school's new raised beds; planted and did worm activities

Enterprise Elementary School District—Redding/Shasta County

	WHAT	TO/FOR WHOM	CONTENT
YEAR ONE 2010-11 ***August 2011***	Far North Food Show for Northern California Student Nutrition Assn	Food Service Directors, Food Service Staff, Food Professionals, SNA members	Nutrition Education (Incredible Edible 6 plant parts, FFV promotion activities)
	Tour of EESD new kitchen facility—to be developed as "hub" for processing produce	Collaborative meeting with Food Service Director and Community Partners	Included tour of EESD's new facility (established to be a distribution hub and cooking site). Also a tour of Steve Westaby's property & discussion with him. Included representatives from Growing Local.
YEAR TWO 2011-12 ***October 2011***	Meeting with Growing Local representatives, Susanna & Steve Sibilksy, Wayne X, and Conchita Mendoza, UCCE.	Community Partners and Regional Support Group	Discussed GL's Strategic Plan & Process for Shasta County Farm to School and related efforts. Discussion on collaborative possibilities with farmers and school district.
January 2012	Direct Marketing to Schools and Institutions & Farm Safety Presentation	Farmers, agency representatives, community partners in collaboration with UCCE Shasta	Food Safety within the context of School Food and Farm to School
YEAR THREE 2012-13 ***August 2012***	Far North Food Show for Northern California Student Nutrition Assn	Food Service Directors, Food Service Staff, Food Professionals, SNA members	*Nuts and Beans: The Seedy Side of Nutrition*
Spring 2013	Shasta Community College Garden	Food Service, UC Cooperative Extension, Garden volunteers	Discussion about possible support for garden workshop

Evaluating the Impact of Farm to School Programs on Vegetable Preference and Consumption Patterns among School-Aged Students

Rachel J. Miller, RD, CSP[1], Rachel E. Scherr, PhD[1], Thea Rittenhouse[2], Gail Feenstra, EdD, RD[3], Jeri Ohmart MA[3], Carol Hillhouse, MS[3], Lucrecia Farfan-Ramirez, MA[4], Sheri Zidenberg-Cherr, PhD[1]

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ABSTRACT

Research evaluating the impact of Farm to School (FTS) programs on vegetable (V) consumption is limited. The goals of this study are to establish methodologies and determine the feasibility of assessing dietary outcomes resulting from FTS. A subset of 4th grade students in Winters Joint Unified School District (WJUSD) and Oakland Unified School District (OSUD) participated in assessments using a pre- post-test design. Student V preferences were measured using a food preference questionnaire. Acceptance and consumption of V from school lunch was measured by plate waste. Dietary behaviors outside of school were measured with a parent questionnaire. At pre-test, 3.7% of WJUSD students chose and ate V at lunch. Of participating OUSD students, 45.8% chose V at lunch, but only 29.7% ate any of the V taken. V preference, measured on a scale of 0-5 (5 indicating a high level of preference) was 3.3 among WJUSD students and 3.0 among OUSD students. Of surveyed parents, 50% in WJUSD and 34% in OUSD reported that their child asks them to buy selected California specialty crop vegetables. When asked if their child receives a healthy school lunch 61.5% of WJUSD parents and 42.1% of OUSD parents replied "yes". Districts were encouraged to use baseline results in developing strategies for FTS implementation. Post-test data will be collected approximately one year post-implementation. (Supported by CDFA, project #SCB10030)

INTRODUCTION

- Farm to School (FTS) is generally defined as any programming that connects schools and local farms with the objective of serving local and healthy foods in school cafeterias and classrooms.
- FTS programs have a presence in all 50 states totaling more than 2,000 programs nationwide in 2010.
- The goals of FTS are to improve student nutrition, provide agriculture, health and nutrition education opportunities, and support small and mid-sized local and regional farms.
- Current literature and findings from the recent USDA FTS team report demonstrates the need for studies that evaluate the impact of FTS programming on dietary behavior outcomes.

FARM TO SCHOOL PROJECT BACKGROUND

- This evaluation is a component of a three-year program funded by the California Department of Food and Agriculture.
- The goal of the overall project is to: (1) expand procurement of local, seasonal, fresh produce; (2) enhance ability to integrate school food, nutrition education, school gardens and classroom lessons by providing outreach and professional development to food service personnel, teachers, administrators and parent volunteers; and (3) assess changes in food preferences and dietary behaviors of students in participating schools in three committed school districts.
- Each school district and their identified community partners received a stipend for procuring local and regional California specialty crops and training and technical assistance purposes.
- Partnerships between communities , local and regional agriculture, schools and parents to support each FTS program is unique to each community. As a result, the development of FTS programming was different within each participating district.

OBJECTIVES

- To determine whether a FTS program, emphasizing farm-fresh local produce, is effective at increasing fruit and vegetable preference and consumption among school-aged students in selected California school districts
- To assess changes in parents' perception and knowledge of food and nutrition-related programming at their child's school

ASSESSMENT TOOLS

SCHOOL LUNCH OBSERVATIONS

- Participating students were asked to visit an observation station after selecting their lunch.
- Observations of fruit and vegetable selection were recorded before students ate lunch.
- Observations of fruit and vegetable consumption were recorded after students ate lunch.

FRUIT AND VEGETABLE PREFERENCES

- Participating students were presented with a tray of four produce items selected to reflect produce that students would be exposed to as a result of the FTS program.
  - Radish, Asparagus, Sugar Snap Peas, Kiwi
- Food preference questionnaires were administered individually to avoid the influence of peer-pressure.
- All produce selections were served plain and raw.
- Students were asked to identify and taste each item.
- If the student chose to taste the item, they rated their preference using a five-point Likert scale (5 = I really liked it a lot).

PARENT SURVEY ABOUT NUTRITION

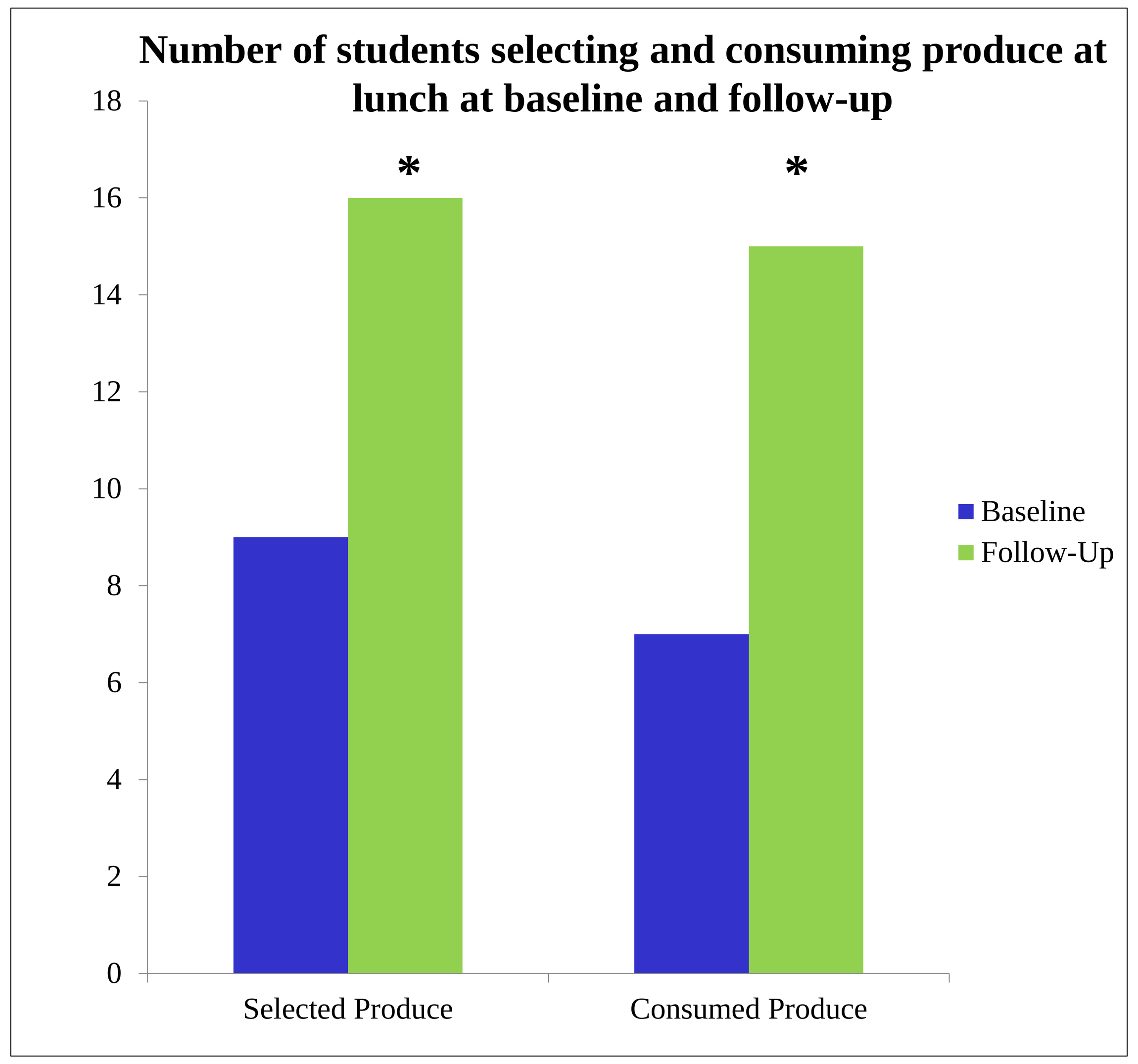
- The Parent Survey About Nutrition was distributed in English and Spanish at baseline and follow-up.
- This self-administered, validated, 18-question instrument included a:
  - modified food frequency table,
  - series of questions regarding their child's food requests and consumption behaviors, and
  - series of questions about the parent's knowledge and attitudes of and regarding school food.

STATISTICAL ANALYSIS

- SAS Version 9.3
- McNemar's Test was used for all categorical data and a paired student's t-test was used for all numerical data.
- $\alpha \leq 0.05$

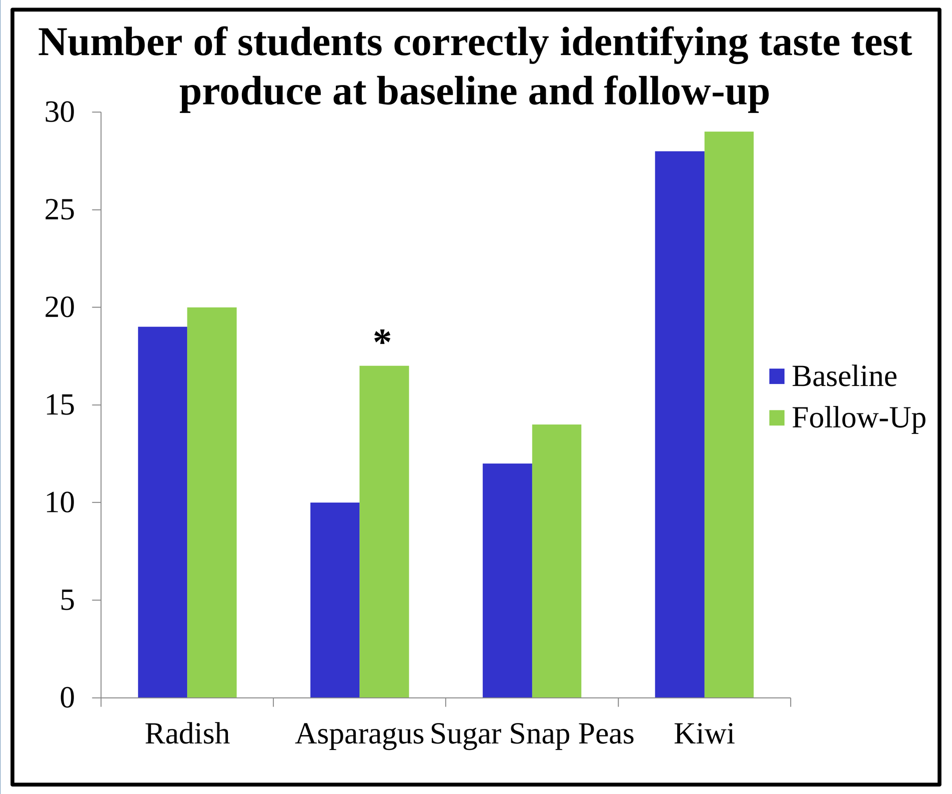
RESULTS: SCHOOL LUNCH OBSERVATIONS

Winters Joint Unified School District	
Gender	41.4% Male
Ethnicity	64.3% Hispanic
	25.0% White
	10.7% Mixed Ethnicity
Age Range	9-10 years



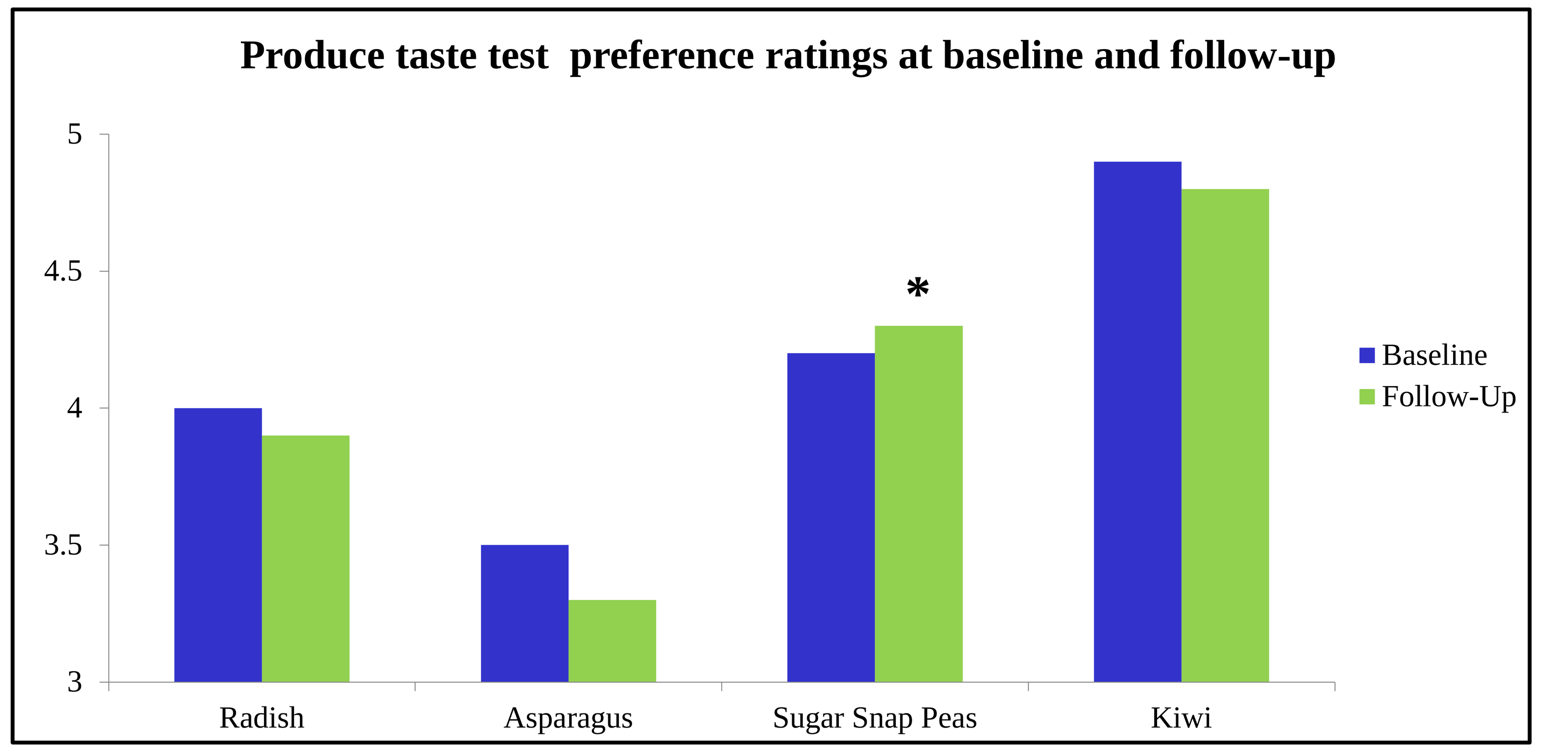
* For selected produce p= 0.0082; * For consumed produce p = 0.0114

RESULTS: VEGETABLE PREFERENCES



* p = 0.0196

Number of students willing to taste produce		
	Baseline	Follow -Up
Radish* *p = 0.0114	26	18
Asparagus	22	19
Sugar Snap Peas	25	23
Kiwi	28	26



* p = 0.0122

RESULTS: PARENT SURVEY ABOUT NUTRITION

Affirmative responses to selected questions on the Parent Survey About Nutrition	Baseline	Follow-Up
Does your child eat asparagus at home?	7	8
Does your child ask you or a family member to buy asparagus?	4	5
Does your child eat asparagus outside of the home?	6	3
Does your child eat kiwi at home?* (* p = 0.0455)	7	11
Does your child ask you or a family member to buy kiwi?	8	11
Does your child eat kiwi outside the home?	6	9
Do you feel that your child eats healthy food at school?	11	12
Are you aware of any nutrition education programs available at your child's school?* (* p = 0.0455)	1	5

CONCLUSION

After one year of exposure to a farm to school program:

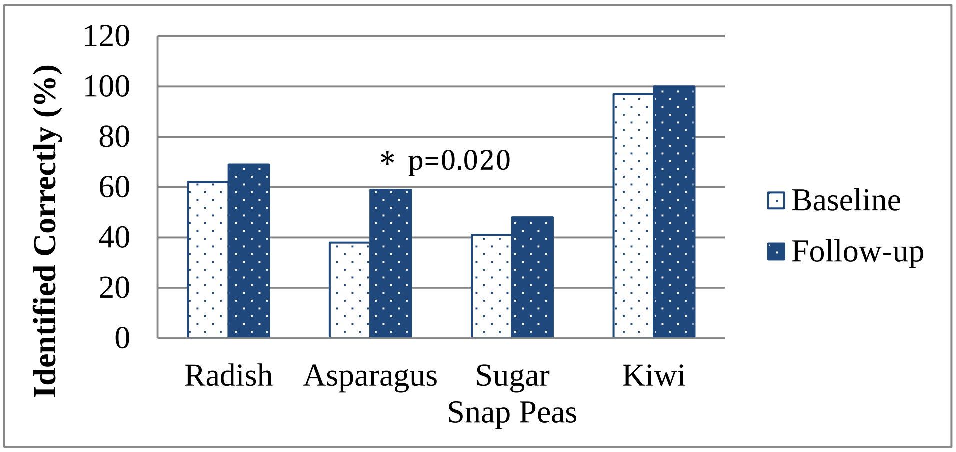
- students increased the amount of produce selected and consumed from school lunch offerings (p = 0.0082; p = 0.0114).
- more students were able to correctly identify asparagus (p = 0.0196).
- students' preference ratings for sugar snap peas increased (p = 0.0122).
- parents reported an increase in their children's kiwi consumption at home (p = 0.0455).
- a greater number of parents were aware of nutrition education programs available at their child's school (p = 0.0455).

ACKNOWLEDGEMENTS

- Thank you to the school staff, graduate student volunteers, and undergraduate nutrition student interns/volunteers, who worked hard to make this project possible.
- Pam Scheeline, Cathleen Olsen, Jessica Linnell, Jacqueline Bergman, Lori Nguyen, Anna Jones, Jazmin Rodriguez-Jordan, Aye Khaing, Yi Feng Tan, Sarah Lau, Kelly Wu, Amy Vu, Courtney Zimmerman, Anna Giessbuhler, Cammane Wu, Samira Abedini, Sraineang Hang, Charissa Chu, Sum Yi Elena Wong, Victoria Reynoso, Ke Luo, Kelly Cheung, Christopher Lam, Meng Fan Chao, Fanny Chen, Tsz Wa Fung, Amanda Hoang, Jolie Pitetta, Morgan Rockwell-Gehrett.

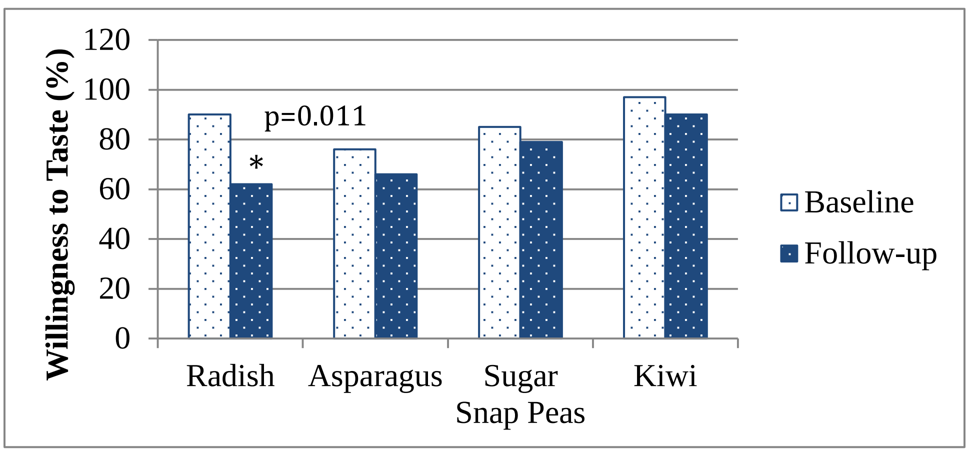
Winters Joint Unified School District

Figure 1. Students' ability to correctly identify F2S featured produce (n=29) Winters Joint Unified School District (WJUSD)



* = statistically significant (p ≤ 0.005)

Figure 2. Students' ability willingness to taste F2S featured produce (n=29) WJUSD



* = statistically significant (p ≤ 0.005)

Figure 3. Students' preference scores for F2S featured produce (n=16-25) WJUSD

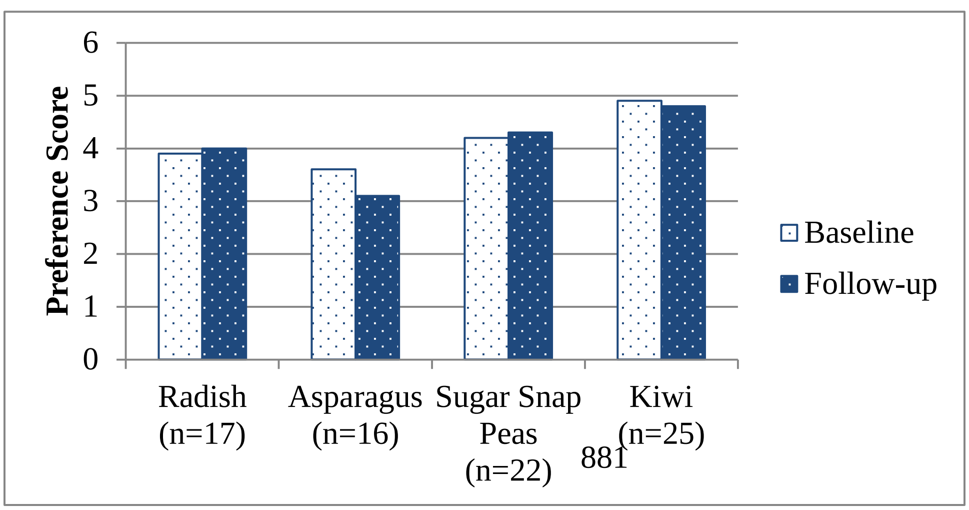
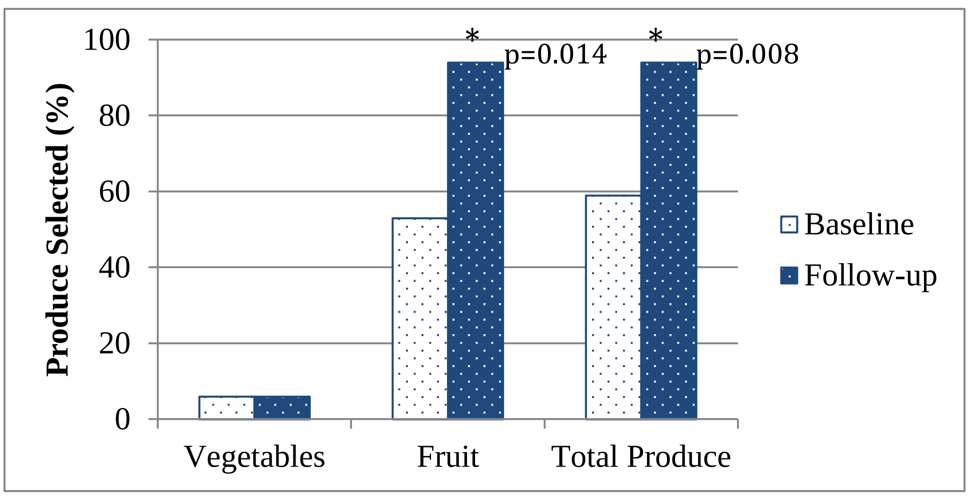


Table 1. Students' self-reported consumption for F2S featured produce WJUSD

WJUSD (n=29)	Radish			Asparagus			Sugar Snap Peas			Kiwi		
	Pre (%)	Post (%)	p	Pre (%)	Post (%)	p	Pre (%)	Post (%)	p	Pre (%)	Post (%)	p
Consumes at home	48	52	0.705	41	52	0.180	66	72	0.527	69	79	0.317
Would ask family to purchase	62	17	0.763	24	34	0.180	83	69	0.157	97	100	0.763
Would eat as a snack	62	41	0.034*	28	34	0.317	72	79	0.414	93	97	0.564

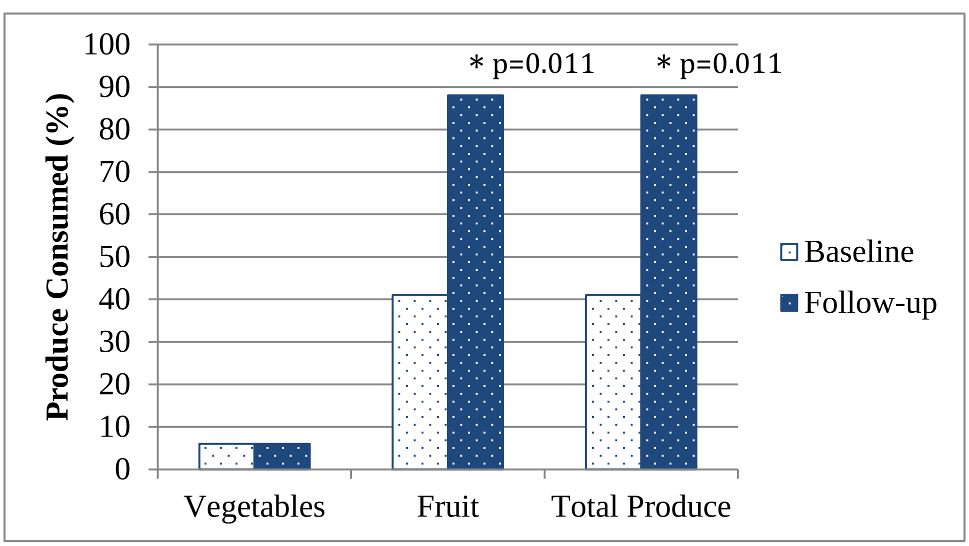
* = statistically significant ($p \leq 0.005$)

Figure 4. Plate waste observation - produce selected (n=17) WJUSD



* = statistically significant ($p \leq 0.005$)

Figure 5. Plate waste observation - produce consumed (n=17) WJUSD



* = statistically significant ($p \leq 0.005$)

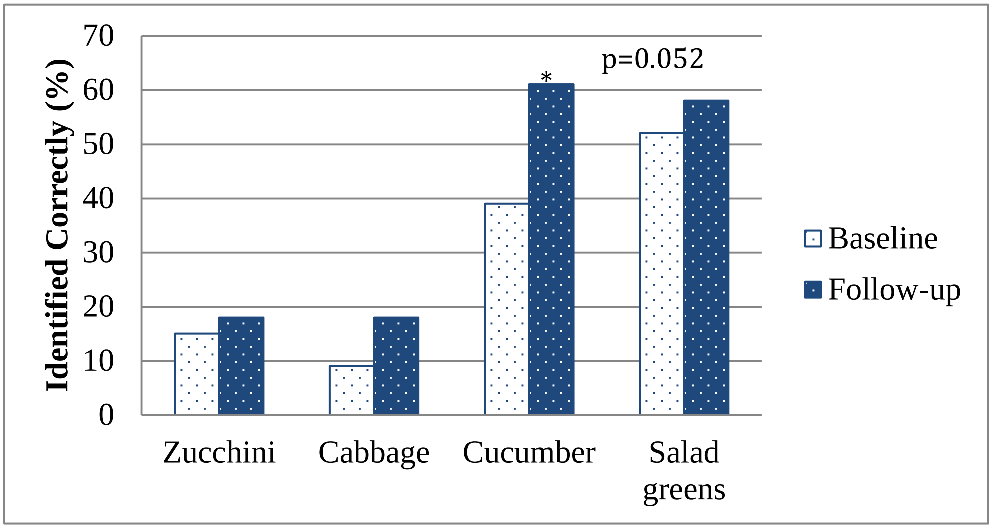
Table 2. Student's consumption behaviors regarding specific F2S produce items as reported by parents WJUSD

	Asparagus				Kiwi			
WJUSD	n	Pre (%)	Post (%)	p	n	Pre (%)	Post (%)	p
Consumes at home	16	50	50	1	17	47	71	0.046*
Ask family to purchase	17	29	29	1	17	53	71	0.317
Consumes outside of the home	17	35	18	0.257	16	44	63	0.180

* = statistically significant ($p \leq 0.005$)

Oakland Unified School District

Figure 6. Student's ability to correctly identify F2S featured produce (n=33) OUSD



* = statistically significant (p ≤ 0.005)

Figure 7. Students' willingness to taste F2S featured produce (n=33) OUSD

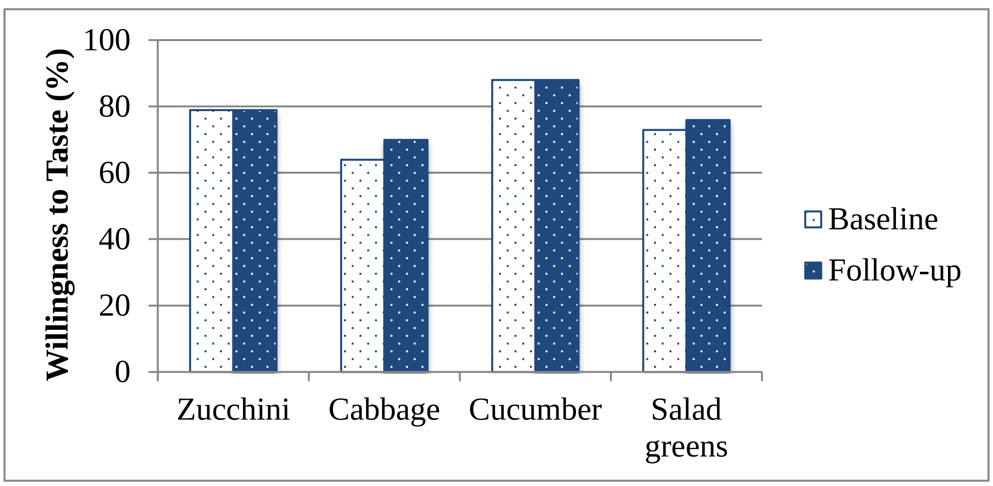
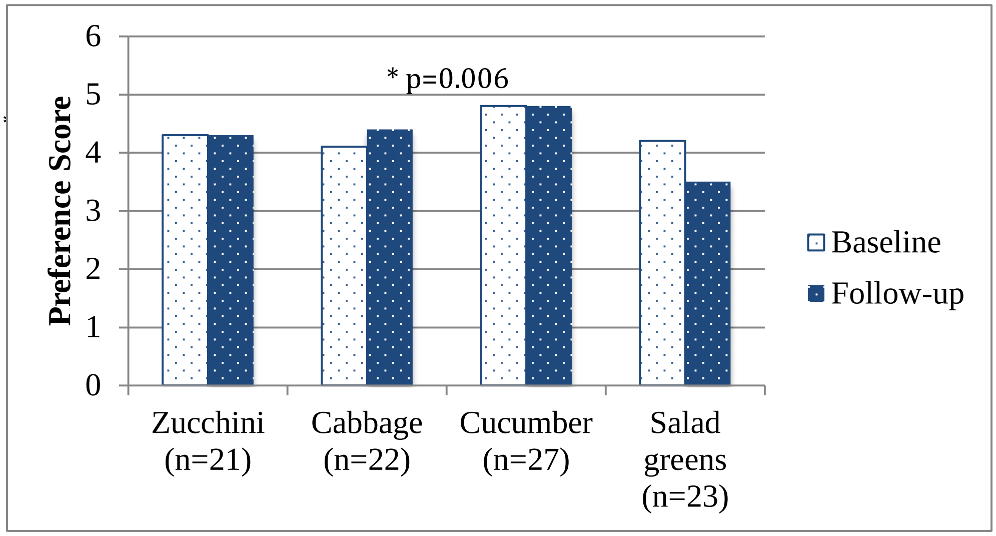


Figure 8. Students' preference scores for F2S featured produce (n=21-27) OUSD



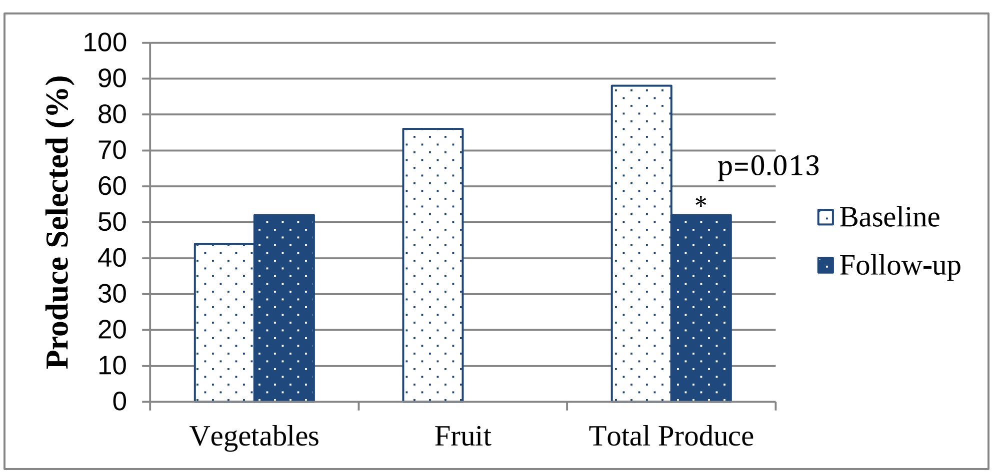
* = statistically significant (p ≤ 0.005)

Table 3. Students' self-reported consumption for F2S featured produce OUSD

OUSD (n=29)	**Zucchini**			**Cabbage**			**Cucumber**			**Salad Greens**		
	Pre (%)	Post (%)	p	Pre (%)	Post (%)	p	Pre (%)	Post (%)	p	Pre (%)	Post (%)	p
Consumes at home	70	64	0.564	53	56	0.796	82	88	0.317	69	53	0.060
Would ask family to purchase	58	64	0.527	59	66	0.563	88	88	1	64	53	0.248
Would eat as a snack	79	73	0.480	63	63	1	76	88	0.046*	59	56	0.782

* = statistically significant (p ≤ 0.005)

Figure 9. Plate waste observation - produce selected (n=17) OUSD



* = statistically significant (p ≤ 0.005)

Figure 10. Plate waste observation - produce consumed (n=17) OUSD

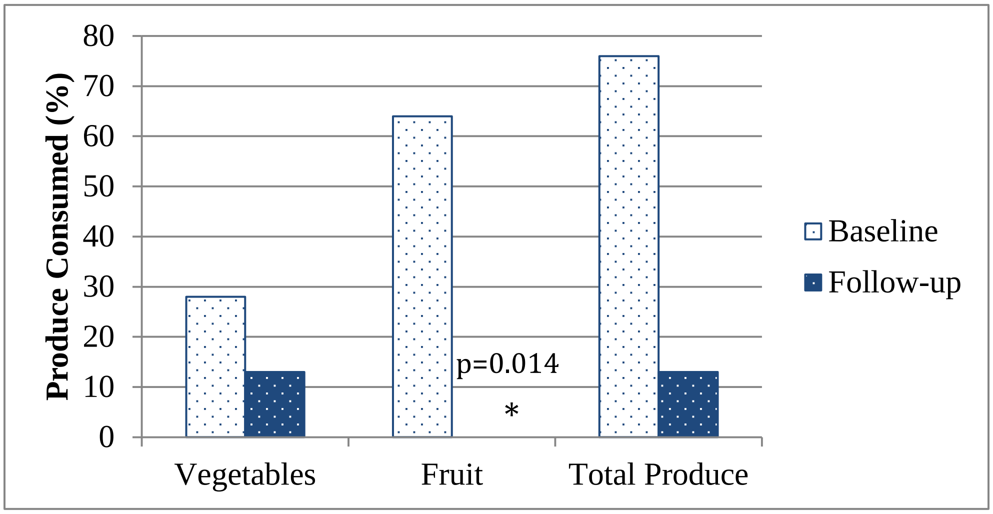
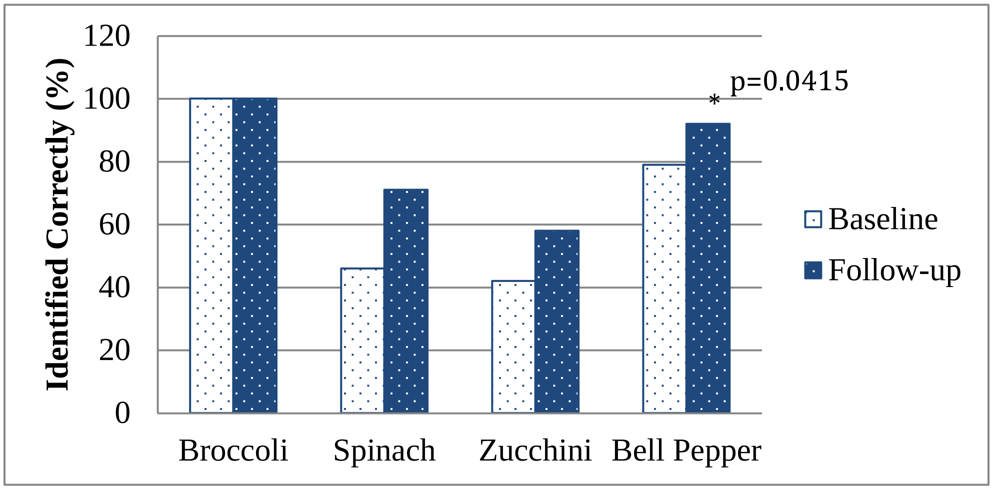


Table 4. Student's consumption behaviors regarding specific F2S produce items as reported by parents (frequency of affirmative answers)

	Zucchini				**Cucumber**			
OUSD	n	Pre (%)	Post (%)	p	n	Pre (%)	Post (%)	p
Consumes at home	17	42	53	0.3173	19	74	71	0.3173
Ask family to purchase	19	21	26	0.6547	19	74	68	0.5637
Consumes outside of the home	19	21	16	0.3173	19	68	80	0.4795

Enterprise Elementary School District

Figure 11. Student's ability to correctly identify F2S featured produce (n=24) EESD



* = statistically significant ($p \leq 0.005$)

Figure 12. Student's willingness to taste F2S featured produce (n=24) EESD

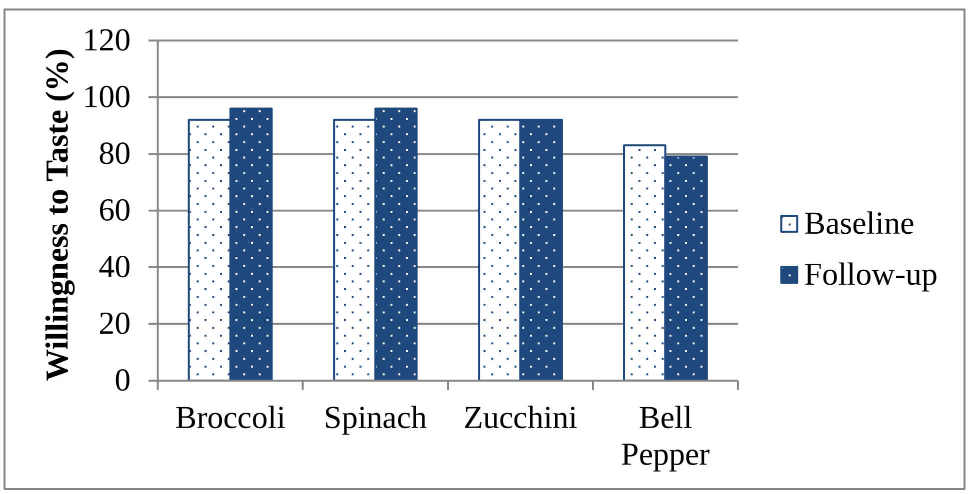


Figure 13. Students' preference scores for F2S featured produce (n=19-22) EESD

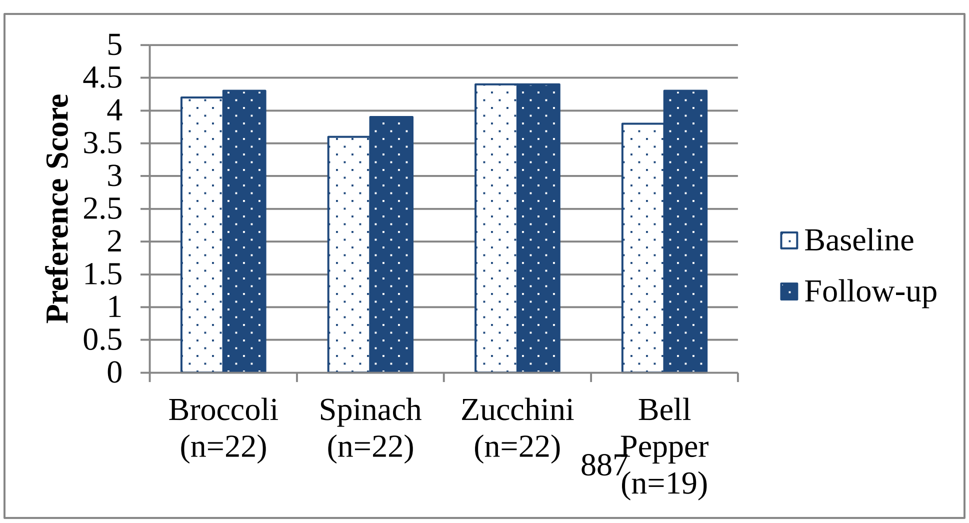
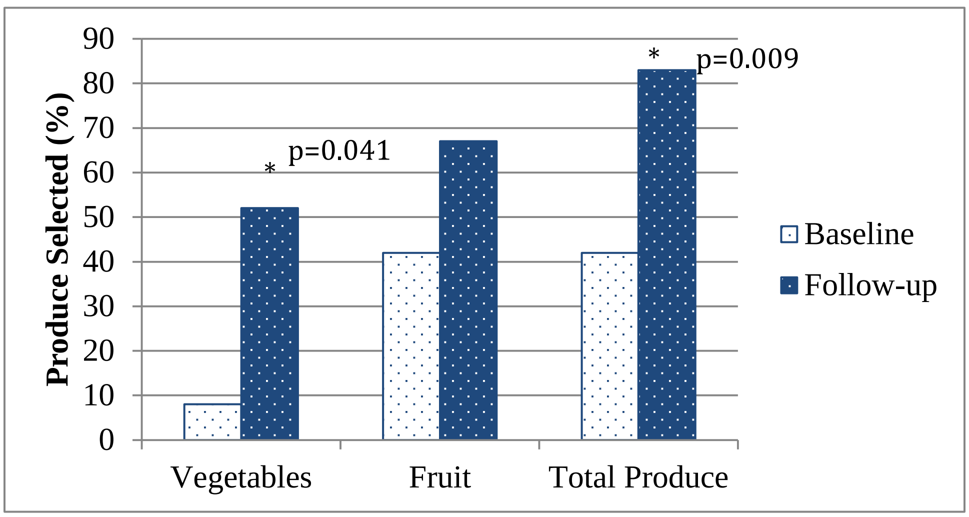


Table 5. Student preference scores for F2S featured produce EESD

EESD (n=24)	**Broccoli**			**Spinach**			**Zucchini**			**Bell Peppers**		
	Pre (%)	Post (%)	p	Pre (%)	Post (%)	p	Pre (%)	Post (%)	p	Pre (%)	Post (%)	p
Consumes at home	88	92	0.164	33	83	0.007*	67	79	0.093	42	51	0.041 *
Would ask family to purchase	75	96	0.011	58	79	0.011	83	83	0.5	58	71	0.041 *
Would eat as a snack	50	71	0.011	46	54	0.213	75	83	0.163	50	58	0.029 *

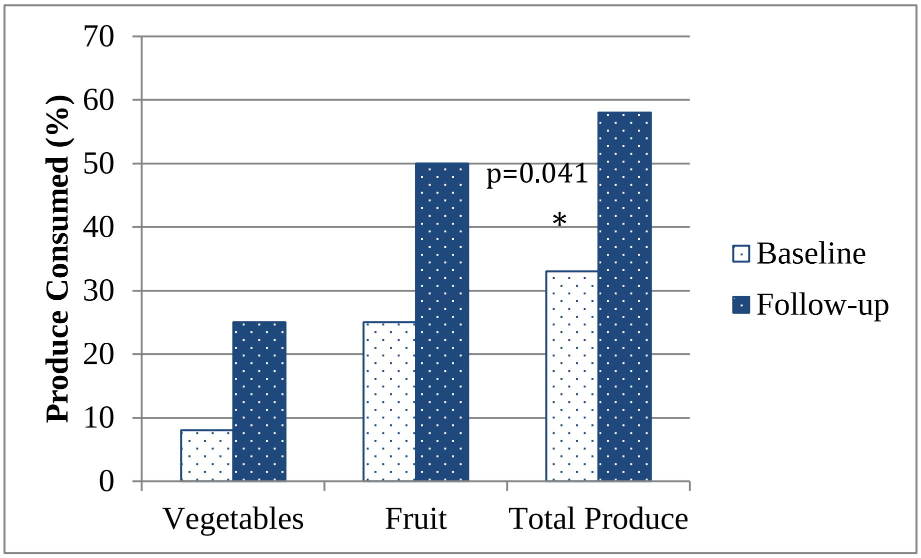
* = statistically significant (p ≤ 0.005)

Figure 14. Plate waste observation - produce selected (n=12) EESD



* = statistically significant (p ≤ 0.005)

Figure 15. Plate waste observation - produce consumed (n=12) EESD



* = statistically significant (p $\leq$ 0.005)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Oakland Eats GARDEN Fresh!

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Bastille Day Feast
Saturday, July 13, 2013
WINTERS CALIFORNIA
FARM TO SCHOOL
We are honored to announce and invite you to support our 1st Winters Farm to School fundraiser.
On July 13th, we will be hosting a multi-course feast featuring Rominger Ranch lamb, locally sourced produce and a selection of fine wine from Yolo's wineries. Long tables, nestled under the canopy of the 150-year old olive trees lining the driveway at the Historic Wolfskill Ranch will seat more than 150 people, as they join together in a leisurely celebration. A tour of the Wolfskill Ranch will be conducted prior to aperitifs and lunch. There will also be an auction of one-of-a-kind food and wine related items. Seating Limited – Tickets Required
Under The Canopy Of The Olive Trees at The Wolfskill Ranch
4334 Putah Creek Road - Winters

Publications and Presentations for CDFA-SBC 10030
Building Successful Farm to School Models to Enhance Markets for Specialty Crops

Publications involving/including this project:

- Scherr, Rachel, Rachel Cox, Gail Feenstra and Sheri Zidenberg-Cherr. 2013. “Integrating local agriculture into nutrition programs can benefit children’s health.” *California Agriculture Vol 67*(1): 30-37.

- Feenstra, Gail and Jeri Ohmart. 2012. “The evolution of the school food and farm to school movement in the United States: Connecting childhood health, farms and communities,” *Childhood Obesity,* Vol 8(4): 280-289.

Posters about this project:

- Scherr, R.E., Linnell, J., Smith, M.H., Nicholson, Y., Spezzano, T., Bergman, J., Brian, K., Briggs, M., Feenstra, G., Hillhouse, C., Keen, C.L., Nguyen, L., Ontai, L., Schaefer, S., Steinberg, F., Sutter, C., Wright, J., Young, H., Zidenberg-Cherr, S. 2013. “The Shaping Healthy Choices Program: A Multi-Component, School-Based Approach to Improve Children's Nutrition and Health Behaviors While Supporting Regional Agriculture.” The Federation of American Societies for Experimental Biology, Boston, MA.

- Feenstra, Gail, Carol Hillhouse, Sheri Zidenberg-Cherr and Jeri Ohmart. 2013. “Building Successful Farm to School Models to Enhance Markets for Specialty Crops.” ANR Statewide Conference, Ontario, CA; Childhood Obesity Conference, Long Beach, CA.

- Miller, Rachel, Rachel Scherr, Thea Rittenhouse, Gail Feenstra, Jeri Ohmart, Carol Hillhouse, Lucrecia Farfan-Ramirez and Sheri Zidenberg-Cherr. 2012. “Evaluating the Impact of Farm to School Programs on Vegetable Preference and Consumption Patterns Among School-Aged Students.” Experimental Biology Conference, San Diego, CA.

- Rittenhouse, Thea, Gail Feenstra, Jeri Ohmart, Carol Hillhouse, Sheri Zidenberg-Cherr and Rachel Miller. 2011. “Building Successful Farm to School Models to Enhance Markets for Specialty Crops.” UC ANR Sustainable Food Systems Conference, Davis, CA.

Workshops for this project:

- “Northern and Central California Farm to School Forum.” Helped to plan and presented at this one-day forum, Robert Mondavi Institute for Wine and Food Science, UC Davis, June 27, 2013 *(100 Attendees).*

- “California Farm to School Forum,” Helped plan and present at this all day workshop as part of our CDFA funded Farm to School project, Glide Ranch, Davis, CA, November 17, 2011 *(20 attendees).*

Presentations that included this project:

- "The Farm to School Program: Its Impacts on Children's Food Choices and Regional Agriculture," invited speaker at the UC Davis/ Bank of Marin Community Conversation and Reception, Novato, CA, April 25, 2013 *(25 Attendees)*.
- "Farm to school: Building successful models," invited speaker at Davis chapter of PEO, Davis, CA, February 25, 2013 *(20 Attendees).*
- "Farm to school evaluation: Concepts and tools," invited speaker in USDA's Farm to School Planning webinar for grantees, January 23, 2013 *(30 Attendees).*
- "Farm to school: The school's perspective," invited speaker at the UC CalFresh & EFNEP Statewide Training Conference, Sacramento, CA, January 15-17, 2013 *(200 Attendees).*
- "Cooking Seasonal Foods: Professional Development for Food Service Staff," Organizer, National Farm to Cafeteria Conference, Burlington, VT, Aug 2-5, 2012, *(30 Attendees).*
- "Farm to School and Regional Growers," invited speaker at Love Lunch Community in Conversation, Robert Mondavi Institute, Davis, CA, May 24, 2012 *(35 attendees)*.
- "Farm to School and Farm to Institution: What are they? What are the benefits to producers?" invited speaker for ANR Sustainable Food Systems Conference, UC Davis, Davis, CA, October 11, 2011 *(50 attended).*
- "Farm to School from the Ground Up," invited speaker for UCCE Farm to School Workshop, Modesto, CA, October 4, 2011 *(60 attended).*
- "Farm to School Programs in California," invited speaker for Sunrise Rotary Club meeting, Davis, CA, September 2, 2011 *(50 attended)*
- "New Solutions: Food Systems Research at UC Davis," presenter at the Hazon Food Conference, UC Davis, August 19, 2011. *(25 attended).*
- "Creating, achieving and evaluating measureable outcomes for local product procurement," presenter at the Rethinking School Lunch: Cooking with California Food in K-12 Schools Conference, UC Davis, Davis, CA, August 4, 2011. *(100 attended).*
- "Sustainable Food Systems: Integrating Food Systems and Public Health," Keynote presentation to the California Conference of Directors of Environmental Health, Monterey, CA, May 26, 2011 *(200 attended)*
- "Farm to Institution Programs: Keys to Success," presentation at the University of Idaho President's Sustainability Symposium, Moscow, ID, March 30-April 1, 2011 *(30 attended)*
- "Successful Farm to Institution Programs," Keynote presentation at the University of Idaho President's Sustainability Symposium, Moscow, ID, March 30-April 1, 2011 *(60 attended)*
- "Regional Farm to School Procurement Options," presentation at the Fresh Fruit & Vegetables: Centerpiece for a Healthy School Environment workshop, Woodland, CA, March 17, 2011. *(75 attended)*
- "Food justice: Connecting farm to school and community food security," presentation at the Food Justice conference, Eugene, OR, February 19-21, 2011. *(250 attended)*
- "Food systems in California," presentation to international visitors as part of World Trade Center/ Northern California, U.S. Foreign Policy and Food Security, UC Davis, February 9, 2011. *(10 attended).*
- "Promising Practices for Partnering: Farm to School-Partnering with Food Service," panel presentation at the statewide EFNEP/FSNEP Conference, Burlingame, CA, December 7, 2010. *(160 attended).*

Attachment 1

Figures and Tables

Table 1: Summary of variables measured in Oregon and California (mean (min-max)).

Variable	Oregon (10 fields)	California (16 sites)
Hives/acre	4	10
Insecticides	0	2.2 (0-6)
HB visitation (visits/5 min period)	9.6(6-14)	7.5 (1-13)
% visits non-honeybees	12%	1.5%
Pollen tubes	15.61 (6-26)	2.6 (0.4-8.5)
Seeds/umbel	1115 (695-1850)	271 (17-695)

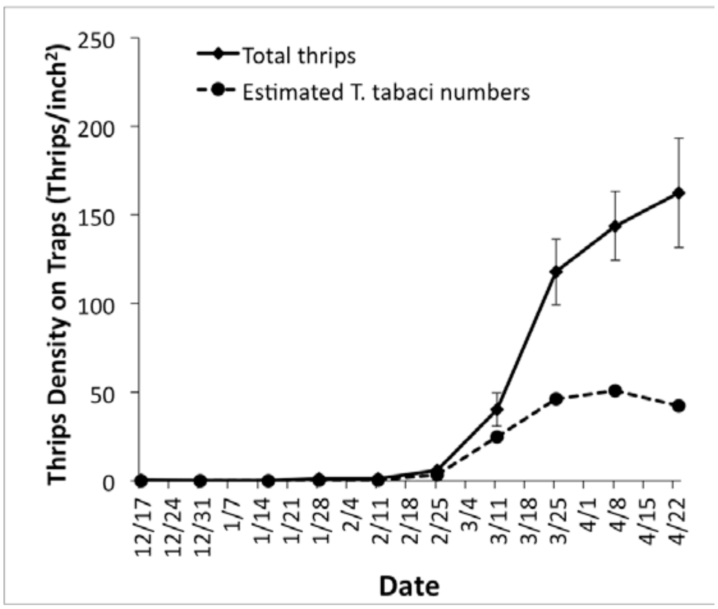

Figure 1: Thrips abundance on traps over time in 2013, showing total thrips numbers and onion thrips numbers as estimated by their proportion of total thrips present, Yolo and Colusa Counties.

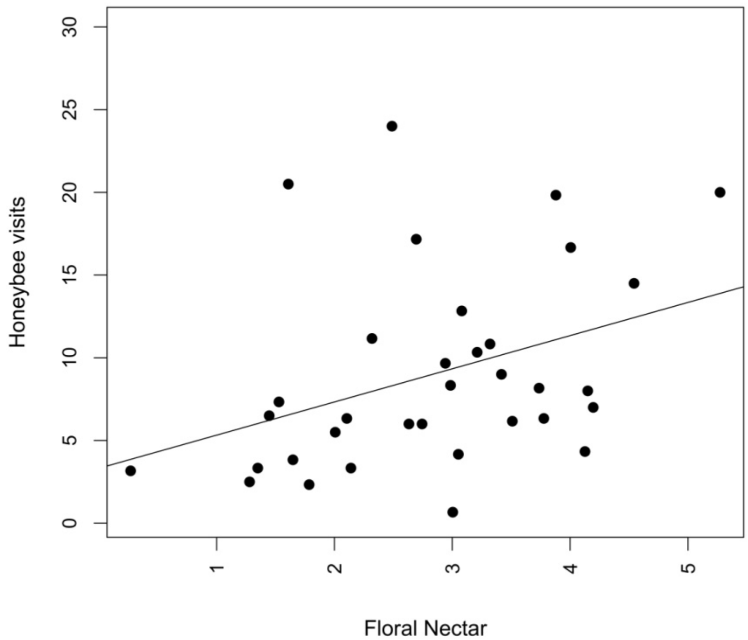

Figure 2: Relationship between honeybee visits and nectar production for field surveys in 2012

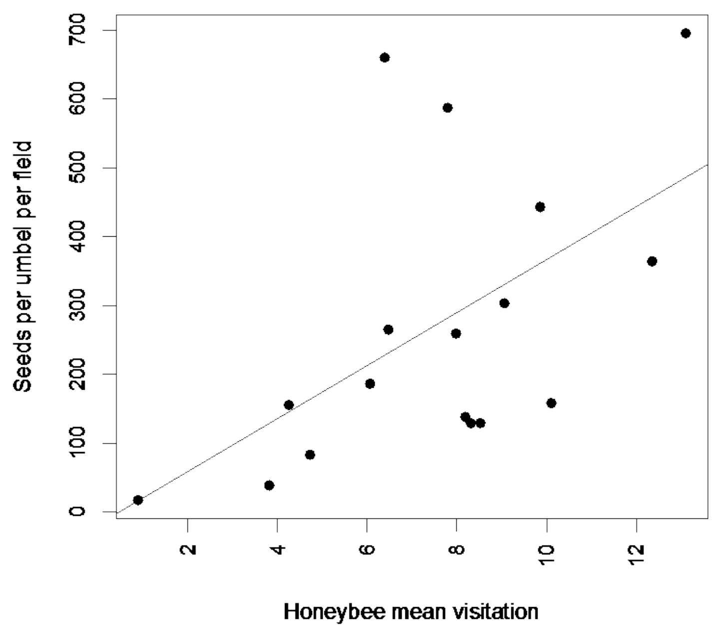

Figure 3: Relationship between honeybee visitation and seed yields for field surveys in 2012

Photo: PI Rachael Long monitoring honey bee activity in a commercial onion seed production field.

University of California
Agriculture and Natural Resources

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UC PEER REVIEWED

RONALD E. VOSS, Cooperative Extension Vegetable Specialist Emeritus, University of California, Davis; **MIKE MURRAY,** University of California Cooperative Extension Farm Advisor Emeritus, Colusa County; **KENT BRADFORD,** Professor and Seed Physiologist, Department of Vegetable Crops, University of California, Davis; **KEITH S. MAYBERRY,** University of California Cooperative Extension Farm Advisor Emeritus, Imperial County; **IVAN MILLER,** Assistant Superintendent Emeritus, University of California Desert Research and Extension Center, Imperial Valley; **RACHAEL LONG,** University of California Cooperative Extension Farm Advisor, Yolo County: and **SANDRA GILLESPIE,** University of California, Davis, Postdoc in Entomology.

Onion Seed Production in California

PRODUCTION AREAS AND SEASONS

Commercial seed production for onion (*Allium cepa* L.) in California occurs primarily in the low desert of Imperial County. The Sacramento Valley (particularly Colusa County) and the San Joaquin Valley are also significant production areas. Onion seed production in the desert includes open-pollinated dehydrator varieties as well as fresh market hybrid and open-pollinated varieties. Production in the San Joaquin Valley also includes fresh market and dehydrator varieties, while seed produced in the Sacramento Valley is primarily for fresh market hybrid onions. Small amounts of onion seed are grown in California's mountain and coastal valleys. Seeds are planted from late July to September for the seed-to-seed system, while bulbs are planted from September to October for the bulb-to-seed system. In either system, seed maturity is reached and seed is harvested from late June to early August of the following year.

ONION SEED ACREAGE, PRODUCTION, AND VALUE

Year	Acres*	Average yield* (lb/acre)	Value (millions)*
2010	2,485	195	$15.53
2011	2,646	242	$16.21

*Because many counties include onion seed production statistics in "Miscellaneous" or "Seed Crops," these data underestimate actual values.

SOURCE: *County Agricultural Commissioners Annual Report Data*, California.

GROWTH CYCLE AND CLIMATIC REQUIREMENTS

Onions are cool-season, biennial plants (that is, they require two growing seasons to complete the cycle from seed to seed), but they are grown commercially as an annual crop. The seeds germinate during the first season and the plants grow vegetatively, eventually forming a bulb. Although onion seeds will germinate at temperatures as low as 35°F (2°C), a temperature of at least 55°F (13°C) is required for 70 percent seedling emergence within two weeks of planting. The optimum temperature range for germination, emergence, and plant growth is 68° to 77°F (20° to 25°C). The early growth rate of onion plants is slow compared to that of other cool-season crops due to slow leaf area development and low light interception.

Bulbing occurs when the leaf bases swell to form storage tissue. Bulbing is triggered by increasing day lengths during the first growing season. Varieties adapted to California will initiate bulbing at day lengths from about 12 to 15 hours. The mature bulb can be stored in a dormant state for varying lengths of time, depending on the onion variety and storage temperature. When a cold-stored onion bulb is planted back into the soil for its second growing season or when it overwinters in the field, it forms one or more stalks (*scapes*), each which terminates in an umbel containing several hundred flowers.

Bolting (the growth of the scape and inflorescence) is undesirable in onions grown for bulbs, but essential for onion seed production. Variety, plant size, temperature, and duration of temperature all interact to determine when and whether bolting will occur. Bulbing is not required before bolting, but the plants must have leaf bases with diameters greater than 3/8 inch (10 mm) before flowering can be induced. Seed stalk initiation requires a period of chilling known as *vernalization*. Induction of flowering occurs when plants or bulbs are subjected to temperatures of 45° to 55°F (8° to 13°C) for approximately one month or longer, depending upon the variety. Insufficient vernalization results in poor inflorescence development and low seed yields. The seed stalks elongate as temperatures rise in the spring. Flowering, pollination, and seed development follow. Mature seeds will naturally fall from the inflorescence (*shatter*) if not harvested. Although onion seed production requires two growing seasons, both seasons can occur in a single ten-month period if the seeds are planted in late summer. This allows enough time for the plants to achieve sufficient size in the fall, vernalize during the winter and produce seeds the following summer.

Onion seed production requires low-humidity ambient conditions during the spring and summer. Disease management, pollination, and seed maturation all are enhanced by warm temperatures and low relative humidities. Foliage diseases are more prevalent under humid conditions, and bees are poor pollinators during rainy weather. Preor postharvest seed drying is also achieved most easily in low humidity climates. Climates that are cool in the winter and warm to hot with low rainfall and low humidity in the spring and summer are best suited for onion seed production.

VARIETIES

There are few public onion breeding programs in the United States (and none in California), but many private seed companies are involved in developing onion varieties. The result is that a large number of competing varieties are available for any given area, with the emphasis on the development of hybrid rather than open-pollinated varieties. Most commercial fresh market bulb onions are now hybrids, though open-pollinated varieties are still used for dehydrator bulb onion production. Thus, production of both open-pollinated and hybrid onion seed is needed.

Onion varieties are generally classified by day-length requirement (short, intermediate, or long), market use (green, fresh bulb, or dehydration bulb), and bulb color (yellow, brown, red, or white) within the fresh market class. A continuum of varieties adapted to various day lengths has been developed, but the distinction between the different day-length classes is not always obvious. In general, short-day fresh market bulbs are of the Granex, Grano, or combination Granex-Grano types. Granex types are flat to thick flat in shape and Grano types are large and globe or top shaped. Short-day dehydrator varieties are generally derivatives (progenies) or selections (best plants from local areas) from Creole or related lines.

Many varieties that are commonly considered intermediate types are selections or derivatives from Sweet Spanish types (which may also be long-day) or short-day X long-day hybrids. Most of these are globe shaped, though some are flattened, and all must have some resistance to bolting since they are grown through the winter. At the California latitudes of 37° to 42°N (i.e., north of Fresno) or altitudes above 1,000 to 2,000 feet, numerous Sweet Spanish types are adapted, as are Fiesta types (Sweet Spanish X Yellow Globe cross). Market color types of red, white, and yellow are available and are grown. The long-day white dehydrator varieties that are important in California are derivatives or selections from Southport White Globe.

Onion seed for all day-length types is produced in California, but the short and intermediate day-length varieties predominate. Most onion seed produced in the Imperial Valley (32° to 33°N latitude) is for short-day varieties, though some intermediate-day variety seed is also produced. Any long-day varieties grown for seed in the Imperial Valley usually fail to bolt or are extremely late and they do not tolerate the valley's heat, whether grown from bulbs or seed. A few Spanish varieties are exceptions: these are grown seed-to-seed for green bunching onions. Seed of both shortand intermediate-day onion varieties is grown in central California (36° to 40°N). Long-day varieties can be grown for seed in the Sacramento Valley, but production is improved when they are grown at the more northern latitudes of Oregon and Idaho (43° to 45°N). Short-day lines grown at the northern latitudes are mostly used as pollinators, not as female parents.

PLANTING

Most onion seed production in California is accomplished via the seed-to-seed system. This system eliminates much of the handling and expense of bulb storage and replanting required in bulb-to-seed production. The bulb-to-seed method may be preferable, however, for open-pollinated production; bulb quality is more variable in open-pollinated onions, and the bulb-to-seed method allows seed producers to select high-quality bulbs for seed production. Bulb-to-seed may also be used in hybrid seed production to stagger planting dates and manipulate the flowering times of male and female lines. The bulb-to-seed system is used for stock or parent seed production to maintain high quality characteristics and genetic purity. With seed-toseed methods, many short-day varieties produce multiple scapes while longer-day varieties tend to produce only single scapes.

For the seed-to-seed system, the onion seed are planted in the field in August or September. Planting must be early enough for the plants to attain sufficient size to be vernalized before growth slows with cooler winter weather. Bulbs are generally planted in mid-September to November, since they require less time to become established. Before planting, the grower should ensure that sufficient isolation distance is present around the field. Onions are pollinated by insects, so onion seed fields must be isolated by a minimum of 1 to 1½ miles from any other onion seed fields to prevent cross-pollination. Onions of different colors grown for seed require 3 miles' isolation.

Onions grown for seed in the Imperial and San Joaquin Valleys are most commonly grown in double rows on raised beds 40 to 42 inches (102 to 107 cm) wide. In the Sacramento Valley, single-row, 30-inch (76 cm) wide raised beds are generally used. The rows are seeded using precision vacuum planters, plate planters, or occasionally belt planters. The desired final plant population is approximately 15 to 20 seed stalks per foot of bed for 30-inch beds or 20 to 25 per foot of bed for double-row 40-inch beds (about 30 seed stalks per m^2). Approximately 3 to 5 pounds of seed are planted per acre (3.5 to 5.5 kg/ha) in either configuration. Raw seed is generally used, although coated or pelleted seeds are available that carry fungicides or insecticides. Onion seeds are planted only ½ to ¾ inch (13 to 20 mm) deep, requiring a well-prepared soil surface that must be kept moist until seedling emergence.

Bulbs for the bulb-to-seed system are generally planted in single rows on beds and spaced at 2 inches (or as close as possible) in furrows sufficiently deep for a soil cover of approximately 1 inch (2.5 cm). Since bulbs produce multiple seed stalks, the final per-acre population of seed stalks is similar, regardless of whether the onions were planted as bulbs or as seed.

Hybrid seed production requires some special considerations. The time period from seeding or bulb planting to flowering differs among onion varieties. To achieve simultaneous flowering ("nicking") of the male parent of one variety and the female parent of another, they may need to be planted on separate dates. Another method to attain proper nicking is to direct-seed one of the hybrid parents and plant bulbs for the other. Seed producers try to avoid planting bulbs for both parent lines. Most commonly, seed companies attempt to develop hybrid varieties from parents that have similar flowering dates. Ideally, the male (pollinator) parent should be flowering shortly before, during, and after the female parent's flowering period. To achieve this, split plantings of the pollinator are sometimes used.

It is essential that seed producers work closely with seed company representatives who know the flowering characteristics of the parent lines.

In the Central Valley, onion seed or bulbs should be planted in north-south rows or parallel to prevailing winds to lower the humidity around the plants and thus reduce the likelihood of foliage diseases. In the Sacramento Valley, early drying of the soil in the spring is critical for timely cultivation and fertilization. With two rows per bed and beds running east-to-west, the south row of each bed would grow more quickly and larger than the north row. In the Imperial Valley, the row direction of onion seed crops varies to best suit the individual field's irrigation slope.

Crop rotation is an important consideration for both onion bulb and onion seed production. To minimize disease, nematode, weed, and soil insect problems, onion crops should not be planted in the same field more often than once every four to five years. A crop rotation of four to five years also helps to avoid volunteer onions of a variety different from the planted crop.

SOILS

Onions are shallow-rooted and grow best on a friable soil with good moisture retention. Onions will grow in a wide range of soil types, but excessively dense clay soils interfere with root growth, while sandy soils require very frequent irrigation. Onion seed germination and seedling emergence require a uniform, clod-free, firm seed bed several inches deep. Because raised beds provide better drainage and an area for salt accumulation away from the onion root zone, they are preferred to planting on the flat or small ridges. Onions are sensitive or moderately sensitive to salinity, primarily at germination and emergence stages; once the plants are established they can tolerate higher levels of salinity. Yield reductions of 50 percent are not uncommon at a salinity of 4 to 5 mmhos/cm (dS/m). Onions are more sensitive to salinity, sodium, and boron than are lettuce, cauliflower, broccoli, and cabbage.

IRRIGATION

Sown onion seed must not dry out and the soil surface must not be allowed to crust during the post-planting, pre-emergence period, which can last 10 to 20 days after the initial irrigation. Since onion seed is planted in the summer when temperatures are high, sprinkler irrigation is the best management practice for stand establishment. Because they have a shallow root system, onions require frequent irrigation or rainfall throughout the season. They extract very little water from depths beyond 24 inches (60 cm); most of their water is from the top 12 inches (30 cm) of soil. Onion roots are essentially non-branching, and all roots originate at the stem (basal) plate of the plant. Thus, the upper soil areas must be kept moist to stimulate root growth and provide adequate water for the plant. The onion plant's rates of transpiration, photosynthesis, and growth are reduced by even mild water stress. Unlike many plants, onions show little capacity to reduce their leaf water potential by osmotic adjustment to compensate for reduced availability of water at the root, whether caused by salinity or by drying of the soil. Stressed onion plants will exhibit poor flower and pollen development, reduced seed yields, lower seed weights, and decreased seed vigor and reduced nectar production and honeybee visitation.

The required amount and frequency of irrigation will depend on the irrigation method, soil type and conditions, and weather (e.g., rainfall amounts and timing, temperature, evapotranspiration, etc.). The optimal time for irrigation is when 25 percent of available moisture in the top 2 feet (60 cm) has been depleted. In general, an onion seed crop will use 25 to 35 inches (65 to 90 cm) of water. With 70 to80 percent efficiency, water applications of 35 to 45 inches (90 to 115 cm) may be required. If more water than that is being used, the frequency and length of irrigation should be examined or a different method of irrigation (e.g., drip, surge, or sprinkler) should be considered.

FERTILIZATION

Because onions are shallow rooted and are generally grown in cool soils, they are quite responsive to fertilization. The optimal fertility program will provide nutrients to the upper 6 to 15 inches (15 to 40 cm) of the soil over the entire growing season. Typically, no more than one-third of the nitrogen (N) should be available at planting, one-third at early season (3- to 4-leaf stage), and one-third at midseason or when seed stalks are visible. High N availability late in the season can delay maturity, but the effect on seed quality is not known. Onions are sensitive to ammonia, so formulations that contain high levels of ammonia should be avoided. However, fall foliar applications (soon after planting) of liquid ammonium nitrate have proven beneficial to onion growth, and may have the side benefit of controlling young weed plants. Total supplemental nitrogen needs may vary from 100 to 400 pounds of N per acre (110 to 450 kg/ha), depending on soil and cropping history and irrigation efficiency. High rates of phosphorus (200 lb P_2O_5/ac [225 kg/ha]) may be necessary if beginning soil levels are low or deficient; moderate rates are sufficient in other soils. Onions are not responsive to potassium in most California soils. Five to ten tons per acre (11 to 22 t/ha) of composted manure are sometimes used to meet planting and early season N requirements and other nutrient needs. Soil tests and tissue analyses are available for all nutrients, and preliminary quick tests on tissues for N are available.

Soil analyses are the best indicators for phosphorus (P), potassium (K), and micronutrient needs, while tissue analyses combined with soil and cropping history are the best indicators for nitrogen (N) needs. For phosphorus, less than 8 to 10 ppm P with sodium bicarbonate extraction is a deficient level; for potassium, less than 80 to 100 ppm K with ammonium acetate extraction is a deficient level. Micronutrients, if needed, are most effectively applied at planting time, banded 2 to 4 inches (5 to 10 cm) below the seed or, if bulbs are planted, at the depth of the bulb bases but to the side of the planting row. For zinc, less than 0.5 ppm Zn by DTPA or dithizone extraction is a deficient level; zinc is commonly applied to onion seed crops, both at planting and as foliar application. Other micronutrient applications may be needed depending upon the specific micronutrient's availability in the soil.

INTEGRATED PEST MANAGEMENT

Pests, weeds, and diseases need to be well managed in onion seed production to achieve high yielding and high-quality seed. The UC Integrated Pest Management Guidelines for onions, including photographs, are available for weed, insect, disease, and nematode pests. Sanitation, crop rotation, resistant varieties, appropriate pesticide use, and frequent monitoring are essential components for prevention and control of the many pests afflicting onions. Visit the UC IPM website at http://ipm.ucdavis.edu/PMG/selectnewpest.onion-and-garlic.html for more information.

Weed management. Onions are poor weed competitors because of the long period before they achieve ground cover and because the long growing season permits the emergence of successive flushes of both winter and summer weeds. Onions for seed are planted in the summer and grow through the fall, winter, spring, and following summer, so they encounter all types of weeds: summer annuals, winter annuals, perennials, grasses, and broadleaves. Field bindweed is a particularly troublesome weed because the seed is similar in size, shape, and color to onion seed, so it is very difficult to separate by seed conditioning. Since field bindweed is a federally designated noxious weed, commercial onion seed must be completely free from bindweed seed. Considerable amounts of good onion seed can be sacrificed during cleaning to remove even a small contamination with bindweed seed. Thus, control of bindweed in the production field is essential.

Early weed control is essential: cultivation often becomes impossible in the winter due to rains, and the result of a lapse in control is the growth of winter annual weeds. The limited availability of pre- and early post-emergence herbicides makes site selection, pre-plant weed management, and early season weed management via cultivation essential components of onion seed production. Hand weeding can damage the onion root system, so field selection, pre-irrigation followed by cultivation or a general herbicide application, and a good early cultivation program, are essential. Nonetheless, one or two cycles of hand hoeing are required in many cases to ensure low weed populations. Postemergence herbicides are available that can be applied at the 3- to 4-leaf stage, and later. Soil solarization is another potentially useful tool. The onion seeds are not planted until mid to late summer, so one to two months of solarization can be completed without disrupting most rotation schemes. Additional information on solarization is available in UC ANR Communications Services Publication 21377, *Soil Solarization: A Nonpesticidal Method for Controlling Diseases, Nematodes, and Weed Pests.* Pre-plant fumigation is another effective tool that has been used increasingly since the removal of early season herbicides from the market.

Disease identification and management. The disease problems encountered in onion seed production are similar to those encountered in bulb production. The most serious disease threats to onion seed are downy mildew (*Peronospora destructor*) and botrytis leaf blight *Botrytis squamosa*), sometimes called botrytis blast. Botrytis blight usually occurs during the fall and winter on onion seed crops. As temperatures rise in spring, and if they are accompanied by high humidity, rain, or sprinkler irrigation, downy mildew becomes the dominant springtime disease. Preventive fungicides, cultural practices that promote leaf drying, and avoidance of sprinkler irrigation are the most effective management practices.

Purple blotch (*Stemphylium vesicarium* [most common in California] and *Alternaria porri*) and Fusarium basal rot (*F. oxysporum* f. sp. *cepae*) are potentially serious diseases as well. Bacterial rots (*Pseudomonas* and *Erwinia* spp.), which start as foliar diseases before they spread into the bulb, can be a threat throughout the season to plants grown under sprinkler irrigation. Pink root (*Phoma terrestris*) and white rot (*Sclerotium cepivorum* Berk.) are potentially serious root and bulb diseases that are managed through avoidance, including field selection and crop rotation. Pink root can also be managed through use of resistant plants and soil fumigation. Black mold (*Aspergillis niger*), neck rot (*Botrytis allii*), and blue mold (*Penicillium hirsutum*) are common harvest and postharvest diseases of bulb crops, but rarely constitute serious threats to the onion seed crop.

Iris yellow spot virus (IYSV) is a relatively new disease for California onion seed and bulb production. This disease is vectored by onion thrips (*Thrips tabaci*). Symptoms include straw-colored lesions on leaves and scapes that result in plant dieback and serious losses in seed yield and quality. Management practices include maintaining good fertility and adequate soil moisture to reduce plant stress, removing and destroying infected plants along with cull piles, eliminating weeds in and around onion fields (especially volunteer onions and wild alliums), and controlling onion thrips.

Insect identification and management. Field monitoring is an important tool for identifying pest problems in onion seed production. Thrips (onion and flower, *Frankliniella occidentalis*) are frequently found and are most likely to cause economic problems if they become numerous on the umbel. Onion thrips is a major concern because this pest vectors IYSV. Onion maggot is also a potentially serious insect pest, while mites, seed corn maggot, leafminers, and armyworms are occasional problems.

Insecticides for pest control should be used with extreme caution, and not at all during bloom, to protect insect pollinators needed for onion seed production. Based on recent research, onion seed fields treated with more than four insecticides (including tank mixes and applied pre-bloom) showed a decline in honey bee activity along with subsequent yield reductions (Long and Morandin 2011; Gillespie et al. 2013). As a result, manage thrips by monitoring fields and applying insecticides only when needed. In general, onion thrips start to develop in fields in late February/early March, so if insecticides are needed, timing should begin then. See the UC IPM Pest Management Guidelines for Garlic and Onions (http://www.ipm.ucdavis.edu/PMG/select-newpest.onion-and-garlic.html) for thrips monitoring practices.

Nematode identification and management. Stem and bulb nematode (*Ditylenchus dipsaci*) and root knot nematodes (*Meloidogyne* spp.) can be found in seed onion fields. However, they do not often cause problems in California onion seed production.

POLLINATION

Pollinator insects are necessary for onion pollination, and honey bees are used widely for this purpose. Hives should be placed in open-pollinated variety fields when about 10 percent of the flowers are open and in hybrid fields when the male variety begins flowering. Nicking (the simultaneous flowering of male and female parent varieties) is critical in hybrid fields, since without it seed production cannot occur. For open-pollinated varieties, 4 to 6 hives per acre are generally satisfactory, while hybrids may require as many as 10 to 12 hives per acre.

Many factors affect pollinator activity in hybrid onion seed production. These include the neighboring crop and weed competition for bees, bee colony strength, onion variety, irrigation management, nectar production, insecticide use, and hive placement.

Ideal neighboring crops for onion seed production are those that honey bees do not normally visit (e.g., tomatoes or grains). Roadside weeds should be controlled to eliminate plants more attractive to the bees, such as mustards and thistles. Nearby alfalfa fields should be cut before bloom.

Growers usually contract with a beekeeper for bees. Colony strength and performance can be stipulated in those contracts. Bee colony strength is dependent on hive populations, activity, and freedom from mites and diseases. Frequent inspections by the beekeepers can ensure that all contracted hives are healthy and that their performance is satisfactory.

Honey bees favor onions that produce higher amounts of nectar. Nectar production depends on the onion variety and is also influenced by irrigation management practices. Onion seed fields that are too dry or too wet have lower amounts of nectar than onions that have good irrigation management practices. Insecticides should be used with extreme caution, and not at all during bloom, to avoid negative impacts to insect pollinators. Seed fields receiving more than four insecticide treatments (including tank mixes and pre-bloom) show declines in honey bee activity and seed yields. Some insecticides may also interfere with the ability of female umbels to receive pollen, though honey bees seem to deposit enough pollen to overcome this limitation. Fungicides do not appear to negatively impact pollinator visitation.

When possible, hives should be placed in and around onion seed fields, with the hive entrances directed toward the field interior. This will help to keep the bees working the onion field instead of foraging elsewhere. Hives should be placed in the field incrementally as flowering increases to ensure the presence of sufficient pollen for the bee population. Fresh hives may also be rotated into the field to replace hives whose bees may have identified more attractive sources for nectar and pollen. Seed companies will know the relative bee-attractiveness of different onion parents and can recommend adjustments in the numbers of hives needed per acre for a particular hybrid.

Other insects also pollinate onions. Flies and leafcutter bees work onion flowers more effectively than honey bees, but they are difficult to manage or keep in controlled areas. Anecdotal evidence suggests that good onion seed yields have been obtained from fields located near dairies or feedlots.

HARVEST AND DRYING

Determining the harvest date is a critical decision in onion seed production. Two objectives are in conflict: to allow maximum seed maturity, and to minimize the loss of seed from umbels shattered during harvest. Too early a harvest will minimize loss to shattering, but some harvested seeds will be immature, lightweight, poor-vigor, or nonviable. If harvest is delayed until all seeds reach optimal maturity, much of the earlier maturing seed can fall to the ground or shatter from the umbels during cutting and transport. Harvest is commonly initiated when about 10 percent of the black seed are visibly exposed in the umbel. This corresponds to a seed or whole umbel moisture content of approximately 65 percent. Shattering increases sharply below a seed or umbel moisture content of 50 to 55 percent. Umbels are cut by hand or machine with approximately 6 inches (15 cm) of the seed stalk (*scape*) attached, transferred to trailers, and removed immediately from the field. They are piled approximately 6 to 10 inches (15 to 25 cm) deep on large canvas or plastic tarps and dried under ambient conditions for 2 to 3 weeks. Canvas tarps are preferable since plastic allows less air movement through the tarp. The piles are turned frequently with pitchforks. After drying, the umbels are threshed using conventional combines and partially cleaned (*scalped*). The seed is then transported to a seed company's cleaning and milling facilities for further processing. Milling will result in the removal of additional material, generally 10 to 20 percent by weight.

Onion seed generally has a relatively short storage life, and viability decreases rapidly at high temperatures or high humidities. To retain seed quality, the grower should dry the seed quickly after harvest, while at the same time preventing the excessive buildup of heat on the tarps. Frequent (daily) turning and shading of the harvested umbels will help maintain high seed quality. Fans can be used to circulate the air and lower the humidity to speed drying. In climatic areas with persistently high humidity, forced-air drying may be necessary.

POSTHARVEST HANDLING AND STORAGE

When the seed is delivered from the grower to the processor/packager, a moisture sample is taken to ascertain that the seed is dry enough to prevent it from heating up during bulk storage. The general goal is to deliver seed with no more than 8 to 9 percent moisture content. If necessary, the seed can be dried further using forced air. An air screen cleaner separates the trash and light seed from the good seed. The seed is then passed across a gravity table separator to remove any remaining contaminants or light seed. If the seed is not sufficiently clean after these operations, and particularly if it contains noxious weeds, it may be run through the previous steps again or through a disk separator or some other specialized cleaning apparatus, depending upon the particular contaminant present. Any seed cleaning operation removes good seed along with the contaminant, so growers and processors/packers use only the minimum number of steps required to meet the desired purity standards.

After cleaning, new samples are analyzed for moisture, germination, and purity. If the results are below standards, further milling may be required to remove low-quality (generally lighter) seed. Once minimum germination standards are achieved (commonly 85%), the moisture content is checked again and brought to 6 to 7 percent before the seed is placed in storage bins. From bulk storage, the seed can be treated with pesticides using either slurry or film coating methods and packaged in metal cans or plastic buckets. Smaller quantities may be sealed in foil or plastic laminated packets. Because of the short storage life of onion seeds and their sensitivity to heat and humidity, care must be taken to protect the seeds from high humidity (using sealed packaging) and from high temperatures during shipping and storage.

MARKETING

Onion seed is grown under a contract between the grower and a seed company. The contract stipulates variety, acreage, quality standards (germination, purity, weed seeds, etc.), and the pricing structure. Pricing is commonly tiered, with a higher price for the first increment of yield per acre and a lower price for successive increments in yield. For example, hybrid seed production may be contracted for approximately $20/lb for the first 300 lb/ac and $10/lb for yields in excess of 300 lb/ac. Open-pollinated seed would be contracted for less than one-half of that price. The grower is responsible for all production inputs, and the seed company provides the parent seeds or bulbs, technical advice, and variety information. Final marketing of the seed is the sole responsibility of the seed company.

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Insecticide use in hybrid onion seed production affects pre- and post-pollination processes

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Abstract

Research on threats to pollination service in agro-ecosystems has focused primarily on the negative impacts of land use change and agricultural practices, such as insecticide use, on pollinator populations. Insecticide use could also affect the pollination process, through non-lethal impacts on pollinator attraction and post-pollination processes such as pollen viability or pollen tube growth. Hybrid onion seed (*Allium cepa* L., Alliaceae) is an important pollinator-dependent crop that has suffered yield declines in California, concurrent with increased insecticide use. Field studies suggest that insecticide use reduces pollination service in this system. We conducted a field experiment manipulating insecticide use to examine the impacts of insecticides on (1) pollinator attraction, (2) pollen/stigma interactions and (3) seed set and seed quality. Select insecticides had negative impacts on pollinator attraction and pollen-stigma interactions, with certain products dramatically reducing pollen germination and pollen tube growth. Decreased pollen germination was not associated with reduced seed set; however, reduced pollinator attraction was associated with lower seed set and seed quality, for one of the two female lines examined. Our results highlight the importance of pesticide effects on the pollination process. Over-use may lead to yield reductions through impacts on pollinator behavior and post-pollination processes. Overall, in hybrid onion seed production, moderation in insecticide use is advised when controlling onion thrips, *Thrips tabaci,* on commercial fields.

Keywords: Pollination, seed production, pesticide, *Apis mellifera*, *Allium cepa*, *Thrips tabaci*

Pollination is a key ecosystem service that increases yields for a large number of agricultural crops worldwide (Klein et al. 2007). Research on threats to pollination service in agro-ecosystems has focused primarily on the impacts of land use change and agricultural practices such as insecticide applications on pollinator populations (i.e. Kremen et al. 2004, Blacquiere et al. 2012, Klein et al. 2012, Whitehorn et al. 2012). Besides negatively impacting pollinator populations and their delivery of pollination (Brittain et al. 2010, Tuell and Isaacs 2010), insecticide use may also have non-lethal impacts that affect the pollination process pre- or post-pollen deposition. For example, pesticides might render crops unattractive to a major pollinator (Long and Morandin 2011), or negatively impact post-pollination processes such as pollen germination. Such impacts have received very little attention and given the potential for new insecticides to come into use, or for applications to increase in certain crops in response to emergent pests or diseases (i.e. Desneux et al. 2010), better understanding of these impacts is crucial.

Post-pollination impacts of pesticides could operate through pollen, stigmas or the interaction of the two. Both pollen and the stigmatic tissue may be susceptible to damage by pesticides, which could reduce pollen germination, pollen tube growth, and ovule fertilization, resulting in reduced seed set and crop yield. Research on fungicides has shown that application directly to stigmas negatively affects pollen tube growth in apple flowers and can damage the cellular structure of almond stigmas, inhibiting receptivity (Yi et al. 2003a, b, c). If insecticides have similar impacts on pollen or stigmatic tissue, they could similarly reduce seed set; yet such impacts on plant tissue have not been examined to our knowledge.

Hybrid onion seed is a small acreage, high-value crop in California’s Central Valley (Voss et al. 1999) dependent on the honey bee (*Apis mellifera*, L., Hymentoptera, Apidae) for successful pollination and seed yield. Seed yields in the region steadily declined between 2003 and 2008, despite an increase in acreage (Long and Morandin 2011). These declines coincided with a marked increase in insecticide use to control the onion thrip (*Thrips tabaci* Lindeman, Thysanoptera; Thripidae) to prevent transmission of iris yellow spot virus, a recently introduced disease (Gent et al. 2006, Long and Morandin 2011). An observational study conducted at farms in Yolo and Colusa counties in California showed that high insecticide use decreased flower visitation to onions by honey bees, with a correlated decrease in seed yield (Long and Morandin 2011). Insecticides are applied pre-bloom in this system and honey bee hives are placed in fields at high densities; thus, it is unlikely that insecticides are directly affecting pollinator numbers. Rather, some reduction in attractiveness due to pesticide residues is likely the mechanism. It is unknown whether insecticide impacts on pollen tube growth are an additional source of yield declines.

To address these questions, we conducted a replicated field experiment manipulating insecticide use to determine its effects on pollination of hybrid onion seed. We examined the impacts of insecticides on (1) pollinator attraction, and (2) post-pollination pollen/stigma interactions and (3) seed set and seed quality.

Materials and Methods

Study system.

Onion, *Allium cepa* L. (Alliaceae) is a self-compatible, biennial hermaphrodite (Zomlefer 1994) grown commercially for its edible bulb and leaves in many different parts of the world (Griffiths et al. 2002). Hybrid seed, which supplies edible onion plantings, is grown in commercial fields that are pollinated primarily by honey bees (Parker 1982). Seed plants produce one or more flowering stalks per bulb, each ending in an umbel, consisting of hundreds of florets, each of which can produce up to six seeds (Griffiths et al. 2002). Hybrid crosses are achieved by planting male fertile onion lines (the pollen donor) next to male sterile lines (female, seed producing) (Voss et al. 1999). For simplicity, we refer to them as male (male fertile) and female (male sterile) plants throughout this study. Only seeds from the female line are harvested. Seed production thus requires pollen transfer from male to female lines by insect pollinators.

Experimental Design.

The study took place at the University of California Davis vegetable crops research farm, Yolo County, California. Onion bulbs were planted on October 2010, according to standard practices (Voss et al. 1999). The experimental field was divided into 75 (6.1 x 3.8 m) plots, organized into 5 blocks of 15. Each plot had two female and two male rows planted on 30-inch (76.2 cm) beds and surrounded by a 1.5 m tilled buffer. One line of yellow onion bulbs was used for male plants (VON-095-G-122C-S2Y) and two lines for the female rows, one in blocks 1-3 (VON-108A-S3Y, “Female type A”) and another in blocks 4-5 (VON-163A-L1Y, “Female type B“). Herbicide was applied to tilled buffers in the fall and mechanical weed control was used in buffers during the spring. Late spring rains caused high levels of infection by downy mildew, which we treated with fungicides ethylene bisdithiocarbamate three weeks before observations and azoxystrobin two days before. Male plants, were infected more severely by the fungus than females. The experiment was flood irrigated twice during bloom.

Treatments.

We tested five conventional insecticides and two organic pesticides all of which are currently applied by growers in California to control thrips pests on onions (Table 1; Orloff et al. 2009), We also tested a plant growth hormone that is being considered for use in onion. We selected two of the conventional insecticides, to conduct additional manipulations of spray number (lambda-cyhalothirn) and spray timing (methomyl; Table 1). Every plot within received a single treatment, randomly assigned within each block. All selected pesticides have different active ingredients belonging to different chemical groups and insecticide categories (IRAC 2011).

Pollinator activity.

We placed nine honey bee hives at one side of the study field on June 6th, 2011, giving a density of ~ 10 hives/acre, equivalent to that seen in commercial fields in the region. Observations of pollinator activity started when ~5 % of florets on female umbels and ~50% of florets on males were flowering (June 10th, 2011) and continued until flowering was finished 17 days later for males (June 27th, 2011) and 20 days later for females (June, 30th 2011). In total, all plots were observed six times for males and seven times for females.

We quantified pollinator activity separately in male and female rows in each plot. Visitation was observed for five minutes in a 1 m x 0.75 m quadrat approximately twice a week during peak bloom. In each scan we counted the number of visitors entering the plot and timed the duration of umbel visits. If possible we measured the time individual pollinators spent on multiple umbels. Pollinators were identified to family and morpho-groups (subdivided by honey bees, non-Apis bees, syrphid flies, other flies, beetles and other groups), and we collected samples of visitors and identified each to genus or species. However, visitation from groups besides honey bees was infrequent, thus we analyzed total flower visitors, including honey bees, then honey bee visitation only. We simultaneously recorded the number of umbels blooming in each plot. Temperatures averaged about 25^{o}-35^{o}C during the experiment and we conducted observations only on sunny/light cloud days, with light wind.

We calculated the total number of visitors in either the male or female plots during each observation period, as well as the number of honey bees separately. For time spent per umbel, we only had sufficient data on honey bees to analyze treatment effects. Where we had multiple umbel-visits for some individual honey bees, we averaged time spent per flower within a bee first, then calculated the average time for all bees across the plot for each observation period.

Pollen germination.

To isolate potential effects of insecticides on post-pollination processes acting through pollen versus stigma/style effects we used reciprocal pollen germination tests from insecticide sprayed and unsprayed plants. We bagged a large number of unsprayed umbels in untreated buffer rows, as well as 5 umbels in each of our plots, excluding the manipulations of timing and spray number. Individual receptive florets were excised from umbels, placed in water and brought into the lab for hand pollination. To test for impacts of insecticides on the style, 5 receptive styles from each treatment plot were hand-pollinated with control (untreated) pollen (n = 25 florets total). To test for effects acting through pollen, 5 control (untreated) stigmas were pollinated with pollen from each insecticide-treated plot (n = 25 florets each). Each stigma was gently brushed with pollen collected from several flowers and the pollinated floret placed in water in the lab at room temperature for 24 hours to allow pollen to germinate and pollen tubes to grow. After 24 hours, the style and part of the ovary were excised from the floret, fixed in 70% ethanol, and stored at 4°C until staining.

To visualize pollen tubes, we followed the methods of Kho and Baer (1968), softening washed stigmas for one hour at room temperature in 1 N NaOH for 1 hour, then staining rinsed stigmas for 24 hours in 0.05% analine blue (water soluble) dissolved in 0.1 K_3PO_4. We gently squashed stigmas with a coverslip in a drop of staining solution. We then counted germinating pollen grains and pollen tubes growing to the base of the style under a fluorescent-light microscope (Nikon E800 with wide-band UV-filter).

Seed characteristics.

We quantified seed set in each plot from a random sample of umbels tagged prior to flowering. After seeds ripened, we collected and dried tagged umbels individually then threshed seed heads and counted viable seeds. We also weighed seeds and tested a subsample for germination. To test germination, we placed twenty-five seeds from each umbel between layers of wet germination paper in petri dishes, then set in a growth chamber set at 20°C to germinate. The number of seeds with emerging roots were counted after 5, 7 and 10 days.

Statistical Analysis.

Visitation. Because male and female plants differed in phenology and disease severity, all analyses of visitation were conducted separately by gender. We examined the effects of insecticide use on three different metrics of visitation: total visitors per 5-minute observation, honey bee visitors per 5-minute observation period, and the duration of honey bee visits. The distributions for total visitors and honey bee visitors were non-normal and the relationships between response variables, date and time were frequently non-linear. Therefore, for these responses, we used general additive models with a negative binomial distribution. Poisson or quasi-Poisson distributions could not be used because of the magnitude of over-dispersion in our data (gamm, mgcv package, R-Development-Core-Team 2009, Zuur 2009, Wood 2011). Honey bee visit duration was normalized by log transforming and was analysed with a gamma distribution.

All models included fixed categorical insecticide treatment and block variables. Continuous explanatory variables were: date of observation, time of day, fungal status as mean of two records taken for each plot, position of plots relative to the hives and number of open umbels in the plot. Because block was confounded with female type it was treated as a fixed effect. Position relative to the hives was included because hives were all placed at one end of the field, potentially creating a gradient within blocks. Date and time were initially modelled as non-linear effects using smoothing terms. When smoothing terms were not significant they were instead modelled as linear variables. In order to determine whether changes in response variables over time differed by treatment, we modelled date within treatment. If there was no variation among treatments, the within-treatment date effect was dropped. Finally we included a treatment by block interaction and a treatment by fungal disease interaction. Non-significant interactions were dropped, following the recommendations of Zuur et al. (2009), to avoid overfitting of our models.

Pollen germination. We examined how insecticide treatments impacted control pollen germination and pollen-tube growth on styles from treated plots using zero-inflated negative binomial models (hurdle, pscl package, R-Development-Core-Team 2009, Zuur 2009). Insecticide treatment and block were again used as explanatory variables. Response variables included number of germinated pollen grains on the stigma and number of pollen tubes reaching the base of the style. Zero inflated models test impacts of insecticide treatments or block first on pollen tubes as a binary variable, then test the quantitative differences among stigmas that had any pollen germinate. For pollen from treated plots germinated on control stigmas, very little pollen germinated, so these data were analyzed using simple binomial models with pollen germinated, or pollen reaching the base, as response variables and block and treatment as explanatory variables.

Seed characteristics. All seed data were normally distributed, so were analyzed with standard ANOVA (glm, stats package, R). All models included fixed categorical insecticide treatment and female type variables and their interaction, and fungus status and position as a continuous variable. We used the same models for seed weight and germination, but added seed number as a continuous explanatory variable. Because female types differed drastically in seed set, fungal status and visitation rates, where there was a significant female type by treatment interaction, we split the data by female line and re-analyzed, excluding block from the model.

Results

Visitation: Female plants.

Insecticide treatments did not significantly affect the total number of visitors to female plots (Table 2). Total visitors increased linearly with the number of open flowers and was non-linearly related to sampling time, with peak visitation at midday. Total visitation also increased non-linearly with date, saturating at later dates, and the effects of date did not vary between treatments. Honey bee visitation results mirrored those for total visitors (Table 2).

The duration of honey bee visits to female umbels was significantly shorter than controls for spirotetramat (-9.34 s, $P < 0.05$) and urea (the plant growth regulator (-0.04 s, $P < 0.01$). The change in the duration of visits over sampling dates varied among treatments. Visit duration increased over the experiment for essential oils ($F = 2.785$, $P < 0.05$), methomyl week pre-bloom ($F = 4.679$, $P < 0.001$) and 4 and 6 applications of lambda-cyhalothrin ($F = 2.943$, $P < 0.01$ and $F = 5.071$, $P < 0.001$ respectively), but it did not change in control plots ($F = 0.042$, $P = 0.92$).

Visitation: Male plants.

There was a significant treatment effect for total visitors to male plants. Specifically, plots treated with essential oils, or with lambda-cyclohathrin six times were visited significantly less than the controls (estimate = -2.609, $P < 0.05$ and estimate = -3.679, $P < 0.01$ respectively; Fig. 1). Furthermore, visitation increased with the number of open flowers, and increased non-linearly over time. There was a significant negative effect of fungal infection on visitation to male umbels, which was more pronounced in plots treated six times with lambda-cyclohathrin (significant treatment x fungus interaction). The pattern for honey bees was qualitatively similar. No factor affected honey bee visit duration in male plots.

Pollen germination.

Pollen germination and tube growth were affected only through styles on treated female plants (Table 3), not via impacts on pollen from treated plants (statistics not shown: all $P > 0.05$). Untreated pollen had a lower probability of germinating on the stigmas of flowers from plants treated with methomyl (binomial model; Table 3B) and fewer grains germinated on stigmas from plants treated with acetamiprid and spinetoram (count model; Table 3; Figs. 2A &B). Fewer pollen tubes reached the base of the style of flowers in plots treated with acetamiprid, spirotetramat, methomyl and lambda-cyhalothrin compared to controls. There were marginally significant, but notable effects of methomyl on the probability of tubes reaching the base of the style (Fig. 2C; Table 3). Curiously, flowers from plots treated with methomyl had higher numbers of pollen tubes reaching the base of the style than controls - but this was driven by only one stigma out of 25 that had high numbers of pollen tubes - the rest had zero (Fig. 2D). Females of type B had significantly fewer pollen tubes reaching the base of the style overall.

Seed characteristics.

Seed set and weight both showed significant effects of pesticide treatment and but these differed by female type (Table 4). Seed characteristics of female type A were not affected, those of female type B were. For females of type B, seed set was significantly lower than the control for

3x lambda-cyhalothrin plots, and marginally significantly lower for lambda-cyhalothrin 4x and 6x plots (Table 5). Conversely, seed set was higher than control in spirotoram treated plots (Fig. 3A, Table 5). Seed weight for females of type B was significantly lower than the control for plots treated with methomyl at 2 and 5 weeks and for plots treated with essential oils and with lambda-cyhalothrin 6x (Fig. 3B, Table 5).

For seed germination, again there were significant treatment-by-female type interactions for 5, 7 and 10 days germination tests (all $p < 0.001$; Supp. Table S1). There was a significant effect of treatment for females of type A and type B at 5 days ($F = 1.914$, $P < 0.05$; $F = 3.44$, $P < 0.001$ respectively). Seeds from females sprayed with methomyl 5 and 8 weeks before flowering showed higher seed germination than the controls. Conversely, seeds of females of type B treated with urea, spirotetramat, essential oils, and lambda-cyhalothrin four or six times all had higher germination than the controls (Fig. 3C, Supp. Table S2). At 7 days, the pattern was qualitatively similar - except that the significant effect of lambda-cyhalothrin six times for type B disappeared (Supp. Table S2). At 10 days, most significant treatment effects disappeared, with the exception of the positive effect of methomyl on female A, and urea on female B (Supp. Table S2).

Discussion

Our experimental approach confirmed our hypothesis that insecticide use can impact both pollinator visitation and on post-pollination processes; however, those effects depend upon how frequently chemicals are applied and the specific type used. The highest spray rates (lambda-cyhalothrin six times) had overall negative effects on visitation to males, supporting the observation that excessive insecticide use was negatively affecting honey bee visitation in commercial fields in 2009 (Long and Morandin 2011). Essential oils reduced visitation to males as well. However, no treatment affected visitation to females, which differs from previous finding where visitation to males and females were similar (Long and Morandin 2011). Certain insecticides also changed honey bee behavior on female flowers, some by reducing visit duration throughout the experiment, others by only reducing visit duration early in the experiment, an effect that appeared to degrade over time.

Interestingly, the specific products that affected pollinator behavior were not always those considered the most toxic to pollinators. Several are traditional insecticides, whereas essential oils are an organic certified biopesticide (http://www.omri.org/), while urea (Bioforge) has no insecticidal activity. Yet all had potentially negative impacts on pollinator behavior that seems to translate into reduced seed set. The negative impact of urea on visitation is surprising because it is a plant growth regulator, not an insecticide. Possibly, it changes floral rewards and thus impacts the time bees spend on a flower. Overall, these patterns suggest that insecticides may have a general repellent effect that is not dependent on toxicity. This indicates that growers cannot necessarily simply replace one product with one of lower overall toxicity to avoid negative effects on bee behavior – rather, reductions in overall spray number may be necessary.

Our data provide interesting insight into the results of Long and Morandin (2011) from commercial seed fields. First, insecticide use in our experiment had less dramatic impacts on visitation than was seen in their study. This may be in part because their study included higher spray levels (>8 application) than ours (maximum 6 applications). Furthermore, in order to identify specific chemicals that repel pollinators, we treated each plot with a single product. In commercial production fields growers apply a mixture of different classes of insecticides, and rarely use the same one more than once. Complex combinations of pesticides may have synergistic repellency that we did not see in our experimental data. However, in the field, the diversity of insecticides applied is highly correlated with the number of applications (S. Gillespie, unpublished data), meaning teasing apart this relationship will require additional experiments.

Several pesticide treatments had strong negative effects on pollen germination and pollen tube growth. This is surprising, given that treatments were applied pre-bloom, and thus did not directly contact the stigmatic surface, unlike in previous studies documenting fungicidal impacts on pollen tubes (Yi et al. 2003a, c). Rather, our insecticidal sprays occurred when umbels were in the pre bud and bud stage. The products that significantly reduced germination all appear to have either systemic or translaminar effects, meaning that they are designed to penetrate plant tissues either locally in the case of translaminar movement, or throughout the plant in the case of systemic insecticides. Thus they may penetrate the stigmatic tissue and cause cellular damage, even as it is developing in the bud stage. Little is known about the potential for pesticides with translaminar movement or systemic effects to have impacts on developing flowers. Both the mechanisms and implications of these results need further investigation.

Though insecticide treatments reduced visitation and pollen tube growth, the seed set results suggest that impacts on visitation were ultimately more important for seed set. Treatments that dramatically reduced pollen tubes had no impact on seed set (i.e. methomyl), or showed even higher seed set than controls (spinetoram - female B only). This suggests that consistent pollinator visitation can overcome pollen tube impacts. Conversely, essential oils or lambda-cyhalothrin treatments reduced visitation to males, and reduced seed set and seed weight from females. This suggests that negative effects of pesticides on visitation to males had negative effects on ultimate seed set, while negative impacts on pollen tube growth did not translate into such changes. However, our data still raises concerns about the possibility of synergistic negative effects between pesticides. If a grower applies one product that reduces visitation and another that reduces pollen germination this could lead to particularly dramatic seed set reductions.

The negative effect on seed yield acting through visitation to male lines is intriguing - no treatment changed visitor number to females; however, we have evidence that visitation impacts in males changed ultimate seed set. For hybrid seed production, movement between male and female rows is essential for seed set (Free 1993), thus a reduction in visits to pollen producing flowers can reduce seed set in female rows. Our results highlights the need to investigate male and female function for understanding pollination processes.

Finally, it is important to note that any negative effects on seed set were only evident for one of our two female types – female type B. Given that female type B had low establishment, lower visitation, fewer pollen tubes, and greater disease severity compared to female A, it seems that plant stress, or other varietal difference such as vigor, compound the negative effects of insecticides on pollination service, leading to negative impacts on seed set or seed quality.

Insecticide use seems to have positive effects on the rate of seed germination. More seeds from treated plants germinated within 5 days; however, this effect was only maintained over ten days for two insecticides, each on a different female type (Supp. Table S1). In one case, the positive effect was from urea, the plant growth regulator meant to stimulate plant growth. It seems likely that this could lead to maternal effects on seed germination. In the other case it was methomyl sprayed 5 weeks pre bloom, but no other methomyl treatment. Given that differences disappeared rapidly for most treatments it seems as though treatments may simply accelerate seed germination relative to the control. The inconsistency in these patterns makes it difficult to conclude that a strong effect exists; however, clearly more investigation is needed.

Overall our results show that insecticides can negatively affect multiple stages of the pollination process. However, many factors, such as varietal differences, will determine whether this translates into negative impacts on seed yield. Our results highlight the importance of considering the indirect effects of pesticides on the pollination/fertilization process. Careful timing and rates of spray applications may minimize impacts on pollinator health, over-use might reduce seed yield.

Supplement: Detailed statistical tables for seed germination

Acknowledgements

Sakata Seed provided onion bulbs for the experiment. Kirsten Northfield, Andrea Shea, William Gross and Mark Kochi all assisted with field work and data collection. Funding was provided by grants awarded by the California Department of Food and Agriculture's Specialty Crop program (Grant SCB10031), funded by the U.S. Department of Agriculture, awarded to RL and NW, and support from the California Garlic and Onion Research Advisory Board.

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Tables

Table 1. Description of insecticide treatments.

Active Ingredient/manipulation	Commercial product	Chemical class	Penetration[a]	Application time[b]
No spray	Control	N/A	N/A	N/A
urea & potassium hydroxide	Bioforge	carbamide	N	8, 6 & 4
essential oils (cottonseed, clove, garlic)	Pest Out + Oroboost	hydrocarbons, terpenes, phenylpropanes	N	8, 6, 4 & 2
azadirachtin and neem	Aza-Direct	tetranortriterpen-toids	T	8, 6, 4 & 2
spirotetramat	Movento	keto-enoles	B	8, 6 & 4
acetamiprid	Assail 30 SG	neonicotinoids	B	8, 6, 4 & 2
methomyl	Lannate SP	carbamates	T	8, 6, 4 & 2
spinetoram	Radiant SC	spinosyn	B	8, 6 & 4
lambda - cyhalothrin	Warrior II	pyrethroids	N	8 & 4

Table 1 continued

Active Ingredient/manipulation	Application time°
methomyl, **2** weeks before bloom	2
methomyl, **5** weeks before bloom	5
methomyl, **8** weeks before bloom	8
3 x lambda - cyhalothrin	8, 7 & 4
6 x lambda - cyhalothrin	10, 8, 7, 5, 3 & 2

a. Weeks before bloom, start of blooming corresponds to start of observations.

b. N: None, S: Systemic, T: Translaminar, B: Both

Table 2: Effects of insecticide treatments on pollinator visitation and behavior in female and male plots.

	Females			Males	
Factor	Total visitors	Honey bee visitors	Time per flower	Total visitors	Honey bee Visitors
treatment	0.954	0.861	1.968*	2.144 *	1.424
Block	1.797	2.608 *	1.814	6.035 ***	5.464 ***
Open	5.646 *	3.912 *	-	36.426 ***	17.539 ***
Position	2.818 •	2.766 •	-	0.681	0.285
Fungus	0.586	1.738	-	8.218 ***	7.455 ***
Time (s)	14.79 ***	21.68 ***	-	-	-
Date (s)	34.65 ***	33.71 ***	-	8.61***	9.555 ***
treatment x fungus	-	-	-	2.092 *	1.413
treatment x block	1.291 •	1.324 •	1.415*	-	-

General linear models. All Values are F-values. • $P < 0.1$ * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Table 3: Impacts of treatments on control pollen germination and pollen tube growth on treated stigmas.

(A)		Pollen germination at tip			Pollen tubes to base		
Statistic	Factor	Estimate	z-value	*P*	Estimate	z-value	*P*
	Acetamiprid	-1.183957	-2.089	0.036667 *	-1.19531	-1.994	0.04314*
	Azadirachtin/neem	-0.161479	-0.290	0.771520	0.42483	1.047	0.2951
	Urea/KOH	0.366859	0.734	0.463157	0.33419	0.907	0.36425
Count	Methomyl	1.505670	1.362	0.173352	1.42596	2.601	0.00928**
model	Spirotetramat	-1.036313	-1.493	0.135361	-2.20097	-2.086	0.03700*
coeffecients	Essential oils	-0.062584	-0.092	0.926865	0.03052	0.070	0.94455
	Spinetoram	-1.516855	-2.250	0.024473 *	-0.75771	-1.133	0.25739
	Lambda-cyhalothrin	-0.501725	-0.873	0.382582	-1.20363	-2.225	0.02608*
	Female B	0.039945	0.123	0.902076	-0.65212	-2.338	0.01941*

Table 3 continued

(B)		Pollen germination at tip			Pollen tubes to base		
Statistic	Factor	Estimate	z-value	*P*	Estimate	z-value	*P*
	Acetamiprid	0.0518	0.801	0.423	-0.085	-1.151	0.250
	Azadirachtin/neem	0.0329	0.496	0.620	-0.043	-0.609	0.542
Zero hurdle	Urea/KOH	1.009	1.479	0.139	-0.015	-0.218	0.828
model	Methomyl	-2.389	-2.109	0.035*	-2.172	-1.910	0.056•
coefficients	Spirotetramat	-0.848	-1.226	0.220	-1.249	-1.591	0.115
(binomial w	Essential oils	-0.933	-1.272	0.203	-0.717	-0.969	0.333
logitlink)	Spinetoram	-1.360	-0.203	0.839	-1.067	-1.348	0.178
	Lambda-cyhalothrin	-5.236×10^{-16}	7.97×10^{-16}	1.000	-2.98×10^{-15}	-4.43×10^{-15}	1.000
	Female B	-0.0077	-0.223	0.824	0.124	0.329	0.742

Results of zero inflated negative binomial analysis. Coefficients represent difference relative to control for insecticide treatments, and relative to Female type A for female effect (n=250). • $P < 0.1$ * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Table 4: Effects of insecticides on seed set.

		Seed set			Seed weight		
Statistic	Factor	Combined	Female A	Female B	Combined	Female A	Female B
F-value	treatment	1.302	0.826	2.953***	2.340**	0.788	2.180*
	female type	3.773•	-	-	0.259	-	-
	seeds	-	-	-	9.649**	4.880*	2.936•
	position	3.724•	2.756•	1.808	0.778	0.306	1.768
	fungus	0.305	3.072•	0.526	0.208	5.838*	0.064
	treatment x female type	1.965*	-	-	1.793*	-	-
	treatment x fungus	1.176	-	-	2.576**	-	-

• $P < 0.1$ * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Table 5: Effects of insecticides on seed characteristics.

	Mean Seed number(±SE)		Seed weight (μg±SE)	
Treatment	Female A	Female B	Female A	Female B
control	293.03(±27.21)	199.10(±42.41)	3.89(±0.09)	3.78(±0.09)
acetamiprid	343.42(±44.85)	172.27(±40.26)	3.74(±0.10)	3.57(±0.13)
azadirachtin/neem	414.00(±43.68)	235.07(±65.55)	4.23(±0.16)	3.61(±0.13)
Urea and KOH	359.18(±43.18)	148.50(±31.69)	3.78(±0.14)	3.53(±0.13)
methomyl	419.26(±38.85)	114.80(±33.49)	4.01(±0.15)	3.64(±0.16)
spirotetramat	463.57(±66.24)	166.21(±33.07)	3.86(±0.16)	3.85(±0.14)
essential oils	372.26(±43.26)	135.23(±55.25)	3.72(±0.14)	3.09(±0.14)***
spinetoram	409.95(±50.06)*	332.20(±56.99)	3.69(±0.13)	3.77(±0.17)
lambda-cyhalothrin 3x	291.23(±59.04)*	82.93(±20.32)	3.74(±0.13)	3.62(±0.12)
lambda-cyhalothrin 4x	350.04(±44.23) •	90.00(±41.36)	3.92(±0.11)	3.44(±0.16)
lambda-cyhalothrin 6x	338.73(±33.64) •	87.80(±29.68)	4.01(±0.11)	3.23(±0.15)**
methomyl 2 week	366.17(±54.75) •	329.57(±93.87)	3.93(±0.18)	3.48(±0.18)*
methomyl 5 weeks	362.08(±42.47)	188.57(±55.20)	3.65(±0.12)	3.42(±0.14)*
methomyl 8 weeks	391.04(±43.24) •	297.07(±59.94)	4.00(±0.15)	3.70(±0.13)

Stars represent significant differences in treatments relative to control for insecticide treatments, from ANOVA analysis. • $P < 0.1$ * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Figure Captions

Figure 1: Average number of visitors to male flowers treated with varying numbers of applications of lambda cyhalothrin. Diamonds represent the mean, whereas horizontal bars show the median.

Figure 2: Insecticide use had significant impacts on the germination and growth of control pollen tubes on treated stigmas. Asterisks show treatments that were statistically different from the control in zero inflated negative binomial models, which simultaneously ask whether treatments differ in the likelihood of pollen germinating and in the number of pollen grains germinating. Thus, for germinating pollen grains, (A) shows how treatments differ in the probability of pollen germinating while (B) shows that, for stigmas with germinating pollen grains treatments differed in the number of germinating grains. For pollen tubes to the base (C) treatments differed in probability of tubes reaching the base and for (D) those stigmas with any pollen tubes to the base (thus excluding zeros), treatments also differed in the number of tubes to the base. Note that for Methomyl, the one stigma with any pollen tubes to the base had significantly more than the control. In bar plots (A and C), bars represent a proportion of 25 stigmas sampled. In boxplots (B and D), diamonds represent the mean, whereas horizontal bars show the median. Zeros are excluded from B and D, as the analysis only tests whether there is an impact on the number of pollen tubes where there was a least one germinated grain.

Figure 3: Pesticide effects on seed characteristics for female type B only. (A) Average seed set (± SE), (B) Average seed weight (μg ± SE), and (C) Average seed germination (proportion out of 25 germinated per umbel ± SE). Stars indicate significance relative to the control. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Figure 1

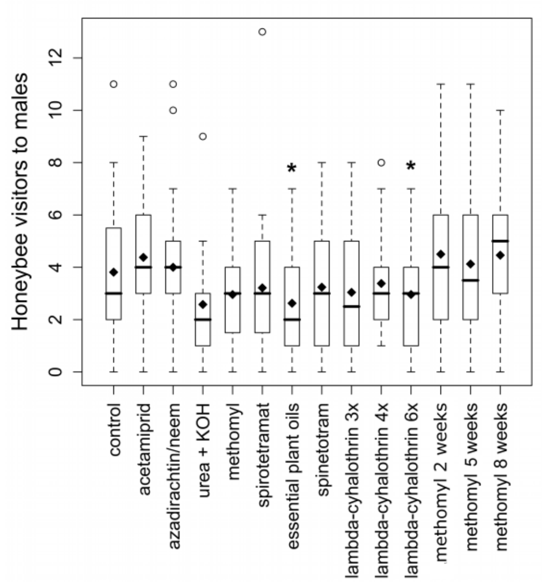
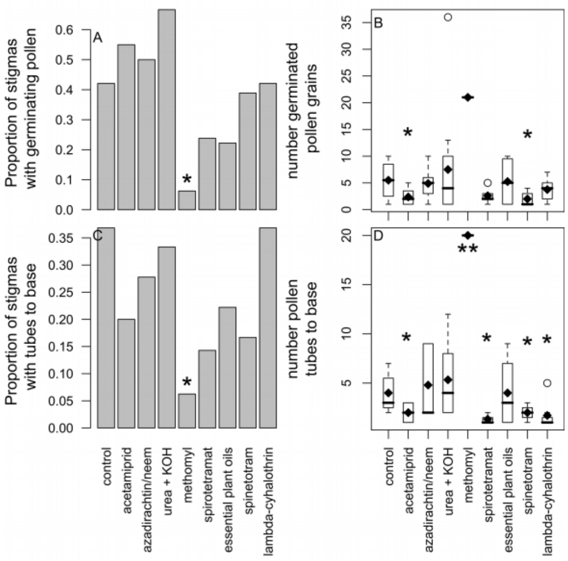
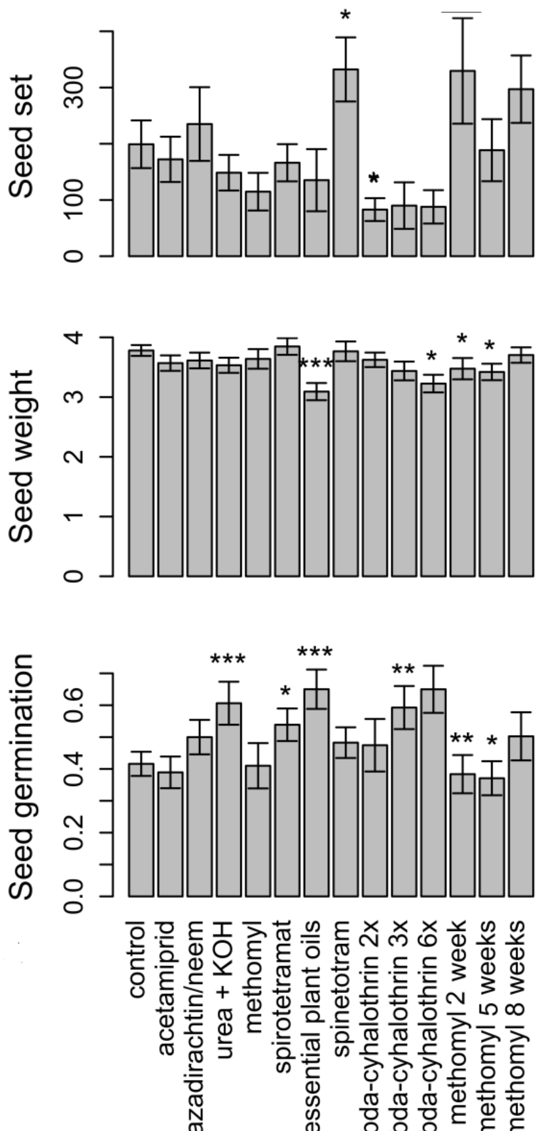

Honeybee visitors to males
0
2
4
6
8
10
12
control
acetamiprid
azadirachtin/neem
urea + KOH
methomyl
spirotetramat
essential plant oils
spinetotram
lambda-cyhalothrin 3x
lambda-cyhalothrin 4x
lambda-cyhalothrin 6x
methomyl 2 weeks
methomyl 5 weeks
methomyl 8 weeks
*
*

Figure 2



A
B
C
D
Proportion of stigmas with germinating pollen
number germinated pollen grains
Proportion of stigmas with tubes to base
number pollen tubes to base
control
acetamiprid
azadirachtin/neem
urea + KOH
methomyl
spirotetramat
essential plant oils
spinetotram
lambda-cyhalothrin

Figure 3


Seed set
0
100
300
Seed weight
0
1
2
3
4
Seed germination
0.0
0.2
0.4
0.6
control
acetamiprid
azadirachtin/neem
urea + KOH
methomyl
spirotetramat
essential plant oils
spinetotram
lambda-cyhalothrin 2x
lambda-cyhalothrin 3x
lambda-cyhalothrin 6x
methomyl 2 week
methomyl 5 weeks
methomyl 8 weeks

Cachuma Resource Conservation District

Your Local Partner in Conservation

Strawberry Production Manual

being produced for June 2013

Topics include:

- Local Production Calendar
- Business Management
- Cost of Production
- Market Trends and Outlets
- Food Safety
- Regulatory Compliance
- Site Establishment
- Plant Establishment
- Irrigation Management
- In-Season Fertilizer Management
- Pest and Disease Management
- Harvest and Post-harvest

Cachuma RCD will be soliciting feedback on draft versions of the manual beginning in April.
This manual will be available in both English & Spanish.

To contribute suggestions for manual content, please contact Julie Fallon
(805) 928-9269 Ext. 116 or E-mail: jfallon@rcdsantabarbara.org

RESOURCE CONSERVATION DISTRICT

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Cachuma Resource Conservation District

Your Local Partner in Conservation

A workshop for growers

Workshop: Nutrient & Pest Management

Date: August 22, 2012
Time: 9:00 am - 12:00 pm
Place: Shepard Hall (Santa Maria Public Library)
412 South McClelland Street,
Santa Maria, CA 93454-5116

9:00	Registration
9:30 - 10:15 am	Nutrient Managment *Mark Gaskell Ph.D. UCCE, Farm Advisor, Santa Barbara County*
10:15 - 11:00 am	Nutrient & Irrigation Water Management *Karen Lowell, Ph.D. Agronomist (Central Coast Cluster) NRCS-USDA*
11:00 am - 11:45 am	Manual Production Updates *CRCD - Misael Sanchez*
11:45 am - 12:00 pm	Pest Management *Surendra Dara Ph.D. UCCE, Farm Advisor, Santa Barbara County*
12:00 pm	Lunch will be provided

RSVP to Misael Sanchez at:
E-mail: msanchez@rcdsantabarbara.org
Phone#: (805) 868-3770

RESOURCE CONSERVATION DISTRICT

Presented by Cachuma RCD with a CDFA Specialty Crop Block Grant for Spanish-speaking strawberry growers
"The NRCS and the RCD are equal opportunity providers and employers"
Co-sponsored by University of California Cooperative Extension (UCCE) and the Natural Resources Conversation Service (NRCS)

Cachuma Resource Conservation District

Su Compañero Local en Conservación

Un taller para agricultores

Taller: Manejo de Nutrientes y Plagas en las Fresas

Cuándo: 22 de agosto de 2012
Hora: 9:00 am - 12:00 pm
Lugar: Shepard Hall
(biblioteca pública de Santa Maria)
412 Sur McClelland Street,
Santa Maria, CA 93454-5116

9:00	Registración
9:30 - 10:15 am	Manejo de Nutrientes *Mark Gaskell Ph.D. UCCE, Condado de Santa Bárbara*
10:15 - 11:00 am	Presupuesto de Fertilizantes y Manejo de agua en el riego *Karen Lowell, Ph.D. Agronomist (Grupo de la Costa Central) NRCS-USDA*
11:00 am - 11:45 am	Video de La Prueba Rápida de Nitrato, Actualizaciones del Manual de Producción de Fresa para el Área de Santa María. Misael Sánchez, CRCD
11:45 am - 12:00 pm	Manejo de Plaga *Surendra Dara Ph D UCCE, Condado de Santa Bárbara*
12:00 pm	Almuerzo y Rifa

Para registrarse, para arreglos especiales, o si tiene preguntas, por favor comuníquese con Misael Sánchez antes del 15 de agosto: (805)868-3770 u MSanchez@rcdsantabarbara.org

Presentado por el Distrito de Conservación de Recursos de Cachuma(CRCD) , CDFA-SCBG
Co-patrocinados por USDA-NRCS y la Cooperativa de Extensión de la Universidad de California (UCCE).
"El Servicio de Conservación de Recursos Naturales (NRCS, por sus siglas in inglés) y el Distrito de Conservación de Recursos de Cachuma (CRCD, por sus siglas in inglés) son empleadores y proveedores que dan oportunidades iguales

RESOURCE CONSERVATION DISTRICT

Nutrient Management Workshop Aug. 2012

Cachuma Resource Conservation District

Your Local Partner in Conservation

A Workshop For Strawberry Growers
Translated in Spanish

Workshop: Field Day - Pest Management

Date: October 16, 2012
Time: 9:30 am - 12:30 pm
Place: Oso Flaco Rd - Del Campo Berry Farms

9:30 - 10:30 AM Lygus Bugs

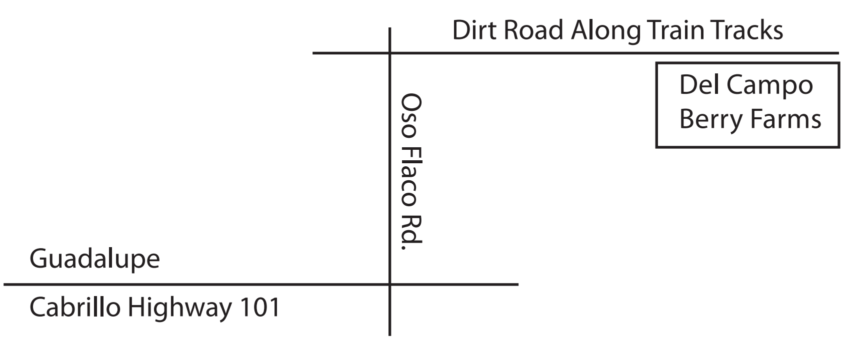
Surendra Dara- UCCE Farm Advisor, SB County & Misael Sanchez -CRCD

- Seasonal Timing and Contributing Factors of Infestations
- Scouting and Identification of Lygus Bug
- Different Alternatives for Control or Preventing Infestations
- IPM Practices

10:30 - 11:30 AM Mites

Surendra Dara- UCCE Farm Advisor, SB County & Misael Sanchez -CRCD

- Different types of Mites (Lewis, Two Spotted, etc)
- Seasonal Timing and Contributing Factors of Infestations
- Two Spotted Mites: Chemical Control and IPM Alternatives
- Beneficial Predatory Mites.



RSVP to Misael Sanchez at:
msanchez@rcdsantabarbara.org
Phone#: (805) 868-3770

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for Spanish-speaking strawberry growers
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RESOURCE CONSERVATION DISTRICT

Cachuma Resource Conservation District

Your Local Partner in Conservation

Un taller para los productores de fresas
Traducido en español

Taller: Día De Campo- Manejo de Plaga

Date: October 16, 2012
Hora: 9:30 am - 12:30 pm
Lugar: Oso Flaco Rd - Del Campo Berry Farms

9:30 - 10:30 AM Chinche Lygus

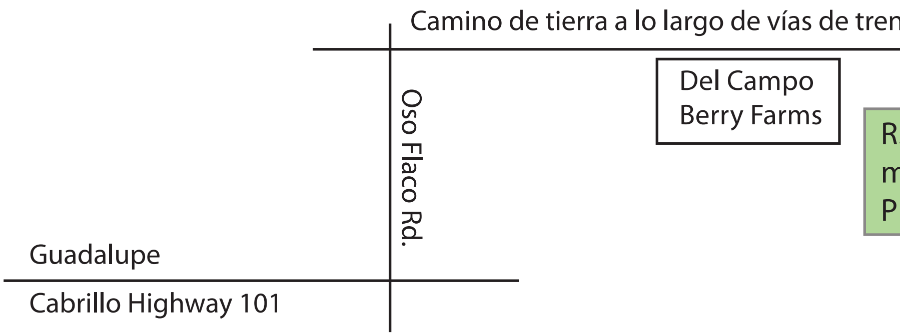
Surendra Dara- UCCE Farm Advisor, SB County & Misael Sanchez -CRCD

- Tiempo de la temporada y factores afectando la infestación
- Como identificar las etapas de la lygus y como buscarlos
- Diferentes alternativas para el control o prevenir infestaciones
- Practicas de IPM

10:30 - 11:30 AM Mites (ácaros arañas)

Surendra Dara- UCCE Farm Advisor, SB County & Misael Sanchez -CRCD

- Diferentes tipos de mites(Lewis, Dos Puntos, etc)
- Tiempo en temporada y factores contribuyendo a las infestaciones
- Arañas de dos puntos negros(two spotted mite)- Control químicos y alternativas de IPM
- Predadores benéficos



RSVP to Misael Sanchez at:
msanchez@rcdsantabarbara.org
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RESOURCE CONSERVATION DISTRICT

Field Day Workshop October 2012

Cachuma Resource Conservation District

Your Local Partner in Conservation

A Workshop For Strawberry Growers
Translated in Spanish

Workshop: Pathogens & Disease Management

Date: November 6, 2012
Time: 9:30 am - 11:30 am
Place: Best Western Hotel (Heritage Room)
1725 North Broadway
Santa Maria, CA 93454

9:30 AM	Registration
10:00 AM	Diagnosing Strawberry Diseases *Heather Scheck–Ag Comissioners Office SB County*
10:40 AM	Break (10 Minutes)
10:50 - 11:30 AM	Update on Strawberry Fungicide Trials *Surendra Dara –UCCE Farm Advisor SB County*

RSVP to Misael Sanchez at:
E-mail: msanchez@rcdsantabarbara.org
Phone#: (805) 868-3770

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RESOURCE CONSERVATION DISTRICT

Cachuma Resource Conservation District

Su Compañero Local en Conservación

Un taller para los productores de fresas
Traducido en español

Taller: Patógenos y enfermedades en fresas

Fecha: 6 de noviembre, 2012
Hora: 9:30 am - 11:30 am
Lugar: Best Western Hotel (Heritage Room)
1725 North Broadway
Santa Maria, CA 93454

9:30 AM	Registración
10:00 AM	Diagnosticando enfermedades en las fresas *Heather Scheck–Oficina del comisario de Agricultura en el condado de Santa Barbara*
10:40 AM	Descanso (10 Minutos)
10:50 - 11:30 AM	Actualización de fungicidas en fresas *Surendra Dara – de agricultura conserjero de UCCE en el condado de Ventura*

RSVP con Misael Sanchez al siguiente correo electrónico:
msanchez@rcdsantabarbara.org
teléfono: (805) 868-3770

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Seasonal occurrence of lygus bug

Cachuma Resource Conservation District

Your Local Partner in Conservation

A Workshop For Strawberry Growers
Presented in Spanish

Workshop: Business Management

Date: December 4, 2012
Time: 8:30 am - 12:30 pm
Place: Best Western Hotel (Heritage Room)
1725 North Broadway
Santa Maria, CA 93454

8:30 AM	Registration
9:00 AM	FSA Assistance *Daisy Lopez–Farm Service Agency (FSA)*
9:25 AM	Recordkeeping *Victor Hernandez–Farm Services Agency*
10:10 AM	Break (10 Minutes)
10:30 AM	Production Costs & Annual Market Trends *Mark Gaskell–UCCE Farm Advisor*
11:30 AM	Lunch (will be provided)

RSVP to Misael Sanchez at:
E-mail: msanchez@rcdsantabarbara.org
Phone#: (805) 868-3770

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Su Compañero Local en Conservación

Un taller para los productores de fresas
Presentado en español

Taller: Manejo de negocio

Fecha: 4 de diciembre, 2012
Hora: 8:30 am - 12:30 pm
Lugar: Best Western Hotel (Heritage Room)
1725 North Broadway
Santa Maria, CA 93454

8:30 AM	Registración
9:00 AM	Asistencia del FSA *Daisy Lopez–Farm Service Agency (FSA)*
9:25 AM	Mantenimiento de registros *Victor Hernandez–Farm Service Agency*
10:10 AM	Descanso (10 Minutos)
10:30 AM	Costos de producción *Mark Gaskell–conserjero de UCCE en el condado de Santa Barbara*
11:30 AM	Alumerzo será complementario

RSVP con Misael Sanchez al siguiente correo electrónico:
msanchez@rcdsantabarbara.org
teléfono: (805) 868-3770

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Business Management Workshop Dec. 2012

Cachuma Resource Conservation District

Your Local Partner in Conservation

A Workshop For Strawberry Growers
Presented in Spanish

Workshop: Nutrient Management

Date: Feb. 4, 2013
Time: 9:30 am - 11:30 am
Place: Shepard Hall (Santa Maria Public Library)
412 South McClelland Street
Santa Maria, CA 93454

9:00 am	Registration
9:30 am	Soil Nitrate Quick Test (SQNT) & Water Sample Analysis Procedure *Daniel Ibarra, Local Pest Control Advisor*
9:50 am	Group Activities *Karen Lowell, NRCS Area Agronomist for the Central Coast* *Daniel Ibarra, Local Pest Control Advisor* *Misael Sanchez,CRCD Technical Field Advisor*
10:10 am	Break (10 Minutes)
10:20 am	Calculating Fertilizer Conversions for Granular & Liquid Fertilizers *Karen Lowell, NRCS Area Agronomist for the Central Coast*
10:50 am	Group Activities *Karen Lowell, Daniel Ibarra, Misael Sanchez*
11:30 am	Lunch will be provided

RSVP to Misael Sanchez at:
E-mail: msanchez@rcdsantabarbara.org
Phone: (805) 868-3770

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RESOURCE CONSERVATION DISTRICT

Cachuma Resource Conservation District

Su Compañero Local en Conservación

Un taller para los productores de fresas
Presentado en español

Taller: Manejo de Nutrientes

Fecha: 4 de Febrero del 2013
Hora: 9:30 am - 11:30 am
Lugar: Shepard Hall (Santa Maria Public Library)
412 South McClelland Street
Santa Maria, CA 93454

9:00 am	Registración
9:30 am	Procedimientos de la prueba rapida de nitrato y analisis de agua *Daniel Ibarra, PCA Local*
9:50 am	Actividades de grupos *Karen Lowell, NRCS Agronomista para la Costa Central* *Daniel Ibarra, PCA Local* *Misael Sánchez, CRCD Consejero Técnico del Campo*
10:10 am	Descanso (10 Minutos)
10:20 am	Calculando conversiones de fertilizantes seco y líquidos *Karen Lowell, NRCS Agronomista para la Costa Central*
10:50 am	Actividades de grupos *Karen Lowell, Daniel Ibarra, Misael Sánchez*
11:30 am	Alumerzo será complementario

Pongase en contacto con:
Misael Sanchez
msanchez@rcdsantabara.org
(805) 868-3770

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RESOURCE CONSERVATION DISTRICT

Nutrient Management Workshop Feb 2013

Cachuma Resource Conservation District

Your Local Partner in Conservation

A Workshop For Strawberry Growers
Translated in Spanish

Workshop: Use and Refine Pest & Disease Management Sections of the Production Manual

Date: Feb. 22, 2013

Time: 9:30 am - 11:30 am

Place: Shepard Hall (Santa Maria Public Library)
412 South McClelland Street
Santa Maria, CA 93454

9:00 am	Registration
9:30 am	Welcome/Introductions/Housekeeping *Misael Sanchez, CRCD Technical Field Advisor*
9:40 am	Introduction to the Strawberry Production Manual *Misael Sanchez, CRCD Technical Field Advisor*
9:50 am	Pest Management Section *Surendra Dara, UCCE Farm Advisor*
10:30 am	Break (10 Minutes)
10:40 am	Disease Management Section *Surendra Dara, UCCE Farm Advisor*
11:30 am	Lunch will be provided

RSVP to Misael Sanchez at:
E-mail: msanchez@rcdsantabarbara.org
Phone: (805) 868-3770

1.5 CCA (IPM) credits have been approved
1.5 DPR (PCA) credits have been requested

RESOURCE CONSERVATION DISTRICT

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Cachuma Resource Conservation District

Su Compañero Local en Conservación

Un taller para los productores de fresas
Traducido en español

Taller: Uso y revisioń de marejode plagas y enfermedades de las secciones del manual de fresas

Fecha: 22 de Febrero del 2013

Hora: 9:30 am - 11:30 am

Lugar: Shepard Hall
(Biblioteca Pública de Santa María)
412 South McClelland Street
Santa Maria, CA 93454

9:00 am	Registración
9:30 am	Bienvenidos / Introducción / Anuncios Misael Sánchez, CRCD, Consejero Técnico del Campo
9:40 am	Introducción al Manual de Producción de Fresas Misael Sánchez, CRCD Consejero Técnico del Campo
9:50 am	Secciones de Manejo de Plaga Surendra Dara, UCCE Consejero Agrícola
10:30 am	Descanso (10 Minutos)
10:40 am	Secciones de Manejo de Enfermedades Surendra Dara, UCCE Consejero Agrícola
11:30 am	Alumerzo será complementario

Pongase en contacto con:
Misael Sanchez
msanchez@rcdsantabara.org
(805) 868-3770

1.5 horas de CCA CE créditos han sido aprovado
1.5 horas de DPR (PCA) CE créditos han sido solicitado

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RESOURCE CONSERVATION DISTRICT

Pest & Disease Management Workshop Feb. 2013

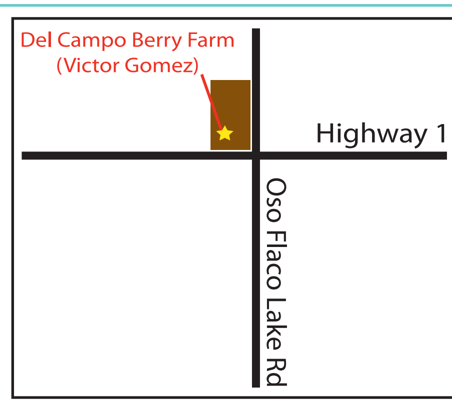
Cachuma Resource Conservation District

Your Local Partner in Conservation

A Workshop For Strawberry Growers
Translated in Spanish

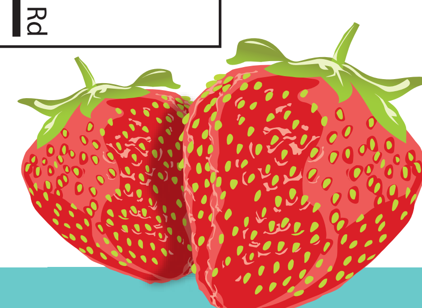
Workshop: Field Day
Control of Whiteflies & Mites
Date: March 21, 2013 **NEW DATE**
Time: 9:30 am - 11:30 am
Place: Oso Flaco Rd. and Highway 1
Del Campo Berry Farm - Victor Gomez

9:00 am	Registration
9:30 am	Welcome/Introductions *Misael Sanchez, CRCD Technical Field Advisor*
9:40 am	Chemical & Alternative Controls for Whiteflies *Surendra Dara, UCCE Farm Advisor*
10:30 am	Break (10 Minutes)
10:40 am	Chemical & Alternative Controls for Twospotted Spider Mites *Surendra Dara, UCCE Farm Advisor*
11:30 am	Lunch will be provided



RSVP to Misael Sanchez at:
E-mail: msanchez@rcdsantabarbara.org
Phone: (805) 868-3770

1.5 CCA CE credits have been approved
1.5 DPR CE credits have been requested



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Cachuma Resource Conservation District

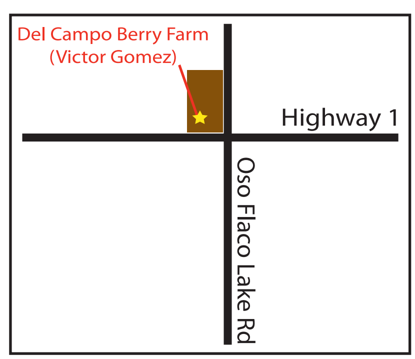
Su Compañero Local en Conservación

Un taller para los productores de fresas
Traducido en español

Taller: Día de campo control de moscas blancas y arañas (mites)

Fecha: 21 de Marzo del 2013 **FECHA NUEVA**
Hora: 9:30 am - 11:30 am
Lugar: Oso Flaco Rd. y Highway 1
Del Campo Berry Farm - Victor Gomez

9:00 am	Registración
9:30 am	Bienvenidos/Introducciones *Misael Sánchez, CRCD Consejero Técnico del Campo*
9:40 am	Químicas y alternativas de control de Moscas Blancas *Surendra Dara, UCCE Consejero Agrícola*
10:30 am	Descanso (10 Minutos)
10:40 am	Alternativas para el control de la Araña(Mite) de dos puntos negros *Surendra Dara, UCCE Consejero Agrícola*
11:30 am	Alumerzo será complementario



Para mas informacion y registracion
llamar a: Misael Sanchez
msanchez@rcdsantabara.org
(805) 868-3770

1.5 horas de CCA CE créditos han sido aprovado
1.5 horas de DPR CE créditos han sido solicitado

RESOURCE CONSERVATION DISTRICT

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Field Day Workshop Mar. 2013

Cachuma Resource Conservation District

Your Local Partner in Conservation

A Workshop for Strawberry Growers
Spanish Speaking

Workshop: Strawberry Production Manual Field Day
Date: June 27, 2013
Time: 9:00 am - 12:00 pm
Place: Jesus Hernandez-Rancho Alegre Berry Farms
HWY 1 South of Oso Flaco Rd (Signage)

RSVP to Misael Sanchez at:
E-mail: msanchez@rcdsantabarbara.org
Phone: (805) 868-3770

9:00 am	Registration
9:15 am	Welcome/Introductions
9:20 am	Business Planning *USDA- Farm Service Agency (FSA)*
9:35 am	NRCS-Cost Share Programs & Erosion Control *Phil Durgin, NRCS*
9:55 am	Food Safety *California Strawberry Commission (CSC)*
10:10 am	Break (10 Minutes)
10:20 am	Plant Establishment, Nutrient Management & Harvesting *Mark Gaskell, UCCE*
11:10 am	Irrigation Managment *Misael Sanchez, CRCD*
11:35 am	Pest and Disease Management *Heather Scheck, Agricultral Commissioners Office*
12:00 pm	Lunch

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Cachuma Resource Conservation District

Su Compañero Local en Conservación

Taller de Capacitación para los Agricultores
de Fresa de Habla Español

Taller: Manual para la Producción de Fresa – Día de Campo
Fecha: 27 de junio del 2013
Hora: 9:00 am - 12:00 pm
Lugar: Jesús Hernández-Rancho Alegre Berry Farms
HWY 1 al sur de Oso Flaco Rd.

RSVP a Misael Sanchez:
msanchez@rcdsantabarbara.org
(805) 868-3770

9:00 am	Registración
9:15 am	Bienvenida/Presentaciones
9:20 am	Plan del Negocio Agencia *Servicios Agrícolas del USDA (FSA)*
9:35 am	Programas de Compartición de Costos del NRCS y Control de Erosión *Phil Durgin, NRCS*
9:55 am	Inocuidad de los Alimentos *Comisión de Fresa de California (CSC)*
10:10 am	Intermedio (10 Minutos)
10:20 am	Establecimiento de la Planta, Cálculos de Nutrientes y Cosecha *Mark Gaskell, UCCE*
11:10 am	Manejo de Riego *Misael Sánchez, CRCD*
11:35 am	Control de Plagas y Enfermedades *Heather Scheck, Oficina del Comisionado Agrícola*
12:00 pm	Comida

RESOURCE CONSERVATION DISTRICT

Presentado por Cachuma RCD con una Subvención Especial del CDFA para Cultivos en Bloque para Agricultores de Habla Español. Copatrocinado por la Extensión Cooperativa de la Universidad de California (UCCE) y el Servicio de Conservación de Recursos Naturales (NRCS). "Los RCD, NRCS, UCCE Y FSA son proveedores y empresas equitativos."

Field Day Workshop June 2013






Attachment 1 –

Professional presentations

Gregoriou ME, Kakani EG, Lourou N, Zygouridis NE, Tsoumani KT, Zalom FG and Mathiopoulos KD. Olive fly resistance in organophosphate and Spinosad insecticides. Sixth International Symposium on Molecular Insect Science (October 2-5, 2011, Amsterdam, The Netherlands)

Zygouridis NE, Augustinos AA, Kakani EG, Zalom FG, Nestel D and Mathiopoulos KD. Adaptation of the olive fly, *Bactrocera oleae*, in new environments: lessons from the invasion in California and the colonization in laboratory conditions. Second International Symposium of TEAM (July 3-6, 2012, Kolymbari, Crete, Greece)

Gregoriou MG, Sagri E, Kouimanis C, Kakani EG, Zygouridis NE, Zalom FG and Mathiopoulos KD. Spinosad resistance in *Bactrocera oleae*. Second International Symposium of TEAM (July 3-6, 2012, Kolymbari, Crete, Greece)

Gregoriou ME, Sagri E, Kakani EG, Salpea K, Harokopos V, Zalom FG, Ragoussis J and Mathiopoulos KD. Spinosad resistance in the olive fly, *Bactrocera oleae*. XXIV International Congress of Entomology (August 19-25, 2012, Daegu, Korea)

Gregoriou ME, Sagri E, Kakani EG, Salpea K, Harokopos V, Zalom FG, Ragoussis J and Mathiopoulos KD. Spinosad resistance in the olive fly, *Bactrocera oleae*. 6th meeting of the IOBC-WPRS Working Group "Integrated Protection of Olive Crops" (May 12-16, 2013, Bečići, Budva, Montenegro)

Zalom FG. Managing the olive fruit fly, *Bactrocera oleae*, in California. Trans-Balkan Olive Symposium, Institute for Adriatic Crops and Karst Reclamation (June 3, 2013, Split, Croatia)

Extension presentations

Zalom FG. Olive fruit fly research update. (Sacramento Valley Olive Day. April 12, 2011, Orland, CA)

Zalom FG. Olive fruit fly research update. (San Joaquin Valley Olive Day. June 2, 2011, Tulare, CA)

OLIVE FLY RESISTANCE IN ORGANOPHOSPHATE AND SPINOSAD INSECTICIDES

M. E. Gregoriou[1]*, E. G. Kakani[1], N. Lourou[1], N. E. Zygouridis[1], K. T. Tsoumani[1], F. G. Zalom[2] and K. D. Mathiopoulos[1]

[1]*Department of Biochemistry and Biotechnology, University of Thessaly, Greece;*
[2]*Department of Entomology, University of California- Davis, USA*

❖ *Introduction*

The olive fruit fly *B. oleae* is the most important and destructive pest of cultivated olives in almost every country where olive trees grow. For the last 40 years, the management of the pest has been based on the use of organophosphate insecticides (OPs). However, the development of considerable resistance to OPs in *B. oleae* populations led to the introduction of alternative insecticides, such as pyrethroids and spinosad. The switch towards spinosad generated the obvious question: will resistance to this new insecticide develop the same way as to OPs?

❖ *Organophosphate Resistance*

Two mutations localized in the catalytic gorge of AChE of *B. oleae*, are known to confer resistance to organophosphate insecticides, I214V and G488S (Vontas et al., 2002). However, no correlation between mutation frequencies and resistance levels was observed (Kakani et al., 2008). In addition, it was demonstrated that certain detoxification systems did not play role in resistance to OPs (Vontas et al., 2001). These two observations indicated the possibility of additional mutations in the *ace* locus.

The search for additional mutations in the *ace* locus in highly resistant individuals revealed the presence of a new short deletion of nine nucleotides corresponding to three glutamine residues. This deletion (termed Δ3Q) lies in the putative exon X of the *ace* gene.

- The most striking fact about this mutation was that it is located at the C-terminal domain of the protein (Kakani et al., 2008). This domain is normally cleaved and substituted by a GPI anchor by which the enzyme is attached on the cell membrane.
- Expression of this mutation in cell lines and analysis of its biochemical properties showed that the deletion of glutamines improves the production of GPI anchored AChE and contributes to OP resistance in the olive fly.
- The working hypothesis is that the mutant Δ3Q fly produces more anchored molecules; the insecticide would inhibit a fraction of the enzyme, but leave a sufficient amount of active AChE molecules to metabolize ACh (Figure 1).

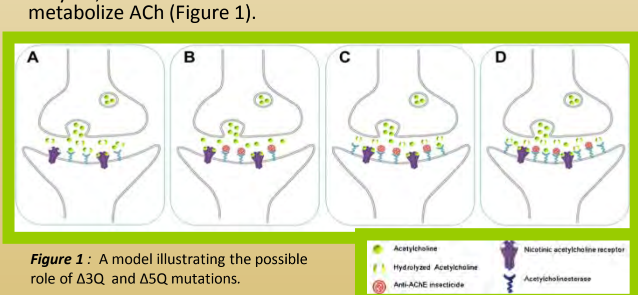
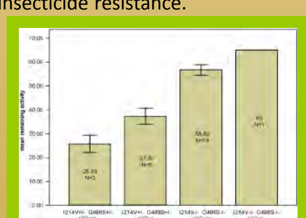


Figure 1 *:* A model illustrating the possible role of Δ3Q and Δ5Q mutations.

Post-translational modifications of AChE had been speculated in many cases of insecticide resistance; however, this is the first time that insecticide resistance is attributed to post-translational modifications, suggesting an entirely novel mechanism of insecticide resistance.

Clearly, the two mutations in the active site (I214V and G488S) play the most important role in OP resistance. However, the more copies of Δ3Q in a genotype the highest the resistance can get, as can be seen in the remaining AChE activity (after OP inhibition) of the multiple phenotypes, in the adjacent graph.



❖ *Spinosad resistance*

Spinosad's target is the nicotinic acetylocholine receptor. According to studies in *Drosophila melanogaster* (Perry et al., 2007) and *Plutella xylostella* (Baxter et al., 2010) resistance to Spinosad has been associated with mutations in the α6 subunit of nicotinic achetylocholine receptor. However, the α6 subunit of the nAchR does not seem to be spinosad's target in *Musca domestica* (Shono T., 2003). Which loci may be involved in spinosad resistance in the olive fly?

- Firstly, in order to determine whether resistance has developed in the olive fly, we performed bioassays on flies from California, Greece and Cyprus. In California, spinosad has been used since the fly's first appearance in 1998, whereas in Greece and Cyprus spinosad has only recently been introduced.

  As seen in Figure 2, up to 13-fold increase in resistance ratio is observed in areas in California, which have had the most extensive use of the drug.

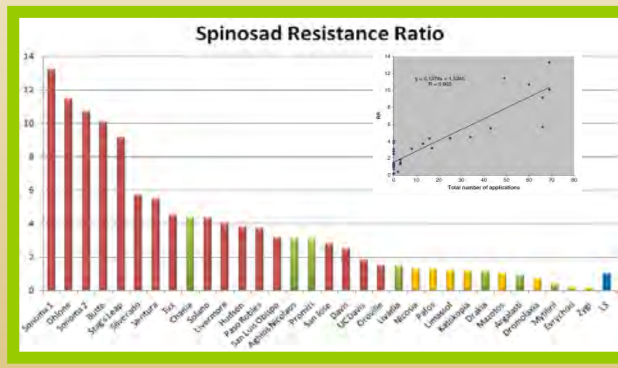
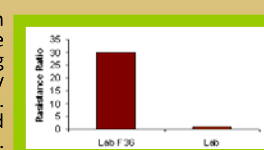


Figure 2 Spinosad resistance ratio (RR) in several places in California (red), Greece (green) and Cyprus (yellow). As seen in the inlet, RR linearly increases with the number of applications. If this rate remains constant, in a period of 40 years of continued spinosad treatments the flies will acquire a 60-fold resistance, exactly as it has been observed in Greece with OP resistance development.

- Secondly, a resistance laboratory strain is being developed, using the Demokritus laboratory strain as starting material. This strain is periodically enriched with field-collected flies. Increasing amount of spinosad is added in feeding water as selective pressure. After 36 generations of selection, resistance to spinosad is increased ~30-fold.



- Finally, using PCR primers based on *D. melanogaster*'s sequence we have currently isolated parts of α1, α6 and α7 AChE subunits. Sequence comparisons in resistant and susceptible individuals are under way.

❖ **References:**

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This research was supported by a Research Potential Support Program of the General Secretariat of Research and Technology of the Ministry of Development, Greece , an SCBG Program of the California Department of Food and Agriculture and the Graduate Programs of the Biochemistry and Biotechnology Department of the University of Thessaly.

SPINOSAD RESISTANCE IN BACTROCERA OLEAE

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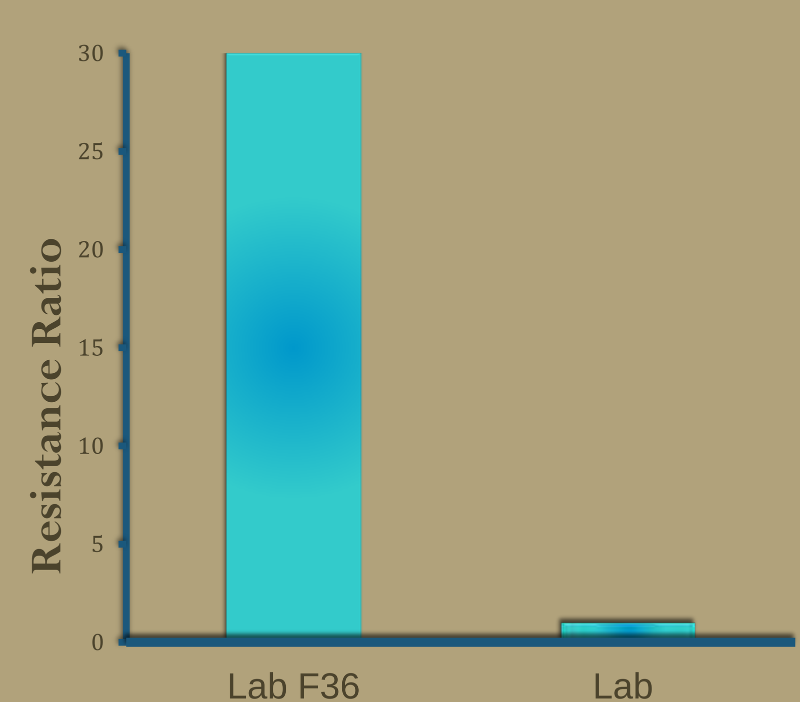
The olive fruit fly *Bactrocera oleae* is the most important and destructive pest of cultivated olive trees, in almost every country where olive trees grow. For the last 40 years, the management of the pest has been based on the use of organophosphate insecticides. However, the increasing awareness of the society against environmental problems turned the industry to the development of environmentally friendly insecticides. A very promising naturalyte insecticide with particular targeted toxicity towards the olive fly is Spinosad. It is a stomach poison with some contact action which kills insects through the activation of acetylcholine nervous system through nicotinic receptors. As it has happened for all types of insecticides, the extensive use of Spinosad would lead to the development of resistance. Low level of spinosad resistance has been demonstrated in flies caught in several California counties where the drug is the only insecticide used for the control of the fly.

In order to determine the mechanism of spinosad resistance in the olive fly we investigated the role of general esterases and we cloned the α6 nicotinic acetylocholine receptor in sensitive and resistant strains, a putative target of spinosad.

Selection of a Resistant strain

A ~30-fold spinosad resistant strain of *Bactrocera oleae* was obtained after continuous selection of increasing insecticide doses through drinking water. As a starting material we used flies from the "Demokritos" strain that was regularly enriched by wild flies from Greece and California.



Role of General Esterases

The differential expression of the esterase activity in male and female flies of both the spinosad sensitive and resistant colonies was determined by polyacrylamide gel electrophoresis. Fly heads were homogenized in non-denaturing lysis buffer, electrophoresed in 7,5 % native gels and incubated with α- or β-naphthyl acetate as substrate, in order to determine the presence of α- or β- esterases (Figure 1).

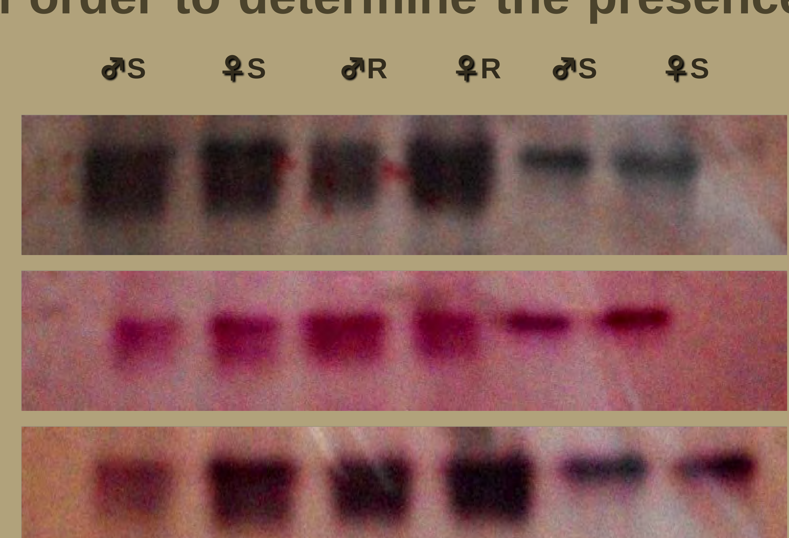


Figure 1: Native gel stained for presence of α-esterases, β-esterases, α+β esterases.
S: Sensitive flies
R: Resistant flies

General esterase (Est) activity was also determined by biochemical analysis. Briefly, 5μl of the soluble protein extract was incubated for 30min at 25°C, in 200μl of α- or β-napthyl acetate solution. After 5min, 15min and 30 min we added 50μl of Fast Blue garnet to the incubation mixture and we recorded the optical density at 630nm. The results are shown in nmol of α-β napthol/min/mg protein (Tables 1, Table 2).

Laboratory strain	α-napthyl acetate		
	5min	15min	30min
Sensitive	0.150 ± 0.06	0.236 ± 0.08	0.385 ± 0.07
Resistance	0.157 ± 0.06	0.239 ± 0.07	0.400 ± 0.07

Table1: Activity of α-esterases

Laboratory strain	β-napthyl acetate		
	5min	15min	30min
Sensitive	0.205± 0.05	0.261± 0.05	0.350 ±0.05
Resistance	0.200 ± 0.06	0.274± 0.06	0.345± 0.05

Table 2: Activity of β-esterases

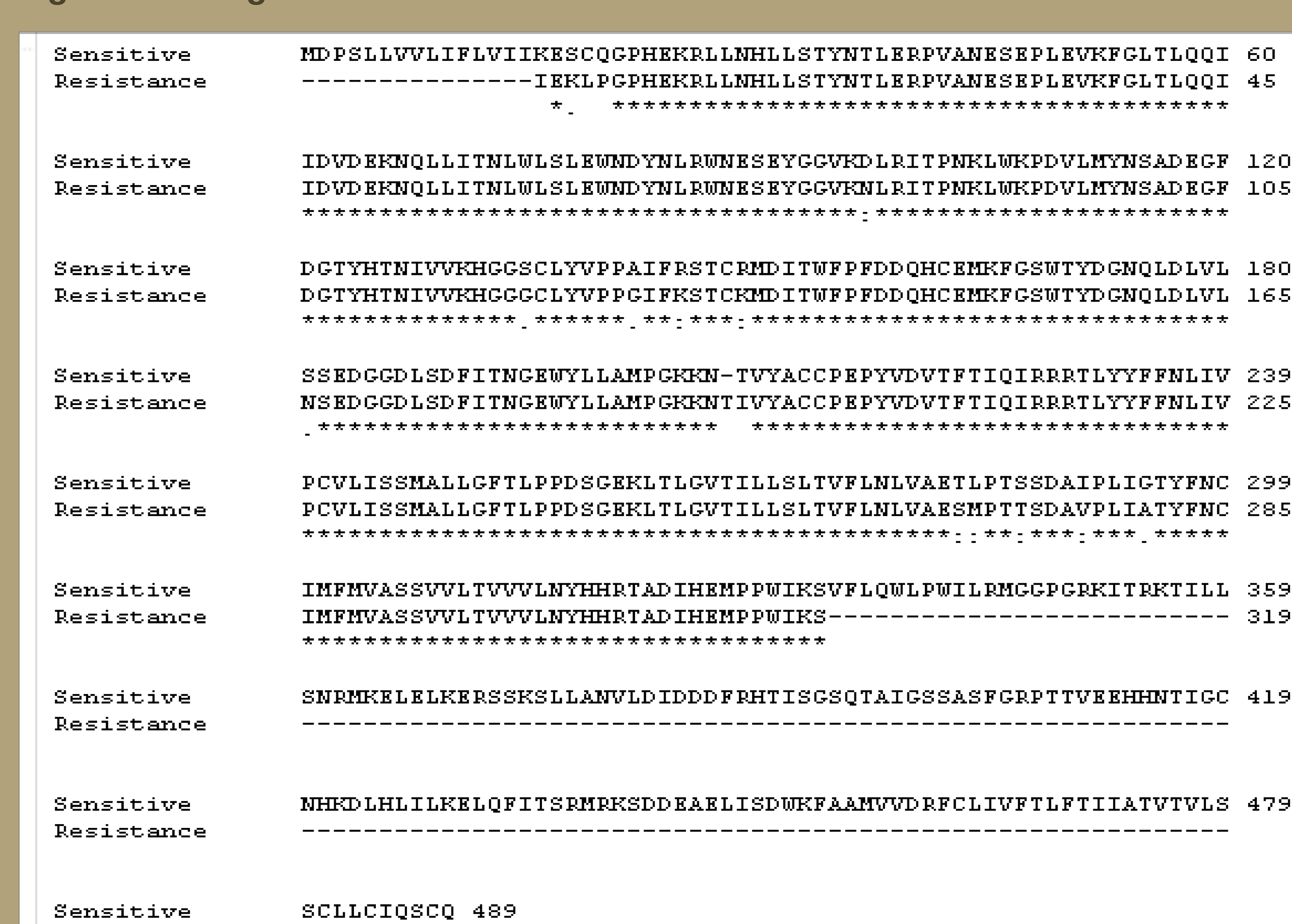
No significant difference in esterase activity between sensitive and resistance strain was determined through proteomic and biochemical analysis.

Boα6 nAChR cloning

A 1724bp cDNA fragment was amplified by RT-PCR from susceptible *B. oleae* by virtue of homology to the *Bactrocera dorsalis* nAChR. The putative 489 aminoacid Boα6 protein showed 97% identity to that of B. dorsalis. In Figure 2 the characteristics of an α-subunit of nAchR are shown.

MDPSLLVVLIFLVIIKESCQGPHEKRLLNHLLSTYNTLERPVANESEPLEVKFGLTLQQIIDV
DEKNQLLITNLWLSLEWNDYNLRWNESEYGGVKDLRITPNKLWKPDVLMYNSADEGFD
GTYHTNIVVKHGGSCLYVPPAIFRSTCRMDITWFPFDDQHCEMKFGSWTYDGNQLDLV
LSSEDGGDLSDFITNGEWYLLAMPGKKNTV~~YACC~~PEPYVDVTFTIQIRRRTLYY**FFNLIVP**
CVLISSMALLGFTLPPDSGEKLT**LGVTILLSLTVFLNLVA**ETLPTSSDAIPLIGTYFN**CIMF**
MVASSVVLTVVVLNYHHRTADIHEMPPWIKSVFLQWLPWILRMGGPGRKITRKTILLSN
RMKELELKERSSKSLLANVLDIDDDFRHTISGSQTAIGSSASFGRPTTVEEHHNTIGCNHK
DLHLILKELQFITSRMRKSDDEAELISDWK**FAAMVVDRFCLIVFTLFTIIATVTVLSSCLL**
CIQSCQ

Figure 2: The N-terminal signal peptides are underlined with a broken line. The four transmembrane units (TM1-TM4) and the three putative N-glycosylation sites are shown in blue and red letters respectively. The YxCC motif of the a-subunits has a deleted line and the six loops (D, A, E, B, F, C) that are responsible for the ligand binding are underlined.



```
Sensitive     MDPSLLVVLIFLVIIKESCQGPHEKRLLNHLLSTYNTLERPVANESEPLEVKFGLTLQQI 60
Resistance    ---------------IEKLPGPHEKRLLNHLLSTYNTLERPVANESEPLEVKFGLTLQQI 45
                             *.   ****************************************

Sensitive     IDVDEKNQLLITNLWLSLEWNDYNLRWNESEYGGVKDLRITPNKLWKPDVLMYNSADEGF 120
Resistance    IDVDEKNQLLITNLWLSLEWNDYNLRWNESEYGGVKNLRITPNKLWKPDVLMYNSADEGF 105
              ************************************:***********************

Sensitive     DGTYHTNIVVKHGGSCLYVPPAIFRSTCRMDITWFPFDDQHCEMKFGSWTYDGNQLDLVL 180
Resistance    DGTYHTNIVVKHGGGCLYVPPGIFKSTCKMDITWFPFDDQHCEMKFGSWTYDGNQLDLVL 165
              **************.******.**:***:*******************************

Sensitive     SSEDGGDLSDFITNGEWYLLAMPGKKN-TVYACCPEPYVDVTFTIQIRRRTLYYFFNLIV 239
Resistance    NSEDGGDLSDFITNGEWYLLAMPGKKNTIVYACCPEPYVDVTFTIQIRRRTLYYFFNLIV 225
              .**************************  *******************************

Sensitive     PCVLISSMALLGFTLPPDSGEKLTLGVTILLSLTVFLNLVAETLPTSSDAIPLIGTYFNC 299
Resistance    PCVLISSMALLGFTLPPDSGEKLTLGVTILLSLTVFLNLVAESMPTTSDAVPLIATYFNC 285
              ******************************************::**:***:***.*****

Sensitive     IMFMVASSVVLTVVVLNYHHRTADIHEMPPWIKSVFLQWLPWILRMGGPGRKITRKTILL 359
Resistance    IMFMVASSVVLTVVVLNYHHRTADIHEMPPWIKS-------------------------- 319
              **********************************

Sensitive     SNRMKELELKERSSKSLLANVLDIDDDFRHTISGSQTAIGSSASFGRPTTVEEHHNTIGC 419
Resistance    ------------------------------------------------------------

Sensitive     NHKDLHLILKELQFITSRMRKSDDEAELISDWKFAAMVVDRFCLIVFTLFTIIATVTVLS 479
Resistance    ------------------------------------------------------------

Sensitive     SCLLCIQSCQ 489
Resistance    ----------
```

Figure 3: Comparison of sensitive and resistance Boα6 nAChR

We, also, obtained part of the Boα6 nAChR from resistant flies. Specifically, we cloned a 960bp cDNA that encodes part of the protein. Comparison of the two proteins shows several aminoacid differences.
The importance of these mutations is being investigated (Figure 3).

Transcriptome Analysis

Finally, transcriptome analysis is being performed in heads of the sensitive and resistant strains in order to study the differential expression of the two strains and identify the loci involved in spinosad resistance. Experiments are under way.

- This research was partially supported by the California Specialty Crop Block Grant Program of the State of California, USA, and the two Graduate Programs of the Biochemistry and Biotechnology Department of the University of Thessaly, Greece.

PS7TH352
Others P7

Spinosad resistance in the olive fly, *Bactrocera oleae*

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The olive fruit fly Bactrocera oleae is the most important and destructive pest of cultivated olive trees, in almost every country where olive trees grow. For the last 40 years, the management of the pest has been based on the use of organophosphate insecticides. More recently, pyrethroids and the naturalyte spinosad have been added in the arsenal against the olive fly. However, the extensive use of any insecticide inevitably leads to the development of resistance. Low level spinosad resistance to the olive fly has been demonstrated in flies caught in several California counties where the drug is the only insecticide used for the control of the fly. In Drosophila, the α6 subunit of the nicotine acetylcholine receptor (nAChR) has been implicated in spinosad resistance. On the contrary, the α6 subunit of the nAChR does not seem to be spinosad's target in Musca domestica. In order to investigate the mechanism of spinosad resistance in the olive fly, we developed a ~30-fold spinosad resistant strain in the laboratory under continuous selection. By virtue of homology we isolated B. oleae α6 nAChR both from the laboratory sensitive and resistant strains in an effort to identify possible sequence variants in this locus that could be responsible for the observed resistance. At the same time, whole transcriptome analysis was performed in heads of the sensitive and resistant strains in order to study the differential expression of the two strains and identify the loci involved in spinosad resistance.

Keywords:*spinosad, insecticide, resistance, olive fly, Tephritidae, nicotine acetylcholine receptor, transcri*

Final Activity Report

DB Promotion in May 2012 „Taste California“

June 2012

Taste California in Germany 2012

Who: California Agricultural Export Council (CAEC)

What: Promoting California Specialty Crops in Germany/Europe

with tastings and retail promotion at large German train stations

Where: Berlin, Dresden, Frankfurt

When: May 2012

Promotion Material

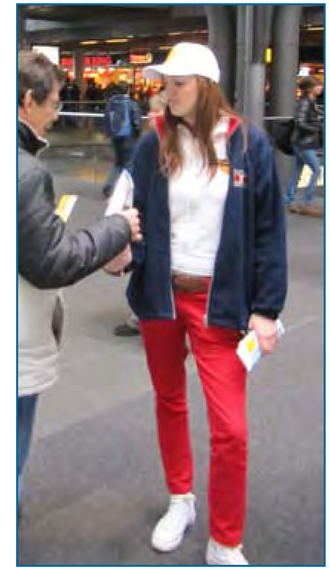
- Brochure
  - Information on Californian travel destinations and food products
  - Bookmark style with zigzag fold
  - Circulation: 100,000
  - Raffle with QR-code: Win a trip for two to California
  - Voucher for Point shops: 15% discount on Californian products

Promotion Material

- Booth
  - Light panels with textile graphic banner and counter
  - TV screen with „Taste California“ film (also shown in 9 point shops in Berlin, Dresden, Frankfurt, Bochum, Stuttgart, Hannover)

Promotion Material

- Staff equipment: Shirts, Caps and Buttons with logo and website adress



- Airstreamer with logos and promotion pictures (only in Frankfurt)

Internet Activities

- **Homepage: www.taste-california.de**
  with information from brochure
  - Total visits: 6,467
  - Raffle: Win a trip to California
    Participants: 30,000 thanks to cooperation with online raffle portal

  - Links to homepages of participants for additional information
  - 345 visitors via QR-Code
  - Social media buttons, 45 “Likes” at Facebook

Internet Activities

– Visitor allocation on the subpages:

35.3 %

12.4 %

13.2 %

16.4 %

11.3 %

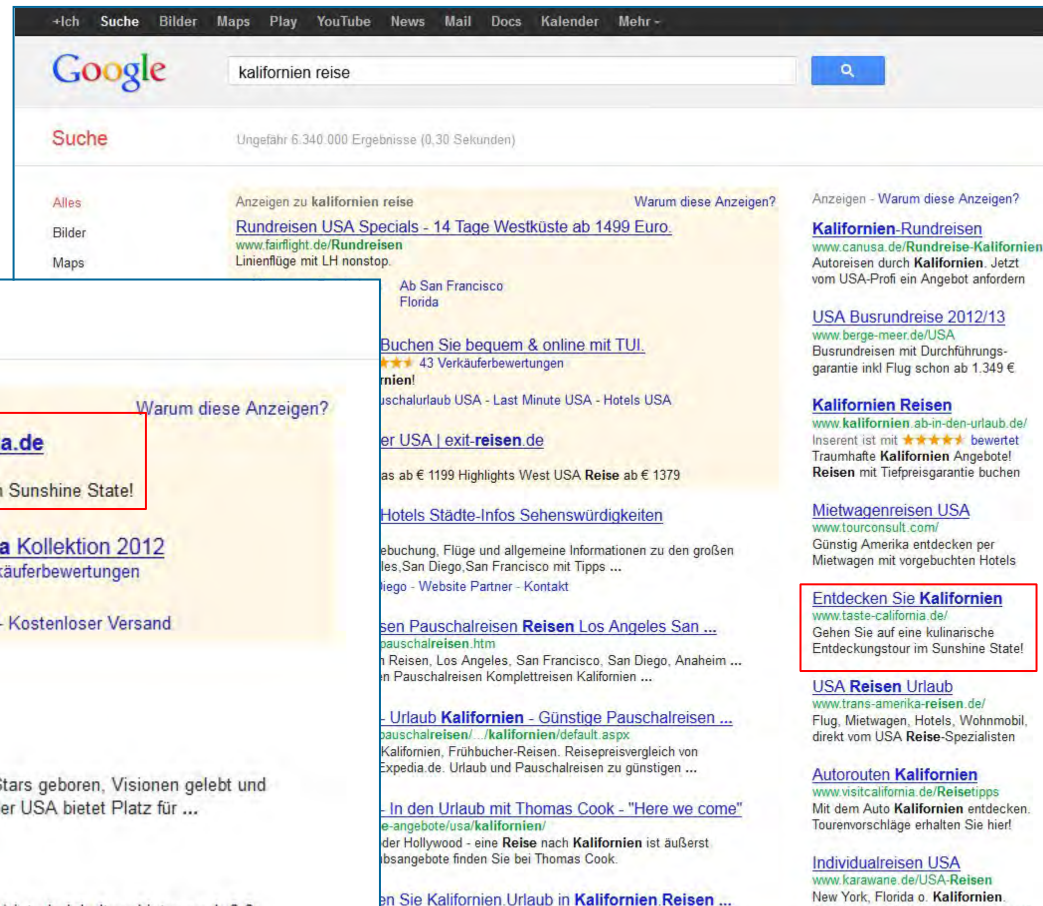
11.3 %

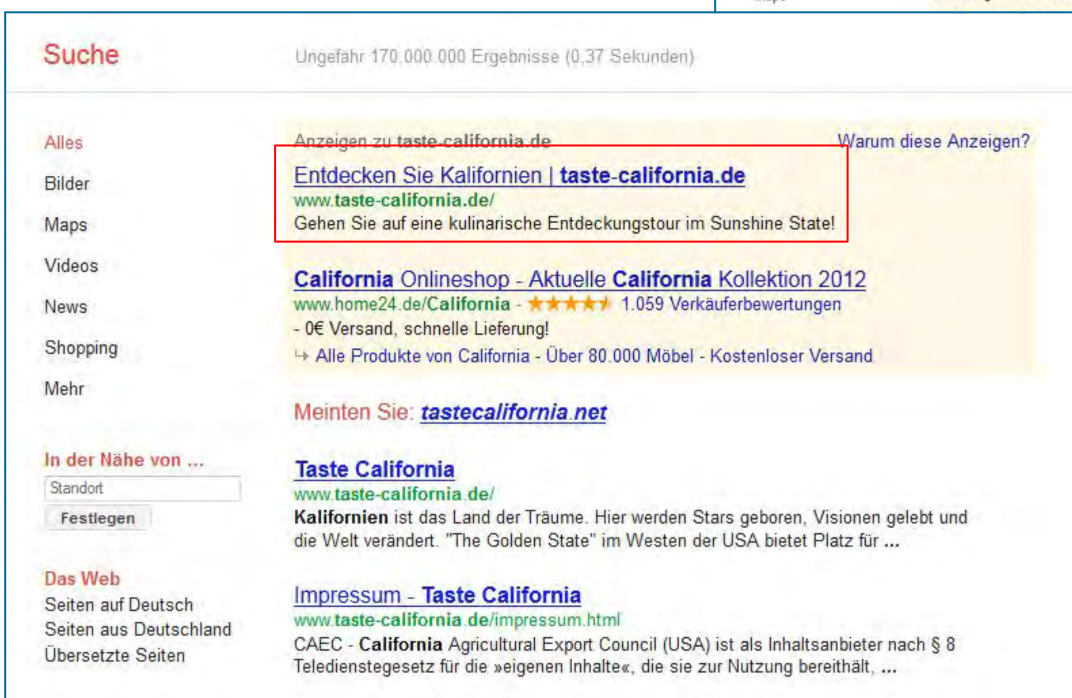
Internet Activities

- **Google Adwords**

Impressions: 701,078

Klicks:1,326





Press Activities

- **DB customer magazin „mobil“**
  Seven page article on California
  Circulation: 502,227
  Reach: 1,381,124
  Value: 105,401 € / 138,143 US $

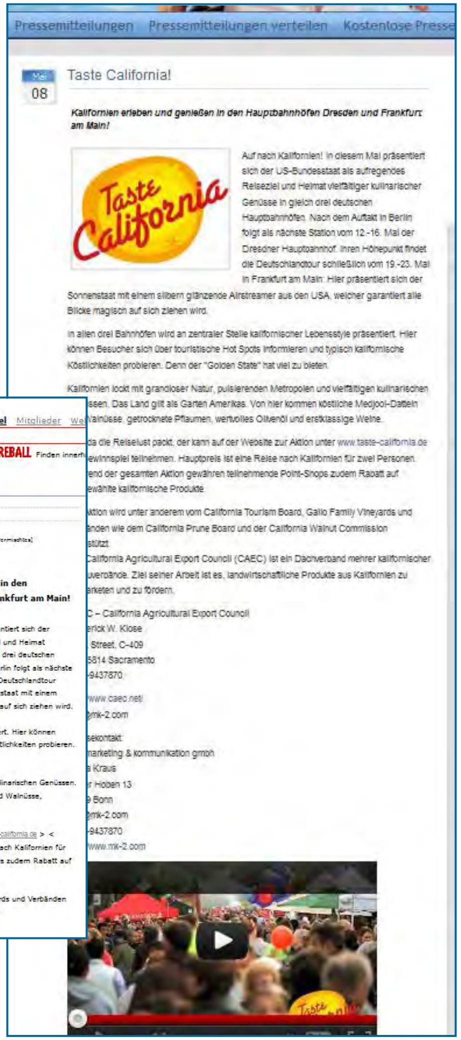
Press Activities

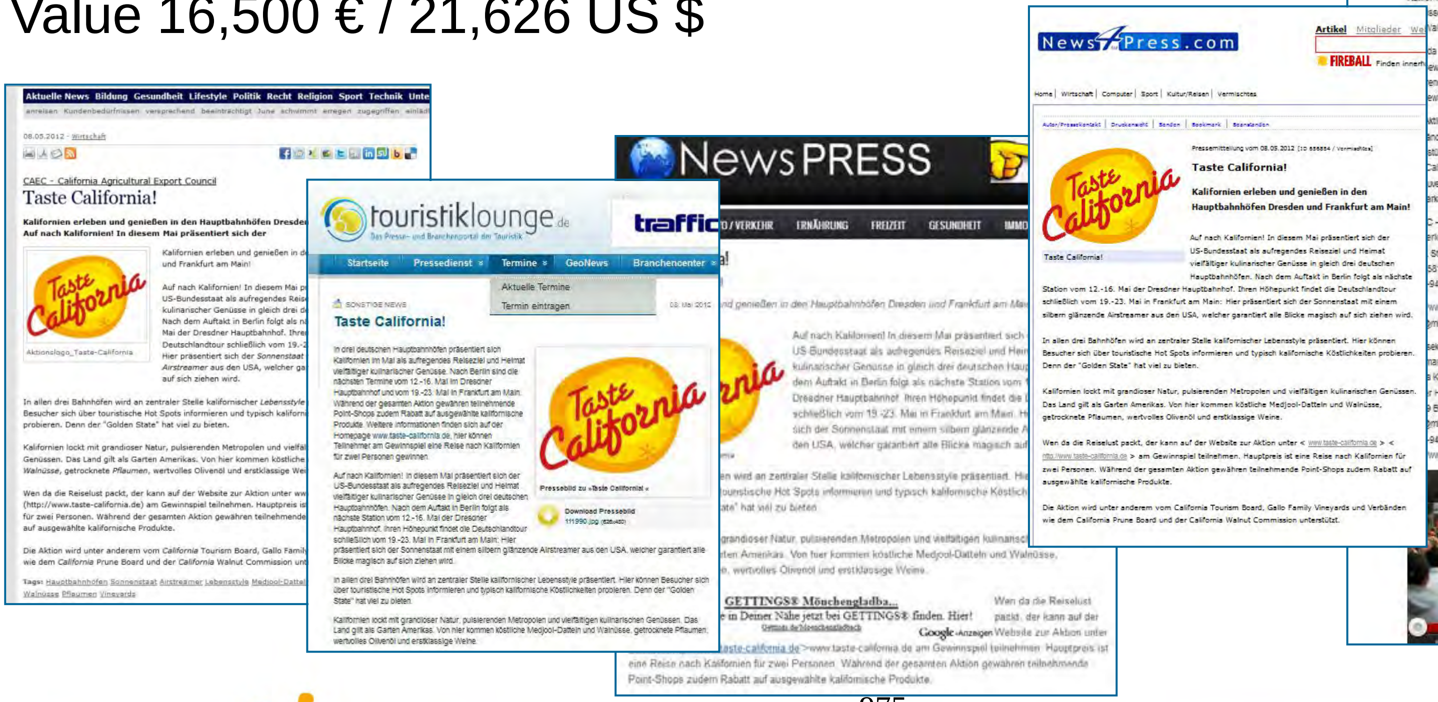
- **PR-Gateway**:

  Press release was published on 56 online portals

  Total circulation: more than 4.5 million visitors

  Value 16,500 € / 21,626 US $





Press Activities

- **Press mailing to local media and media agencies**

Berlin: 18 contacts

Dresden: 14 contacts

Frankfurt: 26 contacts

Kalifornien präsentiert sich im Hauptbahnhof

Vom 12. bis 16. Mai präsentiert sich der US-Bundesstaat Kalifornien unter dem Motto „Taste California" als Reiseziel und Heimat vieler kulinarischer Genüsse im Hauptbahnhof. Besucher können sich über die Reisemöglichkeiten informieren und im Point-Shop in der Kuppelhalle mit Produkten aus Kalifornien eindecken.

Publication: „Dresdner Neuste Nachrichten"

Circulation: 26,000

Value: 100 € / 132 US $

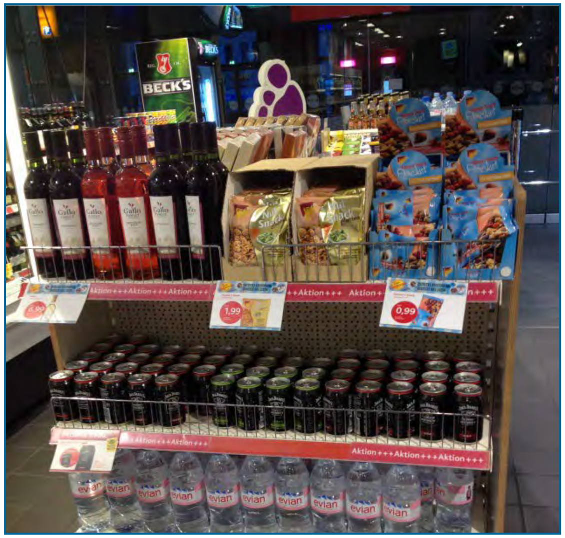
DRESDNER NEUESTE NACHRICHTEN

POS Activities at Point Stores/SSP

SSP Germany
The Food Travel Experts

- Point Stores: Nationwide supermarket chain in train stations and at motorway service areas; offering a selection of food and drugstore articles for travelers

point
shop to go



POS Activities at Point Stores/SSP

- Cooperation:
  - Prominent positioning of Californian products in 92 point shop (at 56 train stations and 36 motorway service areas)
  - Special advertisement / labeling of promotional products at shelves, advertisement posters and ceiling hangers

  - Preferred product placement in stores
  - New listing of two walnut products by Farmer’s Snack, one being mono shelled CA walnuts
  - “Taste California” film on LCD screens in 9 Point Stores (2x Frankfurt, 3x Berlin, Dresden, Bochum, Stuttgart, Hannover)

POS Activities – Evaluation

- Number of customers at Point stores during promotion:

  Expected outcome: > 860,000 customers
  Actual outcome: > 1.66 million customers

- Increase in sales during promotion:

Berlin	Wine: 25.7 %
	Salty Snacks: 18.4 %
Dresden	Wine: 5.1 %
	Salty Snacks: 2.5 %
Frankfurt	Wine: 7.7 %
	Salty Snacks: 18.8 %

Promotion Activities

- <u>Berlin – May, 03.-07. 2012</u>

  4th largest train station in Germany with 300,000 travelers/day

  - <u>Visitors at booth</u>:
    Total: 355,000
    Per Day: 71,000

  - <u>Products distributed</u>:
    Brochures: 13,200
    Prunes: 28,400
    Travel Guides: 2,200

- <u>Dresden – May, 12.-16. 2012</u>

  Central traffic intersection and transfer station with cross-regional significance and about 60,000 travelers/day

  - <u>Visitors at booth</u>:
    Total: 87,000
    Per Day: 17,400
  - <u>Products distributed</u>:
    Brochures: 11,200
    Prunes: 41,600
    Travel Guides: 825

- <u>Frankfurt – May, 19.-23. 2012</u>

  2nd largest train station in Germany with 350,000 travelers/day, most important transport hub for the German railroad traffic

  - <u>Visitors at booth</u>:

    Total: 410,000

    Per Day: 82,000
  - <u>Products distributed</u>:

    Brochures: 28,200

    Prunes: 72,400

    Travel Guides: 1,760

Promotion Activities – Evaluation

- Tastings of CA specialty crops**:**

	Prunes	Olive Oil
Berlin	28,400	0
Dresden	41,600	0
Frankfurt	72,400	400

  - Expected Outcome: 270,000 tastings
  - Actual Outcome: 142,800 tastings

  Reason: Only small amount of olive oil available

- <u>Total Impressions</u>

Passengers moving through station	3,550,000
Shoppers	1,660,000
Media and internet exposure	5,034,700
Total:	**10,244,700**

  – Expected outcome: 2,675,000 impressions
  – Actual outcome: 10,245,700 impressions

Berkeley Food Policy Council
Strategic Plan 2011

Prepared by CFJC (Y. Armando Nieto) and the Ecology Center (Martin Bourque) with the assistance of Joy Moore, Sonia Quintero, and Beebo Turman, and the Berkeley Food Policy Council Steering Committee:

Martin Bourque
Ben Feldman
Margarita Guerrero
Anna Hillgruber Smith Clark
Daniel Miller
Joy Moore
Y. Armando Nieto
Christina Oatfield
Becca Prager
Beebo Turman

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Berkeley Food Policy Council

Strategic Planning 2010

Our Mission:
To build a local food system based on sustainable, regional agriculture that fosters the local economy and assures all people of Berkeley to have access to healthy, affordable and culturally appropriate food from non-emergency sources.

-BFPC September 2000

1. Executive Summary
(Still to Come)

2. Background

In the 1960's and 70's, as part of the new social movements of that era, many local organizers, activists, entrepreneurs, and visionaries laid the groundwork for the alternative food systems of today. The "back to the land" movement became the underpinnings of the organic farming movement. Efforts inspired by Rachel Carson's' *Silent Spring* became the GMO and pesticide focused organizations of today. The ideals of United Farm Worker labor organizers are now embodied in Fair Food organizations. And social justice militants such as the Black Panther Party laid the groundwork for food banks, urban consumer equity programs like Farm Fresh Choice, and the food justice movement in general. Restaurants like Chez Panisse modeled successful local food business and trained and motivated a generation of chefs and leaders. All of the elements of our diverse and dynamic alternative food system today can be traced to ideas, visions, and actions of those radical pioneers.

In the 1980's and 90's Berkeley's Farmers' Markets emerged bringing in farmers from the region allowing all kinds of new programs and partnerships to emerge. These markets continue to thrive and proliferate and have spawned urban produce stands and CSAs of today. Having these farmers come to town weekly allowed many other restaurants to purchase directly and to make the direct connection between struggling regional organic farmers and the urban consumers and institutional buyers in the east bay region. These connections and relationships allowed for exchanges and educational opportunities such as farm tours for kids and a direct moral and monetary reinforcement of the alternative food production desired by a new kind of consumer.

Two other important benchmarks took place during the mid and late 1990's. One was creation of the Edible Schoolyard at King Middle School, which concentrated on engaging students in all aspects of food and farming the garden, including preparing, serving, and eating the food, as well as teaching stewardship of the land.

The other significant achievement was a grant obtained through the U.S.D.A. "Supplemental Nutrition Assistance Program" (now called "Network for a Healthy California") which funded garden classes, cooking classes, and nutrition education. This allowed for the scaling up efforts and dissemination of the concepts underpinning the Edible School Yard to students throughout the district.

The Emergence of the Berkeley Food Policy Council

In the spring of 1998 Tom Bates (former Assemblyman), Zenobia Barlow (Director of the Center for Ecoliteracy), Loni Hancock (then Mayor of Berkeley) and Alice Waters (Owner and Founder of Chez Panisse Restaurant and the Edible School Yard) began to gather resources to consolidate a vision for food in Berkeley, and to coordinate some of the most active entities working on these issues. They wanted to take things further and begin to lay a policy framework on which to develop this system in a more cohesive, complete, and institutional way.

Under pressure from parent activists demanding better food in the schools, Berkeley Unified Scholl District (BUSD) Superintendent Jack McLaughlin convened a meeting of the four visionaries, along with Yolanda Huang, Beebo Turman and grant writers to explore a visioning process in the Spring of 1998. Two notable meetings occurred with a lunch at the Willard Middle School garden, and tea in the Edible Schoolyard at King Middle School. Under the auspices of the Center For Ecoliteracy a grant was written, and late in October 1998 a three-year grant for $280,000 was awarded. The primary goals of the project were to change the lunch program at the Berkeley public schools and form a Food Policy Council. Tom Bates, Melanie Okamoto, Erica Pang, Joy Moore and Jered Lawson were employed towards these goals and under the name, "The Berkeley Food Systems Project."

Simultaneously, Superintendent McLaughlin held monthly meetings with these outraged parents and Elsie Seto, the Head of the Berkeley Unified School District Food Services. The parents (Eric Weaver, Ray Couture, Sibella Krause, Yolanda Huang, Beebo Turman, and Marcy Greenhut and others) were adamant in that they wanted something better than "Tater Tots," "chicken nuggets" and "pizza pockets" for their kids and the rest of the kids in the community. This group was later formalized by the BUSD School Board into the Child Nutrition Advisory Committee, which became increasingly frustrated with the slow pace of change in the school district's food service and welcomed the advent of the Food Systems Project, which was working towards similar goals.

At roughly the same time, the Berkeley Health Department had just published its Health Status report that correlated for the first time Berkeley's health indicators with race and income. While everyone knew that under resourced- people and people of color in particular were disproportionately impacted by chronic illness no one was fully prepared for the results of this study [Insert summary data here-Gwen has it].

These concurrent developments produced the first meeting of the *Berkeley Food Policy Council* (BFPC) on March 30, 1999. With staff support from the Berkeley Food Systems Project and community pressure and direction from the Berkeley Food Policy Council, the BUSD passed a new Food and Nutrition Policy on August 18, 1999 (attached). At the time it was one of few such food policies in the country. Two years later in 2001, following a similar process, the City of Berkeley passed its own Food and Nutrition Policy (attached).

In the years following these initial efforts of the BFPC, the partner organizations and individual activists worked on manifesting the policies through programs that took the ideals of the policies and made them real in the community. In a series of meetings following the passage of the two policies the BFPC developed an action list of programs and services that were needed to achieve the policy goals laid out in the Food and Nutrition Policies (attached). In many ways the passage of the policies was the beginning of the work not the conclusion. Over the following decade the groups have accomplished many of these programmatic goals through dozens of collaborations and partnerships resulting from those meetings.

Some of the most visible results were the subsequent formation of the health department's many diet related programs. [Kate fill in here].

In addition, Farm Fresh Choice was developed by the BFPC and later adopted by the Ecology Center, to bring fresh local organic food directly to under-resourced families in south and west Berkeley through produce stands at subsidized afterschool programs. These stands purchase from culturally appropriate farms at the farmers markets, and sell the produce at wholesale prices to parents when they pick up their kids. This program hires youth leaders from the same communities to become educators and advocates, offering tastings, cooking classes, and peer to peer activities, while raising the awareness of the injustices in our conventional food system and the importance of building community resiliency though healthy eating.

The Ecology Center was able to pioneer the transition from food stamps to electronic benefits transfer (EBT) ensuring that benefits eligible people could still use these federally funded benefits at farmers markets maintaining (or gaining) access to the some the world's best produce and supporting local farmers rather than industrial food processors. This system has been shared with hundreds of other farmers markets across the state and EBT sales at farmers markets continue to grow.

At each of these afterschool programs particularly at the BAHIA inc School Age Program and Berkeley Youth Alternatives (BYA), these stands complemented their internal efforts at making behavior change with parents and staff. BYA was particularly effective at driving change with their own staff members and changing their internal culture by passing and embracing these the same policies internally. And BAHIA has been particularly successful in changing the behaviors of the parents and families in their programs though evening and weekend engagement with families. Both sites have extensive nutrition education programs and food production programs.

Along those lines, BFPC was successful in helping Spiral Gardens to acquire a large plot of public land to start a community food security nursery and communal garden. This project was able to emerge from its parent organization Building Opportunities for Self Sufficiency (BOSS), a homeless and indigent support agency, to become its own non-profit organization, running a nursery that supplies local under-resourced community members with vegetable starts, gardening classes, an urban produce stand, and production land.

But perhaps the greatest success was the radical transformation of the school lunches and nutrition program in the BUSD. While the policy foundation was laid early in the BFPC process, there were entrenched internal barriers and with a new superintendant the effort to reform the school lunch program languished. The new Superintendant Michelle Laurence wasn't convinced that this was a high priority until one of her middle school students died of complications related to type II diabetes. When a physician at Children's Medical Center explained that the lunches they were serving were the kinds of foods that cause this disease she had an epiphany.

With the leadership of the Chez Panisse Foundation, continued pressure from the parents, and unanimous support of the BFPC, a deal was struck with the school district: the Foundation would pay for ½ of a new Director of Child Nutrition salary for three years to reform the schools food programs, if the foundation could choose this new leader. The renegade lunch lady, Chef Ann Cooper, was the perfect candidate.

Under her leadership the district was set on a new path accomplishing was what many had been dreaming about for years. She radically reformed the lunches and reoriented the program towards fresh healthy meals within the budgetary constraints as prescribed by the USDA and the BUSD. High Fructose Corn Syrup, processed bleached flowers, transfats, BST hormone laden and artificially sweetened milk, high sodium foods, and the nacho cheese sauce all went away in the first year. Instead of U.S.D.A. surplus commodities she used with fresh raw products, locally sourced health alternatives, organic foods where possible, and began for the first time in decades cooking every meal from scratch.

With the construction of a new central kitchen and Dining Commons, the completion of the Berkeley High School Food Court, salad bars in all Berkeley public schools, vegetarian choices available every day, and the initiation of the universal breakfast program dramatic improvements were made on every front. In these three short years the BUSD nutrition program was able to change the infrastructure, practices, purchasing, and overall culture of the District's Food System. This demonstrated to the USDA and the rest of the county that it can and must be done elsewhere and it has influenced hundreds of other districts and laid the groundwork for school lunch reform at the federal level.

In summary in its first decade the Berkeley Food Policy Council proudly claimed significant accomplishments:

1. Wrote and passed two pioneering Food and Nutrition Policies: the BUSD Food Policy (1999), and the city of Berkeley Food Policy (2001).
2. Secured political support for City of Berkeley's health department's expansion into community diet related chronic disease prevention programs
3. Got nutrition education and teaching gardens in every public school
4. Developed strong food related youth leadership programs in the City, BYA and Ecology Center
5. Initiated Farm Fresh Choice – a youth leadership program at the Ecology Center bringing fresh produce at wholesale prices to under-resourced community members
6. Secured land and start up funding for Spiral Gardens
7. Pioneered use of Public Benefits EBT and WIC at the Ecology Center Farmers' Markets
8. Radically reformed the Berkeley Unified School District's Food Service programs
9. Shared these experiences and successes with hundreds of other communities who continue to benefit from BFPCs pioneering efforts.

Transition to the future

Although many community projects were initiated in Berkeley during a three year period, the work of implementing the projects required every resource and volunteer time then available. Without continued funding to staff the original Berkeley Food Policy Council monthly meetings continued but with decreasing regularity and eventually stopped altogether. Community partnerships continued, based on relationships developed in the BFPC, and new ones formed for programmatic and funding purposes.

In retrospect, some of those who participated in the original BFPC have indicated that the council would have benefited from greater participation of the economic development and farming sectors, and that BFPC efforts could have benefited from a more firm demand for specific policy changes, rather than a non-binding policy statement.

In the ensuing eight years many other communities have started Food Policy Councils and adopted their own Food Policies. In Berkeley, we are proud of this Food Renaissance and the part we have been able to play. We are also heartened to see that urban agriculture is now a strong movement in our local communities, and in communities across the country.

3. Berkeley Food Policy Council 2010

September 2010 Berkeley Food Policy Council Summit

The Ecology Center hosted the next iteration of the BFPC at a Summit meeting in September 10, 2010, thanks to the work of a dedicated planning committee comprised of Martin Bourque, Ben Feldman, Gera Marin, Joy Moore, Becca Prager, Sonia Quintero, and Beebo Turman. Based on individual interviews with former and potential participants goal was to get he right people in the room and begin to develop a council that could pick up where the work left off.

In between the two iterations of the Berkeley Food Policy Council the residents of Berkeley and members of the original council continued to implement projects initiated by the original BFPC. This Strategic Plan document celebrates their efforts, the continuing efforts of the current BFPC, and builds upon the resiliency of the residents of Berkeley who continue to lead the country in making "home" the kind of place that nurtures both body and soul.

Due to limited resources and the desire for an authentic and grass roots approach the BFPC Strategic Plan is a "living document," informed by the activities of the current Council work teams and committees. The methodology employed captures the ongoing work of council members, and Berkeley residents and weaves a fabric that tells the story of how a community re-establishes core values—that food nourishes and is not *only* a commodity for profit and gain, and that access to healthy food is a human right. We believe that with that fabric we will create a tent that shelters and provides access to healthy food for all residents of our communities—a place for the ongoing development and implementation of policies and practices that embody our values.

4. BFPC: The Next Chapter

a. Mission and Vision Statements

Our Mission:
To build a local food system based on sustainable, regional agriculture that fosters the local economy and assures all people of Berkeley to have access to healthy, affordable and culturally appropriate food form non emergency sources. *September, 2000*

Vision Statement:

To reduce diet related illness of Berkeley's under-resourced residents and communities of color, through information sharing, programmatic collaborations, and changes to the policy landscape that increase the consumption of fresh local foods.

The BFPC model is the kind of informal, loose association of community based organizations, businesses and representatives from Berkeley educational and governmental agencies noted in the publication, *Food Policy Councils: Lessons Learned*, from Food First. And although the geographic scope of the BFPC is limited to the city of Berkeley, its influence and activities are not strictly limited by city boundaries.

While the membership of the Berkeley Food Policy Council in its initial meetings agreed to operate under the original BFPC Mission and Vision statements, in December 2010 an ad hoc task group was formed to consider new language. Ideas to be discussed included looking at a combination of good food/real food/slow food; explicit language addressing the needs of the Berkeley under-resourced community; and the notion of a strategic focus blurb.

Task Group Members included:
Birch Early
Kate Brown
Gwen Loeb
Christina Oatfield
Margarita Guerrero
Joy Moore
Ben Feldman
Gera Marin

b. Real Good Food
After several meetings and discussions of an ad hoc committee and the general membership, the BFPC developed some simple language to refer to the kinds of food and food system we are promoting. It is not meant to be a detailed and rigorous descriptor or tool for evaluating any specific food, system, or farming practice, but rather a general statement that allows us all to share in agreed upon principals of a just fair healthy sustainable local food system. The agreed upon term is Real Good Food which borrows from the terminology of the Kellogg Foundation and the Real Food Challenge.

Berkeley Food Policy Council will strive to promote 'Real Good Food,' which, we define as food that is healthy, affordable, fair, sustainable, local and community based, and humane.

What we mean by these terms is explained below:

Healthy: food that fully and wholly nourishes people and does not cause diseases

Affordable: food that people of all income levels can purchase or otherwise access

Fair: food that is culturally accessible to all and that is produced in a way where all workers throughout the production process are paid a living wage, do not work in hazardous conditions and are not otherwise exploited

Sustainable: food that is produced and distributed with such little impact on water, soil, the atmosphere and the natural environment that the production of food can continue indefinitely without overexploiting or contaminating these resources

Local and community-based: food that the consumer obtains from a direct transaction with the producer or food that is produced on a small enough scale that the consumer can be thoroughly informed on how the food is produced (including all or most of its individual ingredients).

Humane: food produced in a way that maximizes the wellbeing of domestic and wild animals in the context of being raised or hunted for food; or food that is free of animal products.

c. Overarching goals

It was the consensus of members of the BFPC attending the December 2010 general meeting that the BFPC would to consider four or five macro level statements—goals and/or objectives—to help guide work in 2011 and going forward. Although no single subset of the Council was charged or took charge/responsibility for drafting macro statements, an ongoing discussion began with the idea of considering a "low-income" focus, or addressing the goal of "ending hunger."

The following goals emerged during the course of Steering Committee meetings between December 2010 and March 25, 2011:

Draft Overarching Goals to achieve the BFPC Mission

Create a service, education, and policy infrastructure in our region that:

- Makes it not only possible but easy for all residents to grow and share at least some of their food
- Eliminates economic and geographical barriers to purchasing *Real Good Food* for all Berkeley residents

- Effectively supports all residents in acquiring basic *Real Good Food* knowledge and self efficacy of Berkeley all residents regarding how to shop and prepare *Real Good Food* for themselves and loved ones

- Eliminates diet related illness in the long run, and the diet related health disparities in the short run (focus on the core problem areas first)

- Ends hunger in Berkeley, in the long term by ending the root causes of hunger, and in the short term by assuring that all in need have additional assistance

- Fosters a broad based understanding of the injustice and inequity pervasive in the industrial food system and promote tools and mechanisms to create viable alternatives

To achieve these goals the BFPC focuses on the following practices:

1. Information sharing
2. Programmatic collaboration
3. Policy engagement, watch dogging, and advocacy
4. Public education

The Steering Committee will continue to monitor the ongoing discussion as it evolves in the BFPC working groups, and to incorporate changes and findings into the strategic planning document as appropriate.

d. Governance

Although members were gratified by the seamless manner in which the 2010 version of the Berkeley Food Policy Council was initiated and continues to conduct its activities, prudence dictates that some form of governance is required. The thinking is that the least possible governance will likely serve the effort best most of the time, but that protocols have to be in place for those times of contentious issues, which will arise.

Accordingly, using the original "September 22, 1999 Decision Making Rules document for the Berkeley Food Policy Council," the Steering Committee convened three meetings in early 2011 and developed the following language which was adopted at the March 25, 2011 General Meeting:

Membership in the Food Policy Council (BFPC) shall be open to the general public. Members must fill out a membership form to be a voting Member.

1. *A Steering Committee shall be established through self selection of the Membership and shall have the following responsibilities:*
    A. *To plan and convene the Policy Council's meetings. To select a facilitator for each meeting.*

B. *Arrange for speakers and provide information to the Policy Council.*
C. *Do outreach and invitations to members of all sectors of the food system to Policy Council's meetings.*
D. *Provide information to all members of the wider Berkeley Community about the activities of the Policy Council.*
E. *Structure and determine the structure and process for ongoing Policy Council development.*
F. *Perform any tasks that are assigned or approved by Policy Council.*
G. *Develop and propose mid and long term plans for the Policy Council's consideration, and to review plans and progress annually.*

2. *All meetings of the Berkeley Food Policy Council and the Berkeley Food Policy Council's Steering Committee shall be open to the public.*

3. *There is not a specific quorum required in order to meet. Meetings must be noticed at least 10 days in advance to the membership email list service.*

4. *In order to keep meeting agendas structured and organized, any voting member may make a motion on any item on the agenda.*
    A. *A voting member is anyone who has attended 2 out of the last 3 meetings*
    B. *In order for a motion to be considered it must be seconded by a voting member.*
    C. *The Policy Council can consider only one motion at a time, however amendments and substitute motions may be considered on the pending motion. (an amendment makes a change to the motion under consideration; a substitute motion can be made on the same subject and take the place of the pending motion)*
    D. *The Facilitator shall attempt to reach a consensus on all motions.*
    E. *If the Facilitator determines that a consensus can not be reached on the motion, then the motion may be continued to the next scheduled meeting or brought to a vote.*
    F. *When a motion is put to the members for a vote it must receive 2/3 vote of the voting members to be adopted.*

5. *The membership may take up any policy item for adoption it deems to be urgent that is not on the agenda. An urgent motion must receive consensus approval or ¾ vote of the voting membership to be considered and must receive a ¾ vote by the membership to be adopted.*

5. Specific Activities & Working Groups

During the initial organizing meeting of the BFPC in September 2010 a process was used to select priority areas on which the Council would focus. From that process working groups were formed.

In developing the strategic planning process it was decided to create an iterative/living report—this strategic plan—that both documents and celebrates the activities of the working groups, and also informs any Council workplans going forward. The idea is that in lieu of raising funds dedicated to an expensive strategic planning process efforts would be better applied to program development and implementation.

Each working group has developed a set of goals and activates it seeks to promote that help to achieve the overarching BFPC objectives, mission and vision.

Working groups include Urban Agriculture; Policy; Youth; Leadership/Spanish Recruitment; and 100 Days—an "umbrella" action oriented celebration of our alternative food system in Berkeley.

a. Urban Agriculture Working Group

Dedicated to reaching the goal of making it easy for all residents to grow and share at least some of their food, the goals developed to make urban agriculture more widespread include:

1. Create a cadre of paid Coordinators and Trainers (in garden –community outreach – education –of the neighborhood, inclusivity – agents for urban agriculture)

2. Develop a Container Gardening Program (a lot of people do not have a big space for garden—geared for people who have little space)

3. Securing Vacant Lots for Community Agriculture (set up a garden registry in Berkeley)

4. Change Zoning Codes to support Backyard Market Gardens and Urban Agriculture in General

5. Secure Berkeley Youth Funds For Summer Youth Program – (training youth to be agents for urban agriculture)

6. Make Micro-lending and Mini grants available to help start urban gardens for under-served neighborhoods

7. Establish an Urban Land Trust. (Identifying vacant lots and purchasing them to preserve the space for future gardens)

The conception of urban agriculture of the BFPC includes all of the following and more:

- Veggie Plot
- Orchard
- Herbs
- Bees
- Livestock
- Aquaculture
- Mycology (Mushrooms)

Urban agriculture is more than just growing food—it is about Urban Food Self Sufficiency.

b. Policy

The specific goals, actions, and campaigns, of the Policy Working Group will change over time. This Group is dedicated to food related policies that affect:

- Access
- Marketing (both good and bad)
- Formal education (BUSD etc.)
- Food Production (Zoning etc.)
- Procurement
- Funding

Key roles for the Policy Working Group are:

1. Research, analyze, and develop a process to prioritize a policy agenda and to approve and initiate policy efforts in the BFPC on an annual basis

2. Review and respond to emerging policy initiatives that affect or relate to our goals

3. Help the private business sector, local organizations, and agencies support the goals of the BFPC by promoting the best business practices and advocating for change of the worst practices

4. Network and collaborate with other Food Policy Councils and like bodies to share approaches and promote the above goals regionally and at the state and federal levels as appropriate and possible.

Key initial goals for policy advocacy through the BFPC are:

1. Promote WIC and EBT access at large retailers
2. Home Occupation Permits for backyard sales of homegrown produce
3. The Farm Bill 2012 Re-authorization process

c. Youth Leadership Development Group

The Youth Leadership Development Group is focused in ensuring active participation in the alternative food system of young people of color particularly those from under-resourced backgrounds. This group seeks to empower young people to be agents of change in their own families and social circles as well as in their broader communities.

Key goals for youth empowerment through the BFPC are to:

1. Create more employment opportunities for young people particularly in the summer months
2. Secure ongoing funding for staff to support youth and run youth empowerment programs
3. Develop critical analysis skills with youth – so that youth are able to educate the community with actual skills around growing food AND the root causes of injustice in the food system
4. Create mentorship relationships so that youth have more dedicated personal engagement from adults and elders in the field
5. Ensure that youth have counseling, educational and career advising, job training and other support services to help them become successful leaders
6. Support youth in hosting their own events.
7. Provide youth wit the tools to empower themselves and their community though development and opportunities in:
    - Food, farming, and justice training
    - Public speaking
    - Leadership skills
    - Program administration and management skills
    - Media and marketing skills
    - Campaign organizing and advocacy skills

7. Perhaps most importantly, there is a need to develop clear pathways from the youth development programs to higher education, training, jobs, careers, and/or business ownership.

d. Community Engagement and Leadership Development Working Group

One theme that recurred through initial meetings was the need for the BFPC to help recruit, organize, and develop more community leaders from oppressed communities. Whenever there is a new task force or working group in town the same individuals are asked to participate. Rarely does a process begin from them and yet they are always asked to support the processes. More engaged organizers are needed particularly in the Spanish speaking community, and the BFPC needs to be ready and open to responding to community needs and concerns it may be out of touch with.

With regard to the communities of color and Latino community in particular, outreach to natural leaders could help to engage new and potential leaders. While many active participants in the BFPC are paid staff or career activists working on these issues, many of the community members whose engagement is needed, are not. Addressing this concern is a high priority.

Key goals Community Engagement and Leadership Development through the BFPC are:

1. Create paid opportunities for adult evolvement from underrepresented community leaders
2. Create mechanisms to create grassroots dialogue around the activities of the BFPC and bring the BFPC to the community bases
3. Translate documents into Spanish and other languages
4. Recruit outspoken and motivated individuals to participate
5. Ensure that public events have appropriate translation, food, and childcare

e. 100 Day's Working Group

The 100 Days challenge will be the culmination of comprehensive, coordinated food systems and policy work throughout Berkeley. The intention of the 100 Days Working Group is to avoid reinventing the wheel. Rather, to focus on creating partnerships and linkages. By coordinating, focusing, and expanding existing programs, the Group hopes to strengthen the BFPC member organizations in order to build the capacity needed to serve and engage the full community.

The core elements of this Working Group are: program coordination; joint fundraising; major media exposure; community visibility; and grassroots engagement, leadership, and capacity building.

Key goals for the 100 Days Working Group are:

1. 100% participation of Berkeley residents
2. Focus efforts on those most impacted by health disparities and food systems inequities
3. Assess resources and gaps to determine needs to achieve goal
4. Combine with disaster preparedness and neighborhood resiliency efforts
5. Build collaborative fundraising mechanisms
6. Create jobs
7. Develop the metrics and plan for project implementation, including:
   - Block by block approach
   - Neighborhood captains model
   - Media work / Messaging
   - Outreach and canvassing
   - Documentation
   - Assessment

6. Conclusion

Although limited resources defined the approach and format of this strategic planning process and document, the result is already proving to be of benefit to the BFPC. The document clearly lays out the work that has been instigated since the Council began to meet again after a hiatus of nearly nine years. With the 100 Day's Celebration serving as a framework for fundraising, policy, youth, urban agriculture and education and outreach activities under current discussion, an integrated approach for BPFC work is beginning to take shape.

Going forward, the strategic plan can therefore be an iterative document to be reviewed annually that both tracks working group activities and helps chart the course of workplans that will make real our shared vision of a healthy, equitable, and sustainable Berkeley community.

7. Appendices

List of Founding Members

Last Name	Name	Title	Affiliation
Altieri	Miguel	Professor of Agroecology	UC Berkeley
Bourque	Martin	Executive Director	Ecology Center
Bradley	HuNia	Farm Fresh Choice Program Manager	Ecology Center
Burton	Ecaterina	Advocacy and Education Associate	Almda. Co. Comm. Food Bank
Clayton	Kate	Chief of the Health Promotion Section	City of Berkeley Health Dept.
Cueva	Marta	Education Program Director	Bay Area Hisp. Inst. for Adv.
Feldman	Ben	Farmers' Markets Program Manager	Ecology Center
Guerrero	Margarita	Nutrition H2H & Hypertension Specialist	City of Berkeley Health Dept.
Hillgruber Smith Clark	Anna	Slow Food Bay Area Regional Chair	Slow Food USA
Holt-Gimenez	Eric	Executive Director	Food First
Kunitz	Judith	Health Services Manager	Berkeley-Albany YMCA Early/ Head Start/State Preschool
LaPean	Shawn	Director, Cal Dining	University California Berkeley
Marin	Gerardo	Farm Fresh Choice Program Manager	Ecology Center
Michas	Ariane	Manager Buy Fresh – Buy Local	CAFF / Buy Local
Miller	Daniel	Executive Director	Spiral Gardens
Moor	Kelly	Heart-To-Heart coordinator	Lifelong Medical - Heart-To-Heart
Moore	Joy	Host & Producer Also a Garden	KPFA / Pacifica
Nieto	Y. Armando	Executive Director	CFJC
Oatfield	Christina	Policy Coordinator	Berkeley Student Food Collective
Prager	Becca	Director of Heat	Berkeley Youth Alternatives
Quintero	Sonia	BFPC Intern	Ecology Center
Rosencranz	Nance	Director of Strategic Planning & Dev.	Lifelong Medical
Sinai	Julie	Mayor's Chief of Staff	City of Berkeley/Mayor's Office
Turman	Beebo	Project Director	Berkeley Comm. Gardening Collab.
Vietor	Francesca	Executive Director	Chez Panisse Foundation
Villanueva	Mia	Program Coord. Network for a Healthy CA	BUSD

Williams	Kevin	Associate Director	Berkeley Youth Alternatives
Spach	Christina	Volunteer	CFJC
Taylor	Mikoda	Consultant	Fierce Allies
Allen	Kim	Garden Manager	Berkeley Youth Alternatives
Hasse	Andrew	Edible City	
Dillard	Nakia	Outreach & Education Coordinator	Farm Fresh Choice
Loeb	Gwen	EC Development	Ecology Center
Sitemann	Chris	Volunteer	EB Food Not Bombs

Members Org Profiles

- **Food First - Food Policy Councils: Lessons Learned report Pages 19 - 22**

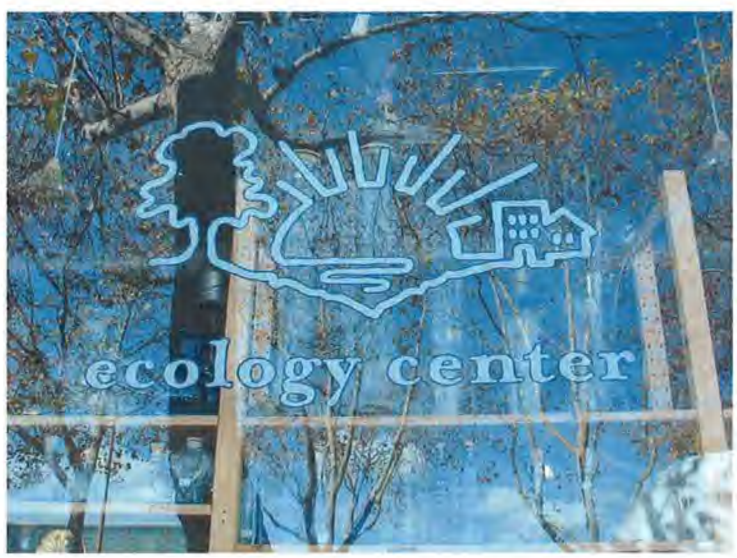
http://www.foodfirst.org/sites/www.foodfirst.org/files/pdf/Food%20Policy%20Councils%20Report%20small.pdf

Other References:

ECOLOGY CENTER FARMERS MARKETS
FARM TO FACILTIES REPORT

I. Introduction & Overview

The Ecology Center is a community-based 501(c)(3) nonprofit with a mission of promoting environmentally and socially responsible practices through programs that educate, demonstrate, and provide direct services. To address issues of health, nutrition, and climate change, the Ecology Center is working with our community to change the way we think about and consume food. As a part of this work, the Ecology Center has operated farmers' markets in Berkeley, California since 1987. Currently, we operate farmers' markets in Berkeley three days per week, year round, rain or shine, in addition to one seasonal market in the neighboring City of Albany. Over the course of the year, these markets serve over 50 small farms from throughout the State, and attract approximately 400,000 customers.



At the Ecology Center, our markets have two primary goals: to support farmers, and to make seasonal, local, organic produce available to city dwellers. We take these commitments seriously, and we strive to continually innovate our operations by finding new ways to serve our community and to further contribute to the financial viability of the farms with which we work. Over the past few years, we have observed an increase in the number of local chefs shopping at our markets, as well as a growing commitment by many organizations to sourcing locally grown fruits and vegetables. We recognized this trend as an opportunity to increase sales for our farmers, and to expand the capacity of our markets to serve a broad range of institutions in addition to individual shoppers. In Fall 2010, we secured a **CDFA Specialty Crop Program Block Grant** to fund a yearlong research project, with the goal of identifying actionable strategies to facilitate increased purchasing at our markets by restaurants and institutional buyers.

We enlisted the services of the **Bay-area Environmentally Aware Consulting Network (BEACN)** to assist with our research. BEACN is a student-led consulting group based at U.C. Berkeley that provides sustainability consulting to nonprofits and local businesses in the Bay Area. BEACN collected and compiled information from farms that participate in our markets, as well as information from produce buyers for local restaurants, distribution companies, and other institutions. Based on their resulting report, we identified three potential strategies for increasing institutional purchasing at our markets. We presented these strategies to farmers and purchasers, and solicited specific feedback in order to determine whether the strategies would truly meet their needs.

The following two sections summarize our research process, results, and conclusions. It is worth mentioning that a number of other organizations have previously implemented similar projects aimed at facilitating local food purchasing by institutions. We believe that the conclusions presented here build upon the successes and limitations of these various projects, and offer straightforward tactics that have specific relevance for farmers' market organizations.

II. Summary of Research

We worked with BEACN to conduct research during Spring 2011. BEACN's process included three components: collecting information on existing local food purchasing models, conducting interviews with key stakeholders, and surveying farmers and produce buyers.

Information Collection

- BEACN collected information about various local food purchasing models including the Appalachian Sustainable Agriculture Project, the Local Food

Marketplace, the Center for Food and Justice, and the Wholesale Free Market.

- BEACN identified the Berkeley Unified School District and U.C. Berkeley Food Purchasing as potential buyers for the Ecology Center Farmers' Market. Both of these institutions have made explicit commitments to increase their purchases of local, sustainable foods.
- BEACN collected information about existing food distribution companies, and evaluated their services and potential ability to partner with the Ecology Center to assist in distributing specialty crops from our markets to hospitals, schools, and restaurants in Berkeley. They identified Veritable Vegetable as an ideal, potential partner given their core commitment to "creating economic, environmental, and social change." Veritable Vegetable's services include managing ordering logistics and providing efficient transportation.

Interviews

- BEACN interviewed Karen Salinger, Sales Manager for Veritable Vegetable.
- BEACN interviewed Leah Smith, Director of Programs for Agricultural Institute of Marin, who implemented a "Farm-to-Fork" food-purchasing program at Marin Farmers' Markets.
- BEACN interviewed Dale VanMatre, Buying Manager for Greenleaf Produce.
- BEACN interviewed Sharon Chec, Farm to Institution Coordinator at the Center for Food Justice.

Surveys

- BEACN surveyed 17 farms that participate in the Ecology Center Farmers' Markets. The surveys helped them to identify barriers that keep farmers from selling more to restaurants and institutions, including lack of time, lack of manpower, difficulty in coordinating efficient transportation, and difficulty forecasting and communicating supply availability. They got feedback on specific proposals for addressing these barriers, including starting a farmers' market "wholesale day," establishing "wholesale hours" at existing farmers' markets, partnering with a local produce distribution company to coordinate pick-ups at the farmers' market, and working with an existing online ordering system to communicate product availability to potential purchasers. Overall, establishing a "wholesale day" or "wholesale hours" and partnering with a distributor were not popular options among farmers due to low potential returns, and additional packaging and food safety requirements expected by distributors. Eleven out of seventeen farmers surveyed indicated that they would be interested in utilizing an online ordering system to communicate supply availability to potential purchasers.

- BEACN surveyed 5 institutions that currently buy from the Ecology Center Farmers' Markets, including 4 restaurants and one U.C. Berkeley student residential co-op. All respondents demonstrated a strong commitment to purchasing direct from local farmers' markets. They identified barriers to buying more at farmers' markets, including inconvenient timing of markets, lack of parking at farmers' markets, inability to transport large quantities of produ ce given their vehicle options, high prices, and lack of a convenient delivery option. The majority of respondents indicated that having a local delivery option from the farmers' market to their businesses would be very useful.
- BEACN surveyed 4 institutions that do not currently buy from the Ecology Center Farmers' Markets, including two restaurants, Berkeley Student Cooperative food services, and the Berkeley Unified School District. These institutions expressed that they were satisfied with their current specialty crop supply systems, and emphasized their need for steady supply, lower prices than those at farmers' markets, and one-stop pick-up or delivery for bulk orders. They would only be compelled to purchase at farmers' markets if it were as efficient and affordable as their current systems. The Berkeley Unified School District showed the most interest in purchasing from the farmers' market. In addition, BUSD offers the most benefit to the markets given that their weekly specialty crop purchases total $30,000, and that they aim to procure 70% of their food from local growers. That said, they would require a delivery from the farmers' market to their central kitchen.

Primary Strategies
Based on their research, BEACN recommended three sales strategies for the Ecology Center to consider.

Strategy #1: Develop relationships with large institutions that have explicit commitments to buying locally grown specialty crops, such as the Berkeley Student Cooperative or the Berkeley Unified School District. By building long-term relationships, the Ecology Center would be able to work with individual institutions to overcome obstacles and create mutually beneficial systems. Once effective purchasing systems are put in place, they would require minimal upkeep for the Ecology Center. Furthermore, large institutions have a lot of purchasing power and offer the highest overall returns for farmers. In addition, large institutions have an expansive reach, and have the most potential to increase the health and wellbeing of the Berkeley community. In order to implement this strategy, the Ecology Center would need to conduct outreach to target institutions to evaluate their purchasing needs, determine if farms at our market can supply enough produce to meet those needs, and then work with institutions to determine best distribution methods. Distribution options might range from institutions picking up at the markets, outsourcing delivery to Veritable Vegetable, or paying a current farmer with delivery capabilities to handle transportation. The Ecology Center's role would primarily be to coordinate ordering logistic and to aggregate orders from multiple farms for institutional purchasers.

Strategy #2: Develop a partnership with Grower's Collaborative (GC), which is a project of the nonprofit Community Alliance for Family Farmers (CAFF). GC already has established relationships with hospitals, local restaurants, and with school districts in Ventura and Oakland. They have developed the Educational Marketing Center model, which aggregates produce from local farmers to facilitate distributor access to local food. GC Bay Area, a well-established private wholesaler, handles produce shipments in the Bay Area. This model has made it easy and accessible for entities to procure local produce if interested. GC also provides education tools to local farmers with information about food safety and proper packaging, which improves farmer access to institutional markets. By partnering with GC, the Ecology Center would be able to leverage established relationships with distributors and institutions, and would be able to outsource distribution logistics to a non-profit organization. In contrast to most for-profit distributors, GC is driven by a mission that is in-line with the Ecology Center's goal of supporting small-scale, local growers, and is

committed to offering farmers a fair price. The downside of this strategy is that GC would not be able to pick-up at the farmers' market, which means that farms would need to coordinate deliveries themselves. Surveys show that many farms do not have the time or personnel to do this.

Strategy #3: Work with a for-profit distributor, such as Veritable Vegetable or Greenleaf Produce, that is willing to pick-up produce at the farmers' market and deliver it to local institutions. This strategy is similar to working with CAFF in that the Ecology Center is essentially outsourcing all sales logistics. Once established, this option would require minimal work for the Ecology Center. Distribution companies have the capacity to handle the ordering, delivery, selling, and marketing of produce. Disadvantages of this strategy include potential low returns for farmers, and potential challenges due to food safety and packaging standards expected by distributors, which many of our farmers would not currently meet. The key to addressing these challenges would be to identify a distributor that is willing to work with the farmers to educate them and build-up a long-term partnership. The Ecology Center might also consider investing time in educating farmers about how to meet food safety and quality standards expected by institutional purchasers. This could be achieved through workshops, panel discussions, or farmer-to-farmer information sharing sessions. The Ecology Center would also likely need to invest time in conducting outreach to local buyers to build up the local market for produce from farms at our markets.

Alternate Strategies
The following strategies were discussed with stakeholders throughout BEACN's research. Based on the feedback they received, BEACN made the assessment that these tactics do not serve the Ecology Center's goals at this time, but may become viable options in the future.

Alternate Strategy #1: Implement a "Veggie Valet" service at the farmers' market where institutional purchasers can "check" large orders, and then pull-up to load the orders into their vehicles. On Saturdays, the Ecology Center may be able to work with local garages to offer free, discounted or validated parking to purchasers who utilize the "Veggie Valet" service. This strategy would require a large investment of time and funding from the Ecology Center. The Ecology Center would need to coordinate, staff, and provide infrastructure for the Veggie Valet service, and would need to identify a location within the market where vehicles, including large trucks, would be able to pull up and load their orders. This strategy would benefit those institutions that already shop at the farmers' market by eliminating the need to find nearby parking, and making it easier to transport and load large orders into vehicles. That said, it is unclear if it would actually enable them to buy *more*. Furthermore, few institutions that do not currently shop at the market have the staff, flexibility, or inclination to pick-up produce during market hours. It is unlikely that a Veggie Valet service would be enough to motivate those institutions to begin shopping at the farmers' market. Overall, this strategy does not seem to have the strongest potential to increase sales for our farmers.

Alternate Strategy #2: Establish a "Wholesale Market" or "Wholesale Market Hours," where farmers can market their produce directly to restaurants, retailers, and other institutional purchasers. This type of market would not be open to the general public, but would instead only be open to those organizations that buy in bulk. One advantage of this strategy is that buyers would have the opportunity to come out to the farmers' market, judge the quality of the produce, make selections in person, and build direct relationships with farmers. In comparison to working with a distributor, farms may get better returns through this model, since they would have the opportunity to sell directly to large institutions. However, in order to participate, farms would need to make a significant commitment of time and personnel. Farms would likely only attend a wholesale market if they had enough guaranteed sales on any given day to cover their costs. This means that the Ecology Center would need to work hard to coordinate pre-orders for all participating farmers, and would need to communicate availability and forecast supply for buyers on an ongoing basis to facilitate sales. To a certain extent, these tasks replicate the services that are already provided in a professional and efficient manner by distribution companies. In order to fund this project in the long-term, the Ecology Center would likely need to charge a commission on sales, just like distributors do, which detracts from the benefit to farmers. Though there may be certain benefits to "face-to-face" interactions between farmers and institutional buyers, on the whole, this model seems to duplicate the services offered by distributors in a way that is less efficient for everybody involved. For this reason, a "wholesale market" is not an ideal model at this time.

Alternate Strategy #3: Work with farmers and buyers to begin utilizing an existing, online ordering system, like Local Dirt (www.localdirt.com). Services like Local Dirt enable farmers to communicate the supply of specialty crops and availability to potential buyers through a web-interface, and enable buyers to search for and source local foods online. Local buyers would have the option of indicating that they'd like to pick their orders up directly from at the Ecology Center Farmers' Markets from participating growers. While this strategy would require minimal work for the Ecology Center, it would not resolve the issues of delivery and distribution for buyers, and therefore may not result in increased sales.

III. Results

After reviewing BEACN's research and recommended strategies, Ecology Center staff developed three feasible approaches to increasing institutional purchasing at our farmers' markets.

Partner with a single, large institution

Overall, our research makes it clear that different purchasers have different needs, as well as varying commitments to purchasing locally. Developing a strategy to meet the needs of all purchasers while also working to meet the specific needs of farmers is impractical. Given this reality, we have concluded that it will be more beneficial to foster a long-term relationship with an institution that has an explicit commitment to buying local foods. At this time, the Berkeley Unified School District (BUSD) appears to be an ideal partner for the Ecology Center. BUSD has large purchasing power, already works with some farms that participate in our markets, and has expressed an interest in increasing their purchases of local foods.

Ecology Center staff conducted a follow-up interview with Dede Sampson, a Purchasing Agent with BUSD who is responsible for managing weekly produce orders for the entire district. This interview confirmed that if the Ecology Center were able to aggregate orders for BUSD and deliver them to the district's central kitchen once a week, BUSD would be able to increase their current purchases from farms that participate in the Ecology Center Farmers' Markets. This strategy has the potential to significantly increase sales for our farmers, and would be logistically feasible for the Ecology Center.

Educate farmers on quality and safety standards

Our research also shows that not all farms at our markets offer specialty crops of the same level of quality. Those farms with robust institutional sales have the knowledge and infrastructure needed to meet quality and safety standards set by institutional buyers. If we were able to help additional farmers to meet these standards, they would likely have increased access to restaurant and wholesale markets.

To implement this strategy, we propose bringing in industry experts to 1) educate farmers about the expectations and needs of restaurants and wholesalers; 2) educate farmers about ways in which they can improve quality and freshness to meet these expectations; 3) help farmers finance and develop the infrastructure needed to improve produce quality; 4) educate farmers about food safety requirements expected by institutional purchasers, and possibly help to finance infrastructure and certifications needed to achieve a higher level of food safety.

Ecology Center staff conducted follow-up interviews with Dale VanMatre, Buying Manager at Greenleaf Produce, and Russell Moore, owner of Camino Restaurant, to get feedback on this strategy. Both Dale and Russell expressed an interest and ability to help educate farmers about quality and safety standards. Dale also stressed the importance of food safety to breaking into larger, institutional markets, and recommended that we consider inviting a food safety specialist to conduct an educational workshop with our farmers.

While this strategy does not address the logistical and economic challenges to facilitating sales from small farms to institutional buyers, it would help farmers break into restaurant and institutional markets if they were motivated to do so.

Secure additional parking, and create a Veggie Valet for restaurants and individual shoppers

One consistent item of feedback from restaurants that purchase at market is that parking is difficult, and that improved parking would make it easier for them to continue purchasing in large quantities. If the Ecology Center validated parking or offered free parking at a nearby lot and operated a "veggie valet" service where buyers could check purchases and then drive through to pick them up, it would reduce the difficulties that chefs currently face when shopping at market. Follow-up interviews with Lauren ce Jossel of Nopa Restaurant, Dondup of Chez Panisse, and Russell Moore of Camino, confirmed that they would appreciate this type of service, and that they currently utilize "Veggie Valet" and "Chef Parking" options at the Ferry Plaza and Marin Civic Center farmers' markets.

Individual shoppers have also expressed an interest in utilizing a "Veggie Valet" service. Consumer studies have shown that finding nearby parking is a significant factor to limiting purchases by farmers' market shoppers. The Ecology Center may be about to cover the costs of implementing and maintaining a Veggie Valet by charging individual shoppers a minimal fee. The service could then be offered to chefs for free.

III. Conclusions

Based on the results of this research it is clear that there are a number of challenges facing small farms in their desire to sell more specialty crops directly to restaurants and other institutions. Given the significance of the challenges, it would be difficult to develop a strategy that looks different than the existing distribution model of a company like Veritable Vegetable or Green Leaf. In the end we have identified strategies that can help us to build stronger ties with restaurants and other institutional purchases and facilitate their purchasing at market. The research in this report should serve other market organizations as well, both to serve as a cautionary tale regarding ambitious delivery systems and to also to provide ideas for strategies that may help them recruit and retain institutional purchasers at their markets.

Albany Farmers' Market
Consumer Study
June 8, 2011

Wednesday, 3:00 – 7:00
Solano Ave. at San Pedro

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Albany Farmers' Market
Consumer Study, June 8, 2011

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Executive Summary and Recommendations

In 1987 the Ecology Center (EC) opened a Derby Street farmers' market on Tuesdays. In 1990 they opened a second Center Street market on Saturdays, followed in 1997 by a third Shattuck Avenue market on Thursdays. All three markets operate year-round.

Fourteen years later, the Ecology Center decided to expand outside of Berkeley by request of the City of Albany. The Albany Farmers' Market opened on Wednesday, May 4, 2011 and became the subject of this study in its sixth week of operation. The Market serves the Albany neighborhood at the western end of the very vibrant Solano retail district that is filled with many independent retailers. In its initial weeks customer counts have ranged from 700 to 1500 adults.

Because similar customer studies have been completed recently at the Berkeley and South Berkeley Farmers' Market in October and March, respectively, many of the results from these markets are compared with Albany data here.

Key insights – by the numbers – from this study include:

- **96%** of market shoppers are local – including 62% Albany and 16% Berkeley residents.
- **70%** of shoppers came to the Solano district specifically for the Farmers' Market.
- **60%** of shoppers spend at least three-quarters of their money on fruits and vegetables, and **79%** of customers spend a majority.
- **50%** of all shoppers are coming a majority of the Market days.
- **48%** of respondents are satisfied (no reason to not buy more).
- **48%** of shoppers have shopped the El Cerrito market most frequently in the last year, and they are more likely to complain about high prices in Albany.
- **33%** of respondents have one or more children with them.

Customers report spending $23.28 at the Market. They also average **$15.54 in Solano businesses,** or $34.34 if we include only the 45% of people who do some Solano shopping.

Wednesday already appears to have a strong base of solid customers, with **57% spending $20 or more.** Spending levels are generally correlated with Market frequency. Return visitors are spending $24.72, 21% above first-time visitors. Yet, **in these early weeks of the Market, one-third of all spending is done by first-time Market shoppers.** While making up 37% of all respondents, first-time shoppers are 48% of those spending $10 or less, and only 26% of those spending more than $20.

The greatest promotion effectiveness is based on high **site visibility** for 48% of shoppers, with 31% noting the **banner** at Solano & Marin and 26% seeing the **poster** in local businesses.

More people buy ice cream (10%) and prepared food (7%) – both write-in purchases – than flowers, pasta/sauces, meat, eggs, plants, coffee, honey/jams and olive oil. Most popular are fruit & vegetables (86%), baked goods (36%), cookies/pies (19%) and cheese (13%).

While 30% of customers spend all of their Market expenditures on fruits and vegetables, 20% spend nothing on fruits and vegetables. This is related to the high incidence of newcomers.

From the 52% of respondents who gave reasons as to **why they didn't buy more,** we find five key issues: 43% ran out of cash, 32% found high prices, 20% complained about variety, 18% can't carry more, 14% lack time and 5% found parking problematic.

When asked **what would increase their purchases,** 56% want more farmers, and a close second is lower prices for 49% of shoppers. Another 18% want coupons and more prepared food, while 12% want cooking demonstrations.

The Market is a **melting pot** of people from **all income levels, ages and races.** Median household income for market customers is $70,192, close to the Albany median of $72,516. Shoppers increase spending generally with an increase in household income, but households under $75,000 still spend 43% of the total, matching those between $75,000 and $200,000.

Customers from all five age categories from 25-34 through 65-74 match or exceed their percentage of the Albany population, and the four from 25 to 64 all have at least 18% of the Market customer base. Those 35-44 and 45-54 make a majority of the purchases (53%), exceeding 25-34 and 55-64 by over 40% on average. Seniors over 65 spend even less.

Three-fourths (76%) of shoppers are white. There are 13% Asian, 5% Hispanic and 2% black, all under-represented vis-à-vis the Albany population.

Two-thirds of shoppers **(64%) are adults shopping alone.** One-third of customers have one or more children with them. This "green" market has 55% coming by foot and 5% by bike.

The full results presented in the study below provide the Board of Directors and staff with a detailed picture of Wednesday customers at the new Albany Farmers' Market. Potential courses of action in the form of recommendations are presented here for consideration, for review with vendors and/or for more thorough investigation with customers. Time and a more established customer base might lead to a change in some of these recommendations:

1. Aggressively develop an e-mail mailing list, using promotional incentives.
2. Construct a flag bank at the Market entrance to reinforce a lively, positive atmosphere.
3. Look into providing an on-site ATM machine for customers to have easy access to cash.
4. Consider pick-up zone at west end of the market to ease customers' burdens.
5. Keep the Market full every week by keeping a vendor list for "last-minute notice" with products that might spark first-time shoppers to return.
6. Search for volunteers who can develop child-oriented experiences at the Market.
7. Repeat price concerns to all vendors as stated by customers.
8. Ask vendor help crafting incentive program to motivate youth-centric attitudes/behavior.
9. Host vendor mini-meetings to strategize how to grow customer purchases and frequency, including customer ideas: more farmers, lower prices and more prepared foods.
10. Implement an Albany Farmers' Market Frequent Shopper card.
11. Prepare a trial direct mail coupon postcard reinforcing Albany resident attendance on an event day(s), based on their high frequency and good spending level.
12. Key banner words: real farmers, great atmosphere, baked goods, and ready-to-eat.
13. Conduct an Albany resident study of non-shoppers, investigating concerns & disincentives.
14. Study other area Markets to see what they're doing right, especially with ethnic sensitivity.
15. Ask especially people of color what events/improvements would stimulate greater attendance.
16. Develop a promotion that is a win/win for Solano businesses and the Market: a poster campaign, sponsorships for events, music, cooking demonstrations, etc.
17. Green the Market with canvas bags cooperatively printed by a local sponsor.

I. Overview

In its first season of operation, the Albany Farmers' Market runs every Wednesday from 3-7 p.m. on Solano Avenue just west of San Pablo Avenue. Present on the day of the study were 10 farmers (complex fee formula) and 11 non-agricultural vendors (6% plus $10). Opened on May 4, this was the Market's sixth week of operation. The customer turn-out was steady throughout the four hours. People were happy to be supporting their own local, neighborhood market and the weather was perfect, warm but not hot.

The study goal was to obtain solid customer data while obtaining a reasonable response rate to assure the data's validity. A single-sided, 18-item questionnaire was developed that could be answered in three minutes. The intercepts were done on June 8 at both the eastern end next to the market information booth near San Pablo Avenue and the western end in the middle of the crosswalk before Adams Street. Survey staff attempted to discern when customers were leaving the Market, and asked them to help the Market for two minutes by completing the survey. It was presented to them on a clipboard with a pen for self-administration. They were told that they would receive a gift, and upon completion they were handed a slip to turn in for a free cookie thanks to Starter Bakery.

Customer counts were difficult to do given that the survey was being done generally by one person at either end of the Market. The estimates provided here should be validated by future counts. These are useful in noting seasonal changes and responses to advertising and promotion activities. Consumer research including counts also can be useful in inspiring vendors to participate because they better understand the demographics of their customer base.

This report on the Albany Farmers Market on Wednesday stands on its own, but having studied the Berkeley and South Berkeley markets in October and March, respectively, we thought it valuable to note similarities and differences on occasion. Comments and figures for those markets are often presented here in parentheses for comparison purposes. It is assumed that the reader of this study may have read the October 9, 2010 Saturday study and the March 29, 2011 study, so comments about them are limited.

The customer counts and intercepts of 180 shoppers were done by a team led by Vance Corum. Many thanks are due Adam Edell for his intercept work on the Market's west end, and for periodic assistance from Ben Feldman and market manager Francesca Costa. Corum completed all the data input and analysis.

As with any survey of this nature, care must be taken in reflecting on data and recommendations that are based on counting 1200 adult shoppers, even though we attained a good 21% capture rate with 180, or one-fifth, of the shopping groups out for a Market experience on a beautiful, sunny June afternoon.

II. Customer Count

There was no extra staff to count customers. We attempted to arrive at a reasonable crowd estimate without allocating staff even for 15-minute counts in the middle of each hour, i.e., from 3:20-3:35, etc. The survey staffperson at either end of the market tried to do customer counts while also intercepting customers; this was difficult, especially at the east end where counts were not possible during the first and last hour of the Market. We multiplied each number by four to arrive at the hourly estimates below. These numbers are less accurate than is normally the case, and should be viewed with caution. An actual count should be conducted in the near future.

MARKET ENTRANCE COUNTS
(by number and percentage each hour)

	West/Adams		East/San Pablo		-- Total --	
3:00-4:00	100	8%	200	17%	300	25%
4:00-5:00	64	5%	220	18%	284	24%
5:00-6:00	104	9%	176	15%	280	23%
6:00-7:00	100	8%	225	19%	325	27%
	368	31%	821	68%	1189	99%
Pre-count					11	1%
Total Customer Count					1200	100%

On June 8, 2011, we estimate that 1200 adults entered the market. It appeared that at least twice as many customers enter from San Pablo on the east relative to Adams on the west.

The pre-count was a low 11; that is the number of adult shoppers in the market prior to opening. The Market seemed to have a slow initial start but once people began entering, the flow was fairly steady throughout the afternoon.

We divided our total adult estimate of 1200 by an estimated 1.4 adults per shopping group, based on Question 1, to arrive at a figure of 857 shopping groups. This is important for determining the economic impact on market vendors.

III. Consumer Survey

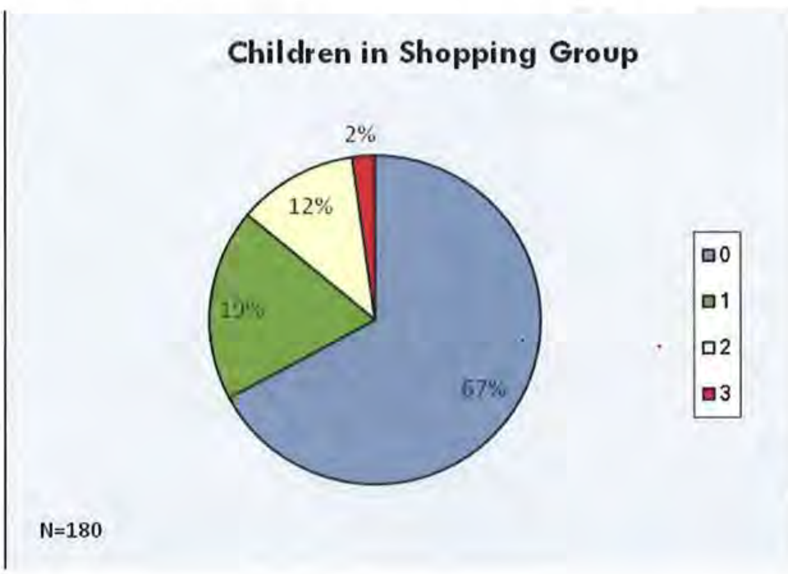
We intercepted 180 customer groups with an 18-question written survey. Customers were extremely positive and responsive to our intercept request, eager to help this neophyte market get on its feet. There was a sense of "this is my local neighborhood and we want this market."

Question 1: How many adults (18 or older) are in your shopping group today?

Almost two-thirds of those surveyed (64%) were adults **shopping without any other adult, similar to South Berkeley on Tuesday.** Another 31% were couples or two adults shopping together, and only 4% were in groups of three adults. Like Ecology Center's original weekday market, the average 1.4 adults per shopping group reflects a fairly strong single shopper trend while one-third shop with one or more companions.

Vendors should engage shoppers regularly since the single who isn't distracted by another adult companion may be inclined toward a longer conversation. Of course, this may be affected by the presence of kids.

Question 2: How many children (under 18) are in your shopping group today?



Two-thirds (67%) of shopping groups had no children under 18 with them, which leaves vendors and management to ponder how to intrigue a good **one in three parties** that **have children.**

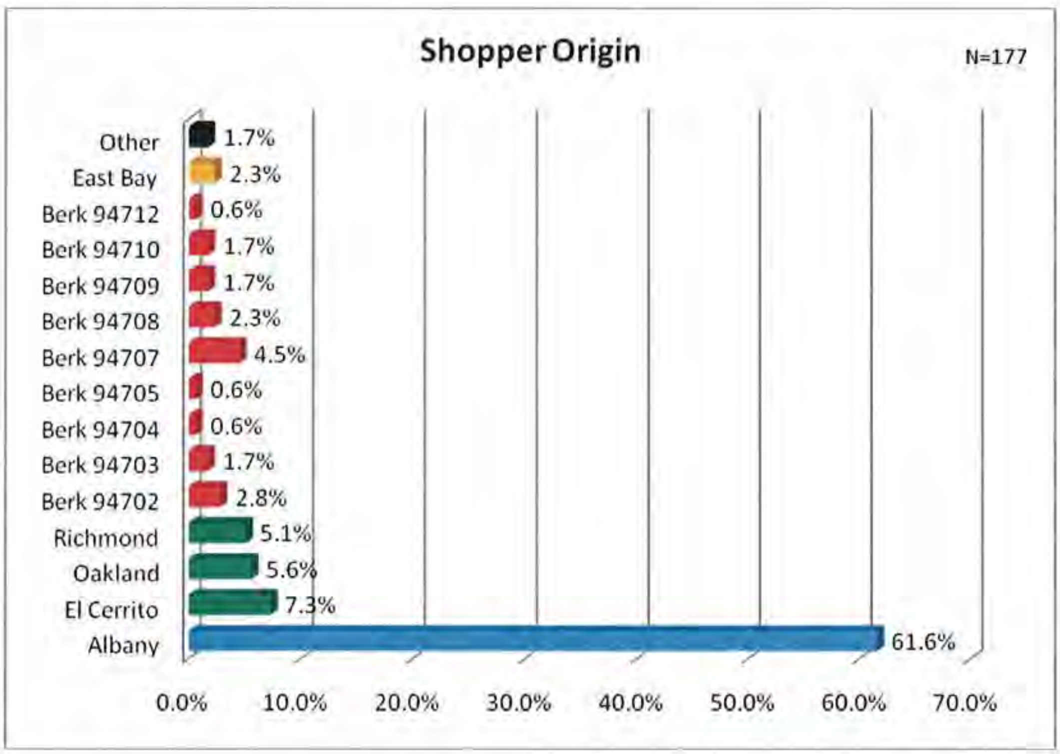
As in other markets, people may be less inclined to participate in the survey when they have children to care for, or more inclined as an example of good citizenship. Certainly, this weekday evening market in the summer is a place and time to educate our youth. Not only can the Market and its vendors reinforce adults' inclination to return by respectfully addressing children's wants and needs, but they can build the next generation of customers.

Child-friendly activities might expand that segment. Balloon and face-painting artists should be tested at this evening Market. Letters might go to Albany, Berkeley and El Cerrito school teachers presenting the option of an after-school class project. The Market might create programs to stimulate student interest or list community service projects at the market, anything from marketing and consumer research to vendor assistance and management support.

Vendors might be encouraged to consider how they can use spare moments to entertain and educate kids. Samples of bread, chocolate, kale, carrot or strawberry have sparked many a parent to buy a product when their child shows interest within a new environment. After all, who is better suited to convince a child of the health benefits of broccoli or cherries than a farmer?

The importance of children in the Market is also relevant to sales since adults shopping with children spend more than shoppers without kids [see Q7/Q2 on page **31**]. Since children are the Market's future, we may want to pay attention to their needs and survey parents' specific desires.

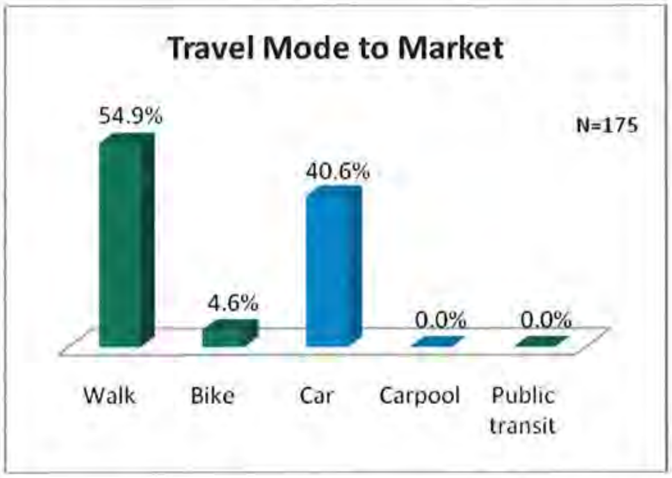
<u>Question 3</u>: What is your home <u>zip code</u>?



A solid majority of shoppers, **61.6%, live in Albany.** There was a clear statement of community pride repeated verbally by many very local customers. They are happy to have their own local market and want to have it thrive. Unsurprisingly, one-fourth as many shoppers (16.5%) come from Berkeley (red) and slightly more, 18%, live in El Cerrito, Oakland or Richmond (green). Thus, a total of **96% are very local shoppers.** Berkeley zip code percentages should be reviewed collectively since 0.6% represents a single shopper. Only 4% are other Bay Area or outside the Bay Area. This is not a tourist market.

The Albany Farmers' Market certainly makes it easier for a farmers' market shopper to get to market. It does not appear to be drawing any significant number of Berkeley residents away from existing markets in Berkeley, rather complementing Berkeley markets. We estimate that about 140 Albany customers are coming from Berkeley, and they come less frequently than Albany residents [see Q12/Q3, page 27].

Question 4: How did you travel to the Farmers' Market today?



After only six weeks the Albany Farmers' Market is demonstrating its neighborhood focus with a stronger level of "green transit" shopper than even the South Berkeley market, as evidenced by 55% of shoppers walking to Market. Only 40% of shoppers are coming by car, with a small number of bicyclists (4.6%). No respondent indicated coming by carpool or public transit. The means of travel to this market validate the neighborly feel.

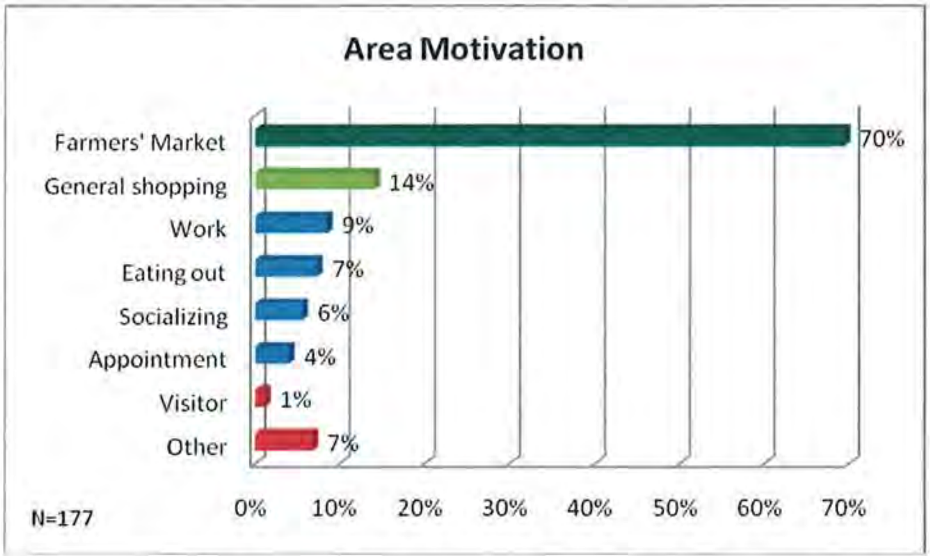
South Berkeley had 25% walkers and 21% bicyclists, and 49% coming alone by car. Another 6% were carpool or public transit users.

The "green" factor may be high, in part, because of the newness of the Market, strong local response (61.6% from Albany) and the smaller size of the Market. Those farmers' markets with larger vendor numbers often become attractive to customers from a wider geographical area; Albany is not yet drawing those crowds because of its size relative to many local markets.

The Inner Sunset Farmers' Market in San Francisco stands as the greenest market studied in the Bay Area with 76% walkers, including 91% of Inner Sunset residents (Corum, 2011). The small market size and limited parking are strong motivations for walking customers.

An Alameda Farmers Market study (Corum, 2005) found 57.2% came by car and 3.4% carpool. While 32.4% walk (very local), only 5.5% bike and 1.4% use the bus. Transit riders might be encouraged in Albany with a bus or transit stop ad campaign (see AC Transit or BillboardMart).

Question 5: What was your primary motivation for coming to the Solano section of Albany today?



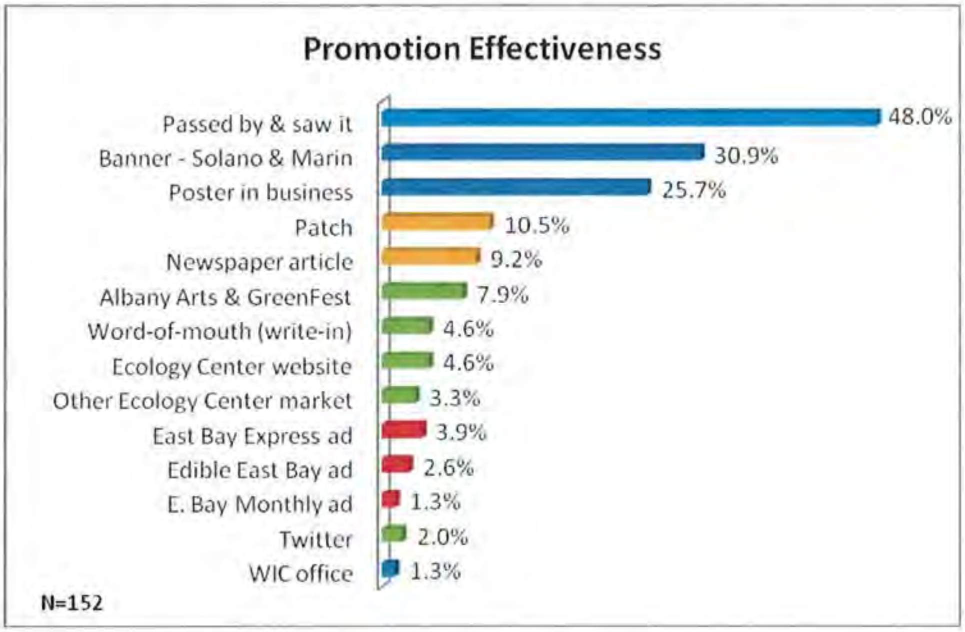
The Albany Farmers' Market is the key reason 70% of customers are in this area, stronger than the 59% for Berkeley and South Berkeley. Another 14% say they are motivated by general shopping. Thus, **the Market is a powerful draw with 5:1 greater influence than general shopping options.** (There were 1.17 responses on average for the 177 question respondents.)

Because of the location of heavily traveled Solano and San Pablo avenues, the Market is capturing 9% of its customers on the way to/from work, versus 6% in South Berkeley. In reverse, only 6% come for socializing (10% in two Berkeley markets studied). While 7% come to eat out at this dinner-time Market, additional choices would most likely cause the number to grow.

Getting promotional incentives to local companies for distribution to their employees may yield results with long-lasting impact. Various events are important in attracting new customers who might not otherwise attend. Other reasons customers are in the area include: post office, movies, haircut, job interview, break from studying, CSA pick-up, soliciting donations and curiosity.

This Wednesday market compares closely with West Palm Beach, FL where the farmers' market is the principal reason for 77% of shoppers coming to a much less active retail district (Corum, 2010). When only allowed one answer, 66% had the same motivation in Montpelier, VT (Corum, 2006), 65% in Manhattan Beach (Corum, 2009), and 56% in Roslyn, WA (rural destination town, Corum, 2010). The Santa Monica Sunday market found 71% (Low, 2010).

Question 6: What publicity about this Farmers' Market have you noticed?



While almost one-in-six didn't respond, the average 1.6 responses per customer provide some insight into the most effective publicity activities. Site visibility has the most powerful influence as evident by half of Market shoppers (48%) simply seeing the Market as they pass by. Another 31% notice the banner at Solano & Marin. One-quarter have seen the poster in local businesses.

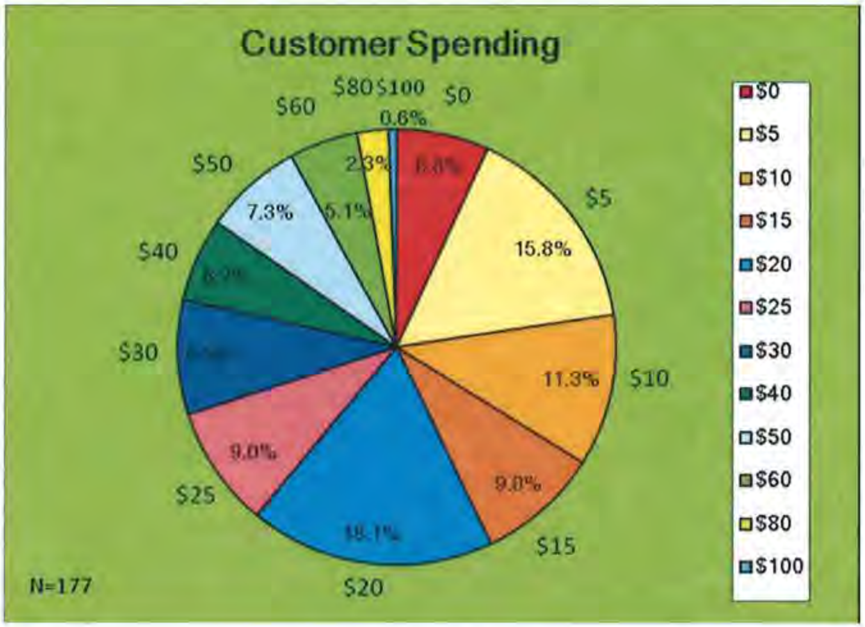
The Albany Patch, an electronic newspaper, appeared to equal to the local newspaper, though it must be noted that Patch representatives were present at the Market and proudly promoting their publication. Those media were substantially more noted than the ads in the East Bay Express, Edible East Bay and East Bay Monthly (red bars).

The Albany Arts & Greenfest appears worthwhile with 8% notice, equal to the number of people who found out through the Ecology Center website or one of the EC markets.

The recent South Berkeley Farmers' Market Consumer Study found that the three most powerful publicity motivators were coupons (21%), events (18%) and e-mail/newsletter (16%). All of these would be made more effective by a strong campaign to encourage customers to sign up to the e-mail account (for a coupon).

A colorful set of street banners/flags at the Market entrance would take advantage of the Market location, especially impactful for Solano traffic and a small deterrent to any random vehicular intrusion.

Question 7: How much did you (or will you) spend in the Farmers' Market today?



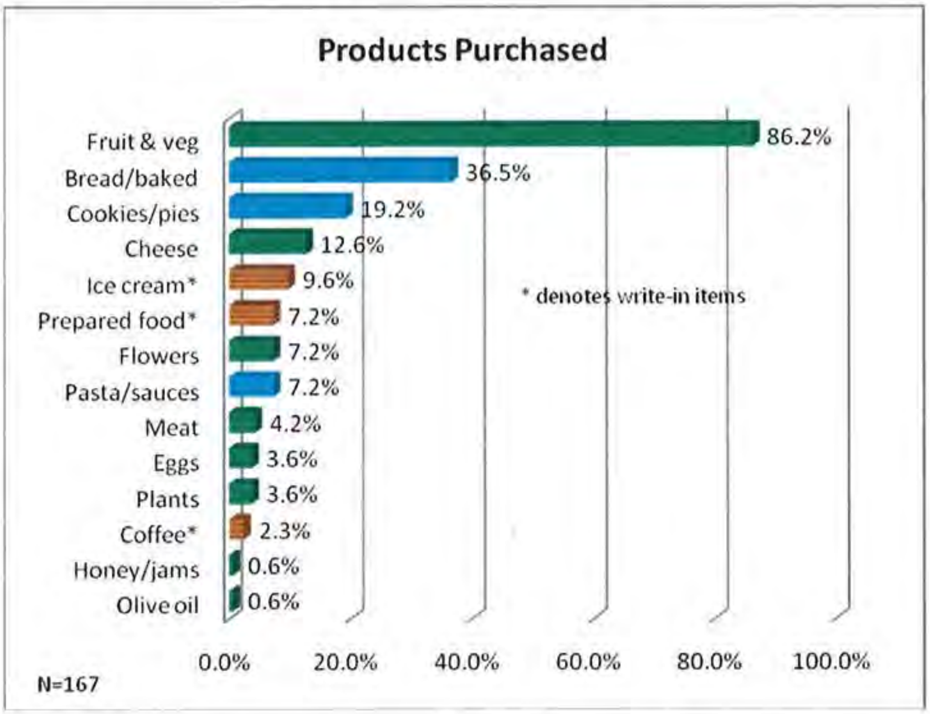
Customers spend $23.28 on average, about $4 (or 15%) less than the $27.43 spent in South Berkeley, or $8 (27%) less than the $31.83 at the Berkeley Saturday market. About 57% of shoppers spend $20 or more (about 65% in both Berkeley markets) and 21% spend $40 or more (25% in South Berkeley). These are typical figures for a new urban market of limited size, reflecting a good Market customer base with potential for bringing other shoppers to a higher level of spending.

By comparison, Alameda has 54% who spend $20 and 12% spending $40 or more, though six-year inflation is not taken into account (Corum, 2005). Davis had 49% spending $20 or more, and 15% spending $40 or more (Corum, 2005).

The 37% of respondents who were first-time Market visitors [see Q12 on page 16] makes up almost one-half of those who spend $10 or less [Q7/Q12 on page **27**]. While 6.8% of shoppers spent nothing, double that of South Berkeley, it is reasonable for a new market, and Berkeley had 8%. The Market already has a very comfortable feel.

If we assume 857 shopping groups, based on an approximate customer count, and multiply by the $23.28 average purchase, we can estimate daily sales at $20,000. Using the seasonal Market estimates of 1-3,000 customers, reinforced by this June day's estimate, we project sales of $750,000 if the Market were to run year-round. This figure might be better estimated with full summer shopper estimates (and higher average sales). It must be noted that over-estimates are common based on this calculation, likely a combination of 1) customer over-count, 2) non-participation in the survey by non-spending visitors (thus, average spending would be lower) and 3) customer over-reporting of purchases. It is wise to use this calculation in comparison with vendor sales reporting to determine probable total sales, especially with a new market.

Question 8: What products did you buy today at our Farmers' Market?



Fruits and vegetables are the #1 category for purchase by 86% of shoppers, well ahead of bread and baked goods with 36%. These data are validated by a May study of a San Francisco market where both categories were within two (2) points.

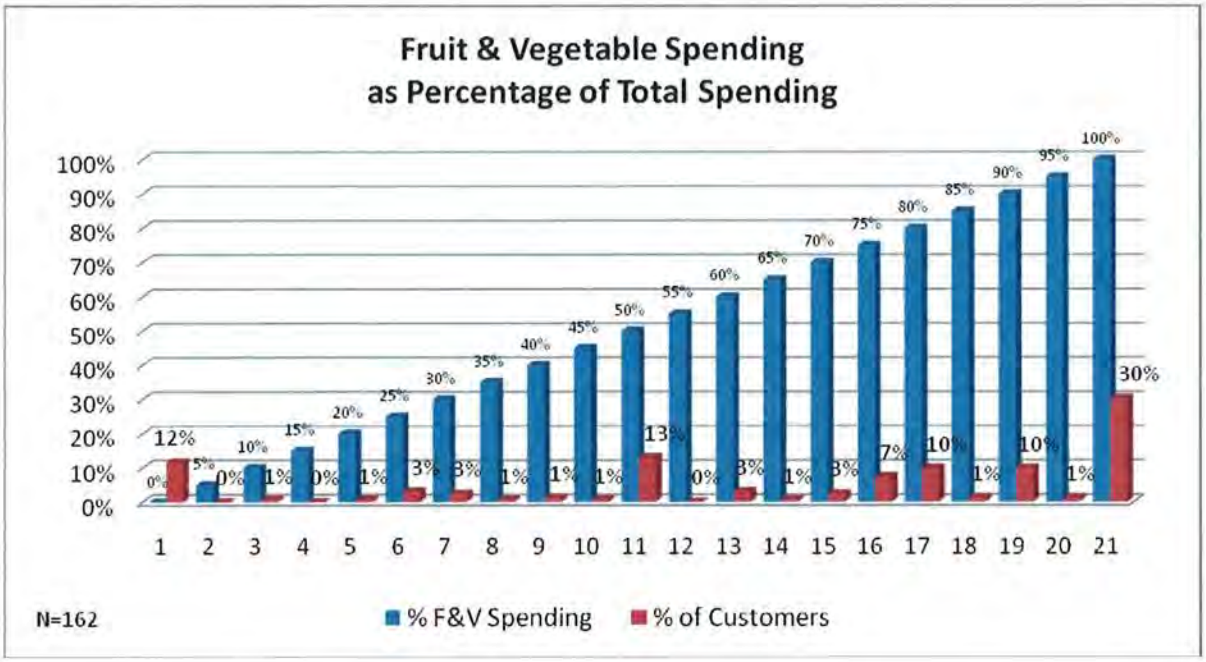
Cookies and pies were #3 at 19% of shoppers (4 times that in S.F.) followed by #4 cheese at 12.6% (43% higher than S.F.).

Write-in comments caused ice cream/sorbet to rank #5 with 9.6% and prepared food to be #6 with 7.2%. Tied as well for #6 were flowers (160% higher in S.F.) and pasta/sauces (similar to S.F.).

Meat, eggs and plants each had about 4% response, followed by coffee (write-in). Honey/jams and olive oil had only a single buyer each (while 14% and 3%, respectively, in S.F.).

The average respondent noted 2.0 items. These responses should allow management to review the relative merits of particular vendors and whether further competition might be appropriate. Consistent research may allow the Ecology Center to determine how their various markets have different buyers and whether new buyers can be encouraged based on products offered.

Question 9: What percentage of your farmers' market spending today was for fruits and vegetables?



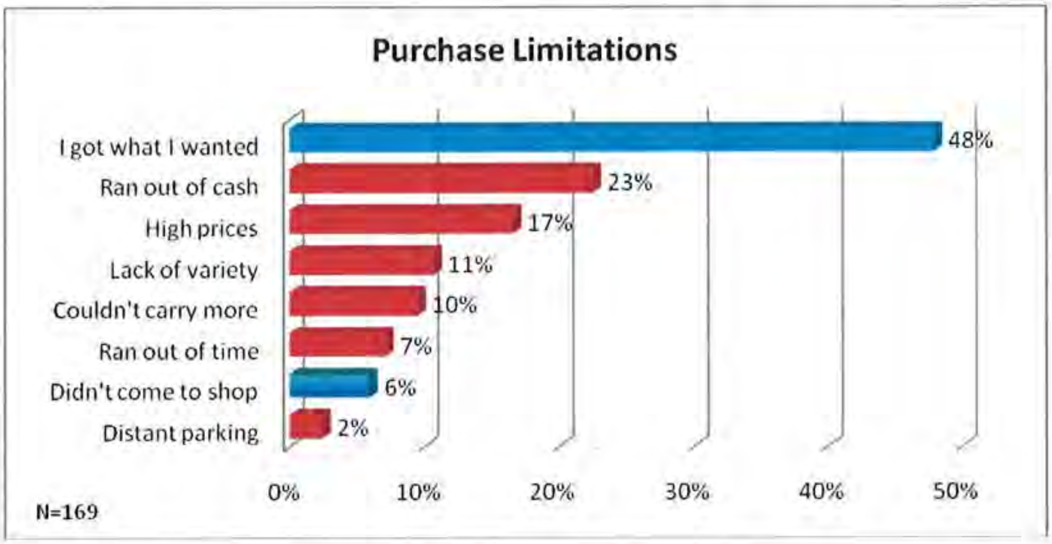
The blue columns represent possible fruit and vegetable spending levels as a percentage of total customer purchases in 5% increments from 0% in column 1 to 100% in column 21. The red columns reflect the percentage of customers in each spending category. Thus, column 11 shows that 13% of customers claim to spend 50% of their total on fruits and vegetables.

A good 30% of customers state that 100% of their Market expenditures for the day were spent on fruits and vegetables (column 21), comparable to Berkeley. Combining top categories, we see that **41% of shoppers spent 90% or more on F&V** (46% in South Berkeley), and 60% of shoppers (62% on Tuesday) spent at least three-quarters of their money on fruits and vegetables (columns 16 to 21).

Another 19% of shoppers dedicated 50-70% of expenditures to F&V. Thus, **79% of Albany customers spend a majority of their market dollars on fruits and vegetables** (comparable to Berkeley and South Berkeley).

Of the 21% spending less than half of their market money on F&V, over half spent absolutely nothing. Since the 12 people who spent $0 in the Market (Question 7) did not answer this question, we know that 1-in-5 Market visitors spend nothing on fruits and vegetables.

Question 10: What stopped you from buying more at the Farmers' Market today?



Respondents gave an average of 1.2 responses. Half of all respondents (48%) were satisfied. Only 6% didn't come to shop (11% at Berkeley market).

Shoppers gave five key explanations for not buying more:

- 23% run out of cash (less than South Berkeley but more than Berkeley),
- 17% consider high prices an issue (while only 5% at two Berkeley markets),
- 11% note the lack of variety (higher than the 7% in South Berkeley and 5% in Berkeley),
- 10% can't carry more (less than both Berkeley markets),
- 7% lack time (5% in both Berkeley markets) and
- 2% note the distant parking.

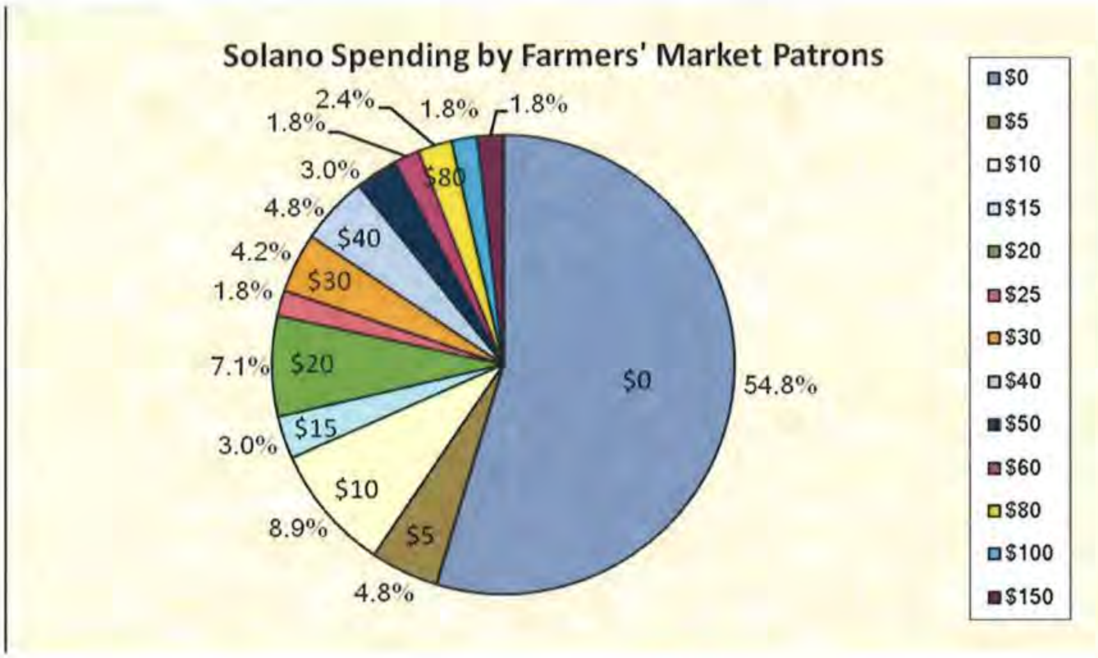
To address these issues, market management might consider these suggestions:

1. Provide cash access through an on-site ATM machine, even though not everyone who "runs out of cash" wants to have more. Some may have fewer resources or want to limit their cash available at market.
2. Repeat customers' price concerns to all vendor. With triple the frequency of complaints in Berkeley markets, Albany may have a more price-sensitive shopper, or it may be simply a function of a new market and high expectations.
3. Check to see that there is competition within various product categories. Ensure that all street space is used consistently by adding unusual items in the off-season. Maintain a list of last-minute vendors to call when there are openings for any reason.
4. Ease customers' burdens with a pick-up zone at the west end of the market.

Staff may want to explore various "cash" and "carry" solutions (ATM and pick-up zone) with customers before implementing a plan.

With 17% of customers stating that high prices limit their purchases compared to 5% in both Berkeley markets, which is already much higher than in dozens of other studies by this author in various states, this Market should quickly address this issue. If this concern lessens among customers, it may simply reflect the disappearance of customers who are complaining here during the initial start-up period. This could be explored with an area telephone survey.

<u>Question 11</u>: How much will you spend in <u>Solano businesses</u>, including restaurants, in conjunction with your market visit today?



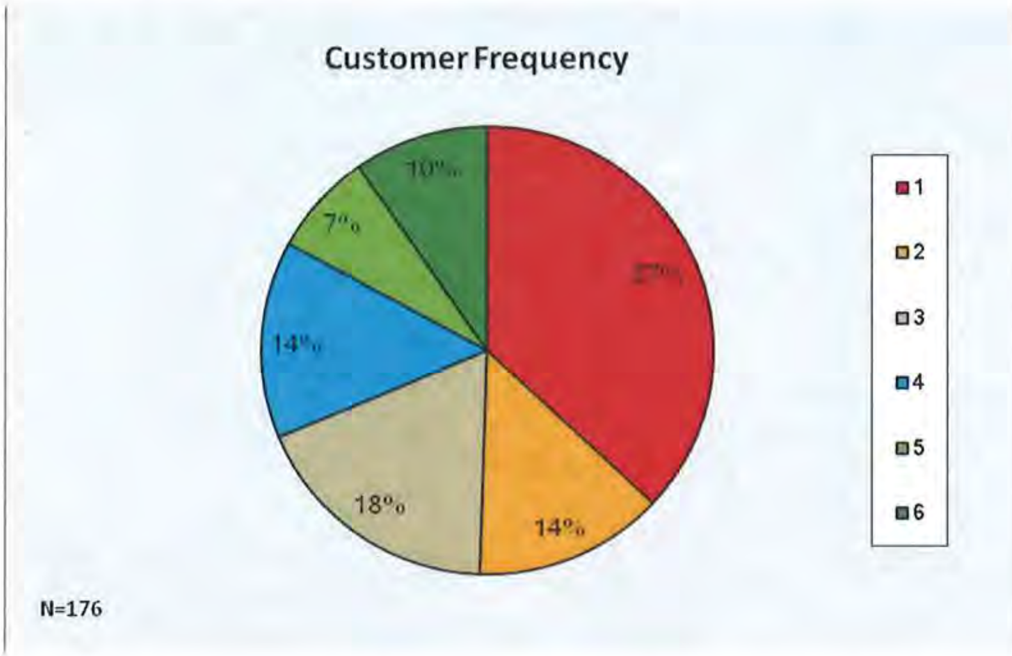
Albany Farmers' Market shoppers can be grouped in several categories relative to spending on Solano Avenue:

- ***Non-spenders*** – 55% of the market customers who spend nothing in other businesses when coming to shop the market.
- ***Low spenders*** – 17% of shoppers who spend $5 to $15 – have 10% of the total economic impact provided by all market customers to Solano businesses.
- ***Mid-size spenders*** – 23% of Market shoppers who spend $20 to $60 – provide 49% of the local economic impact.
- ***Top spenders*** – 6% of shoppers who spend $80 to $150 on a trip – provide 41% of the economic impact on Solano businesses.

The average Market visitor spends **$15.54 in Solano businesses** in conjunction with their trip to the market. What may be more important to note is that **those who do some amount of Solano shopping** (45%) spend more than they do at the Market, **$34.34.**

If there is interest, Solano businesses and the Market could engage in a joint promotion campaign. Also, local businesses might gain visibility as a Market sponsor of music, cooking demonstrations, book signings, pick-up zone or canvas bags. Any type of "Partner" or "Friend" of the Market has an intuitive understanding of the importance of all Market shoppers in helping to create a stronger set of *"destination desirables."* Market partnerships are a strong collective statement by the business community and the Market showing mutual appreciation.

<u>Question 12</u>: How many <u>times</u> have you shopped at this Market, including today? (This is the 6th week!)



As a new market, Albany is experiencing a tremendous number of new first-time shoppers each week. Given the difficulty of convincing newcomers to respond to a survey, we can be fairly sure that more than one-third (37%) of shoppers stopped in for their first visit. Significantly, half of all shoppers were on the first or second visit testing the Market.

It is too soon to say for sure, but it is healthy to see **50% are good or loyal shoppers** – coming a majority of market weeks since the May 4 opening – while South Berkeley has 45% and Berkeley about 35%. These Albany figures may likely change over time.

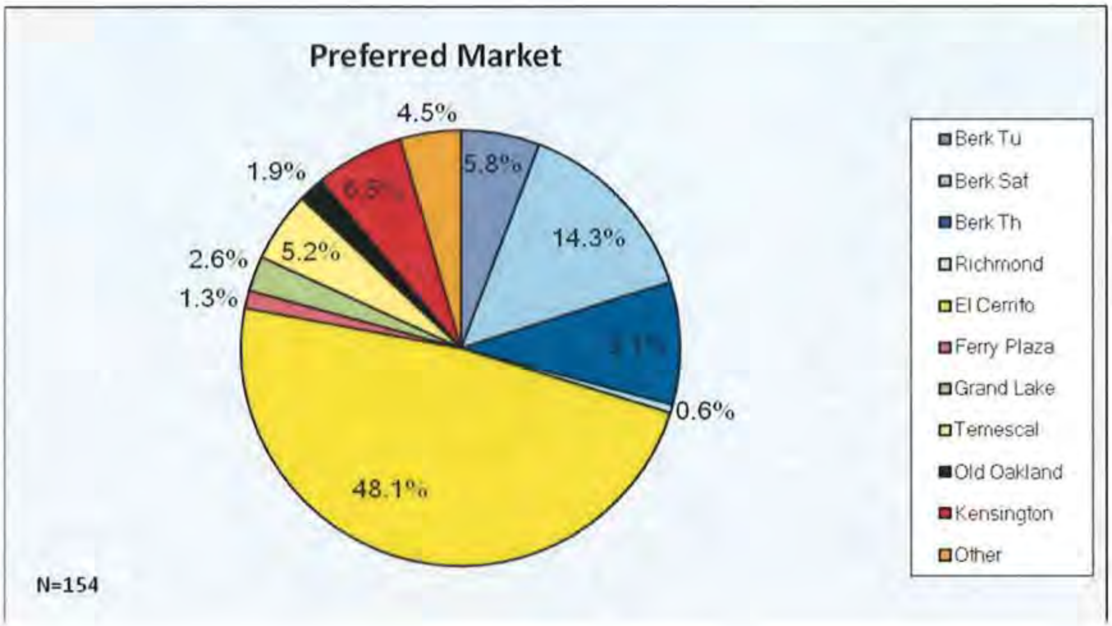
Market management and vendors share two strong goals: attract new visitors and reinforce their visit in a positive way to make them regular customers. Knowing that half of those who walk through the Market are relative neophytes should cause vendors to use samples, smiles and conversation to demonstrate the friendly nature of the Market.

We want all these shoppers to have a positive experience and participate in the organic word-of-mouth campaign that is the ultimate sign of a successful market. A "Bring a Friend" campaign might reinforce this concept, especially important among the 61% who are from within the City of Albany limits.

Key ways to grow the Market sales include:

- increase the frequency of existing customers,
- increase the spending level of customers, correlated with frequency [Q7/Q12, page 27],
- address customer purchasing limitations [Q10 on page 14],
- create more special events and incentives to stimulate first visits, and
- consider key products to spark first-time shopper interest and reinforce repeat customers.

Question 13: Which farmers' market have you shopped at most often in the last 12 months?



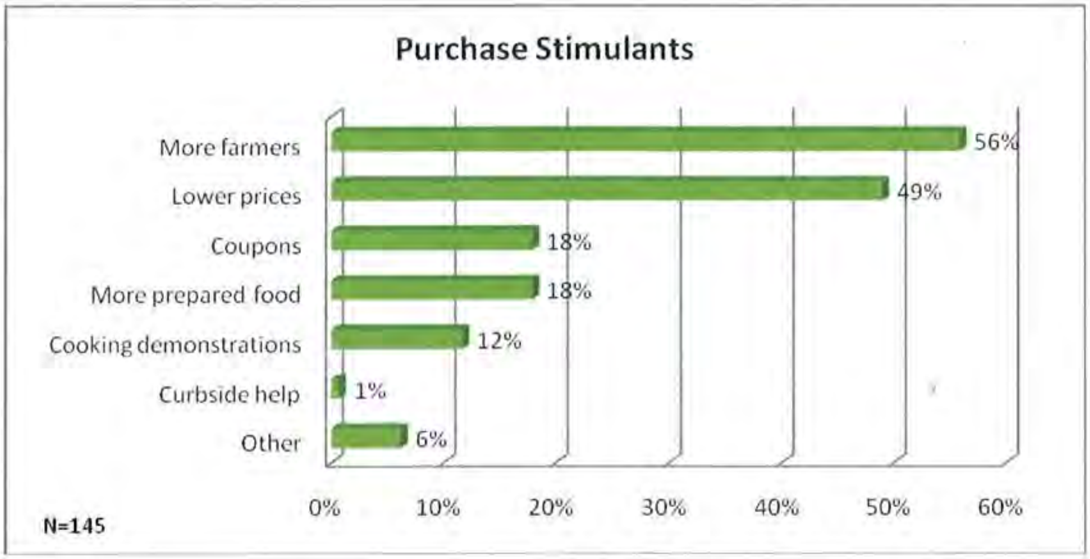
Half of Albany Farmers' Market shoppers have been to the El Cerrito market most frequently in the last year, not surprising given the strong base of Albany residents. The three Berkeley markets together (three blues) compromise about 30% of the Albany shoppers' historical preference. (We did not account for the various people that named more than one market, frequently in Berkeley.)

Kensington and Temescal markets were next most popular with 5% or 6% of shoppers. Grand Lake lagged behind because of the distance. Ferry Plaza has little following among the new Albany market shoppers.

There is a definite "farmers' market shopper" in the Bay Area, but that shopper is frequently not married to one farmers' market. They may shop two or three farmers' markets with equal frequency or dependent on their driving patterns and needs. They also may shop Monterey Market, Berkeley Bowl, Whole Foods, Trader Joe's, Costco and elsewhere. When they think of farmers' markets and other options, they evaluate the advantages and disadvantages of each (e.g., abundant variety and best hours versus crowded aisle and parking challenges). To maintain and expand our market's customer base, we should be sensitive to purchase limitations noted by customers (Q10). Given shoppers' tendencies, the Market should stay most aware of the El Cerrito market's relative merits and attempt to satisfy Albany residents.

The nearly 15% of survey participants who did not respond to this question seems to indicate that this Market is expanding the "Know Your Farmer, Know Your Food" message by reaching a new customer base that has not been going to any local farmers' market. Another 3% wrote in Albany, showing that they had not been shopping any farmers' market prior to this convenient start-up.

Question 14: **What changes would cause you to increase your purchases at this market?**



The top recommended change at virtually every market studied by this author is more farmers, noted by 56% of shoppers in Albany. What has never been seen before is the desire for lower prices running a close second among half of all Albany shoppers. This price focus is reinforced by the desire for coupons among 18%.

An equal number want more prepared food. Cooking demonstrations are desirable for one-in-eight shoppers. Only one shopper mentioned the need for curbside help.

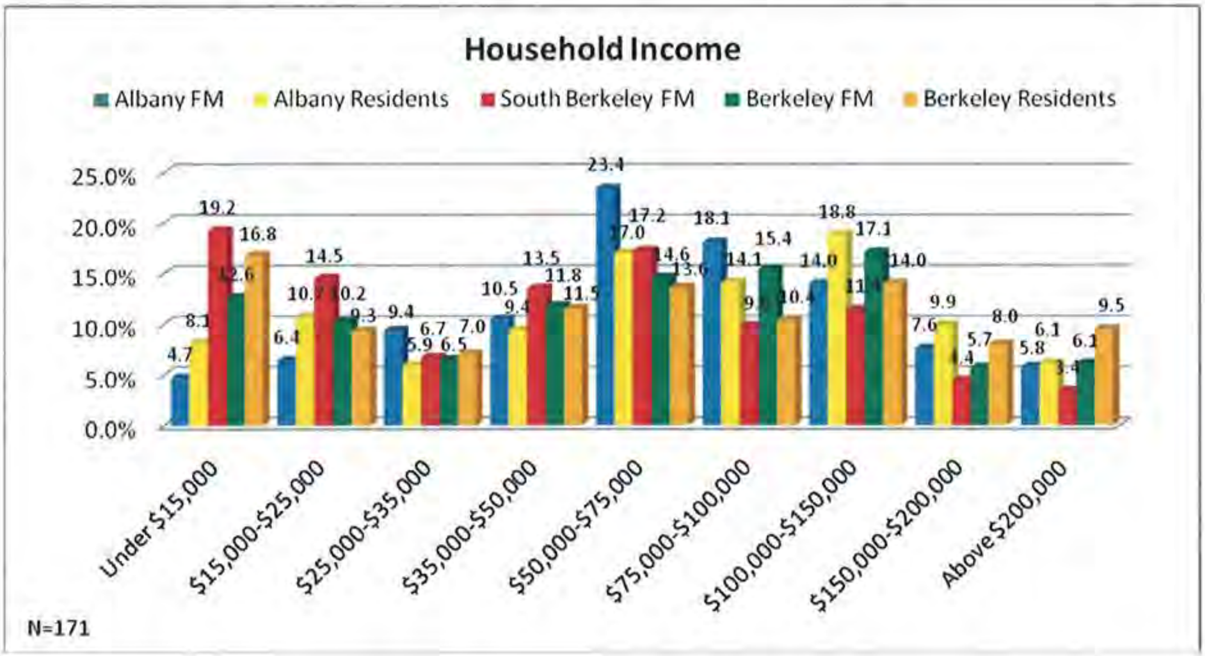
About 20% of shoppers did not answer the question. For a majority, the market meets their expectations, much as one shopper wrote, "None, I shop all the markets." Other written suggestions to increase purchases included music (2), tables (2), a job, bigger paycheck, bringing more money, chicken, and dogs allowed.

The author – developer of the original Tuesday market at El Cerrito Plaza in the late 1990s – hypothesizes that the non-organic history of the El Cerrito market just 6/10 mile north is directly conflicting with the organic focus of Ecology Center at its Albany Market. While an *organic* farmers' market alternative is positive, the 48% who are El Cerrito market patrons (Q13) mirror the 49% requesting lower prices. They are simply not used to paying the higher organic price.

Cross-tabulating those who have an issue with price with those who have most frequented the El Cerrito market from Q13, this hypothesis gains validity [see page **36**].

Demographic questions (to know if we get a representative group of people from the area):

Question 15: what is your total household income?



Recent studies show that the Berkeley market has a fairly representative set of customers from each income category relative to their numbers in the Berkeley population while South Berkeley has a stronger presence of customers from households under $75,000.

The Albany market has all income groups with a bit lower presence of the lowest income and the highest income shoppers and strong representation from the middle range. Only 20.5% of shoppers come from households below $35,000 (which are 24.7% of Albany households) and 27.4% are above $100,000 (34.8% of Albany). The other 52.0% of shoppers have $35,000 to $100,000 household income (40.5%). We need to remember that Albany residents comprise only 61.6% of Market customers.

By comparison South Berkeley has 40% below $35,000 (33.1% of Berkeley households), 40.5% in the middle three categories (35.5% of Berkeley), and under 20% above $100,000 (31.5%).

Berkeley shoppers were in between those two sets of statistics with 29% in the lowest three categories, 42% between $35,000 and $100,000, and 29% in the top categories.

Generally, households between $25,000 and $100,000 were most well represented in the Albany Market followed by households above $200,000 income.

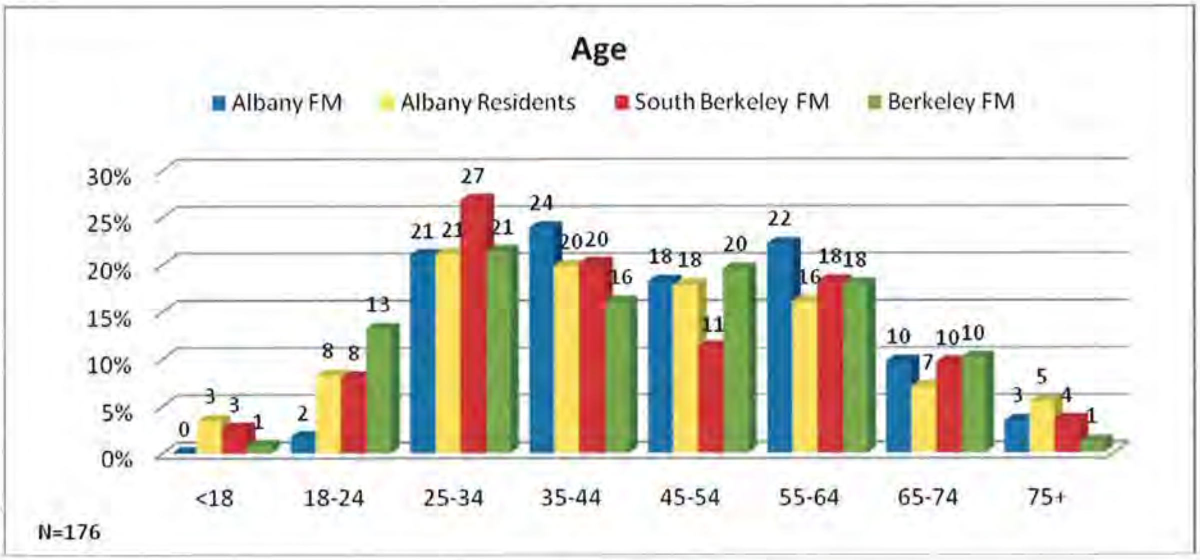
Median household income for the **Albany Farmers Market customer** is **$70,192,** well above Berkeley's $60,069 and South Berkeley's $45,667. This is fairly explained by Albany's median household income of $72,516 (American Community Survey) versus Berkeley's $59,335 U.S. Census. The South Berkeley market's median income is further explained by a 3:1 ratio of Berkeley to Oakland shoppers and Oakland's $49,695 median household income (U.S. Census).

With 95% response to this question, the income picture is fairly reliable.

Albany has lower rates of poverty than Berkeley, yet the number of Market customers from households below $25,000 appears low. Only 11.1% of shoppers are below $25,000 whereas 22.8% of Berkeley and 33.7% of South Berkeley customers come from the two lowest income groups. Two explanations may suffice: 1) 18.8% of Albany households vs. Berkeley's 26.1% are below $25,000, and 2) Berkeley markets attract more Oakland residents.

<u>Question 16</u>: Your <u>age</u>?

It is exciting and reinforcing to see that the brand new Albany Farmers' Market is already ageless. This **strong age cross-representation** is reflected in Berkeley markets and it may be a reality of the 21st century, following a period where studies show 35-44 year-old dominance. Markets today may have transcended all age barriers. This may result from the growth in young farmers and employees necessary for market system expansion, as well as various urban-based food businesses led by young entrepreneurs who attract a younger crowd.



All four age categories from 25-34 through 55-64 are evenly balanced with each having between 18% to 24% of the Market customer base, and 65-74 nearly 10%. Several age groups are especially well respresented at Market; 35-44 are 20% higher while 55-64 and 65-74 are 38% above what might be expected.

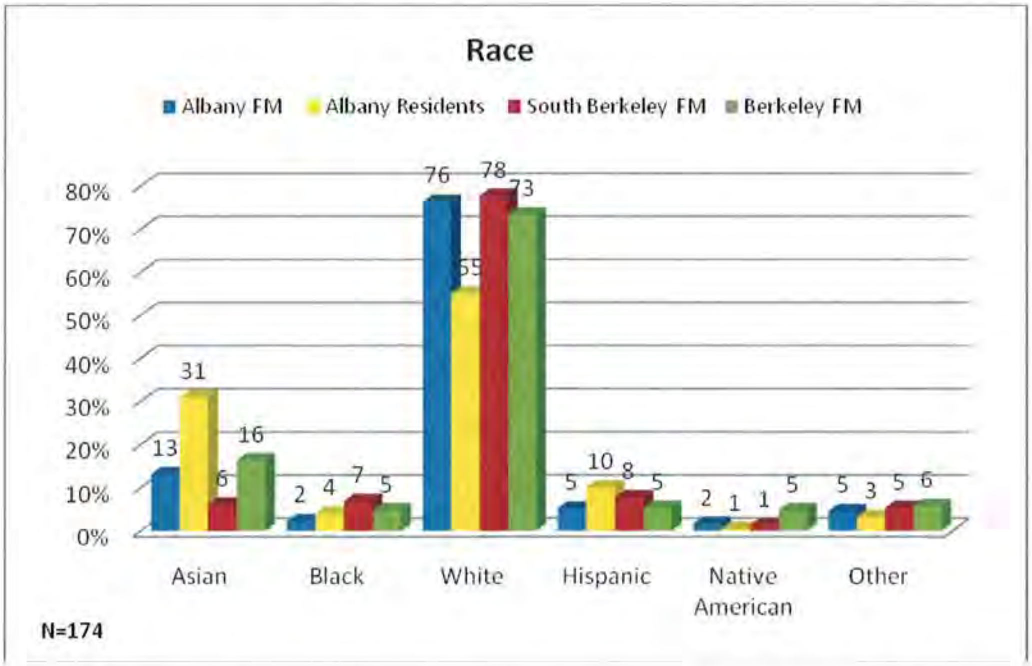
The 18-24 year-olds are less present (2% vs. 8% of the Albany population) than in Berkeley. Many may have chosen not to do the survey. No potential 15-17 year-old buyers (<18) completed the survey though they are 3% of the Albany population.

The Albany Farmers Market is an excellent melting pot of all ages above 25. While children were under-represented among actual respondents (typical), we know from Q2 that 33% of respondents had one or more children with them, so the Market has good family representation. Within Albany's population, 23.5% are children under 18, much higher than Berkeley's 4.7%. These potential future customers can be encouraged by Market youth program planning.

[Note: "Under 18" is assumed to be inclusive of only 15-17 year-olds. Children 14 and under are not represented in Albany resident data. The population figures for ages 15 to 75+ total only 80.2% of the total Albany population. Therefore, all eight age categories for "Albany Residents" are proportionally increased to total 100% so that the blue, red and green columns are comparable with 100% of the potential buying population. However, another limitation remains: that only Albany resident data is used, while Albany provides only 61.6% of the consumer population.]

Question 17: Your race?

Albany's population is 18,539. Recent growth has made Asians (5,790) 31.2% and Hispanics (1,891) 10.2% of the population. White residents have dropped from 61% in 2000 to 55% in 2010. The city's black population (645) declined to 3.5%. Native Americans are only 0.5% of residents. More residents are reporting multiple races than in 2000. Albany now has 7,889 housing units, and a vacancy rate of 6.2%. (2010 U.S. Census).



Much as in Berkeley, white shoppers make up three-quarters (76%) of the Albany Market population, though admittedly the English-only survey may skew these results. Asians make up 13% of shoppers compared to their strong 31% presence among Albany residents.

However, blacks (2%) and Hispanics (5%) were more well represented given they constitute only 3.5% and 10.2%, respectively, of the Albany population. Native Americans at 2% and other races at 5% are both well above the local populace.

These data should be considered when looking at new vendors (especially hot food), culturally appropriate products, event planning and promotional strategy. Any demographic group may find any of the many East Bay markets more desirable based on day, hours, location, products, prices and other characteristics. Albany shoppers were not averse to answering this question about race, with only 3% skipping the question, versus 12% and 23% respectively in Berkeley and South Berkeley.

Question 18: Other product or improvement ideas?

Of all survey respondents, 44% provided written comments compared to 57% in Berkeley and 33% in South Berkeley.

Comments were especially expressive of the desire for additional products, followed by those showing thanks for the market. Others provided ideas about seating, music, prices and the busy intersection. A variety of suggestions were made. All comments were transcribed as written by Market shoppers.

Vendors/Products (34)

I love it! More vendors!
More CCOF vendors, more entertainment.
More varieties.
A few more farmers & performers.
More farmers :)
2nd block - more of everything!
More selection.
More fruits & veggies.
Bigger variety - veg, ginger, garlic, eggs; more expensive than other markets.
More Asian vegetables, miracle fruit.
Disappointed that there were no peppers, cucumbers, tomatoes.
Eggs
I would buy eggs if I saw them!
I think there's a great mix! I didn't find eggs today but would have bought some.
Another meat vendor - sausage.
Starter plants.
Love the farmers and the food that is here! Maybe cheese?
More fruit.
It's great! Fresh milk. My son would like farm animals to pet.
Tofu & seafood
Pancakes!
Tomatoes please!
Chocolatier
Want eggs, olive oil & nuts.
Okra!
Coffee/espresso
Place to sit & eat, like community booth, want more prepared food choice, love eggs, would love dairy. If it were half way up Solano, I probably wouldn't go. I really enjoy the walk from my home.
Reasonably priced ready to eat dinner/meals.
Want Bernie's apple juice - goes Th & Sat.
Invite Catalan Farms!!
David at Fort Mason - soups/salads/
More vendors, like Flaco's Tacos, music.
More prepared foods.
Less prepared food.

Kudos! (17)

Like farmers' market because not overwhelmed - low key.
Great produce, friendly vendors.
It's great. No improvement needed.
Nope. Glad you are in this neighborhood finally!
Happy you're here!
Love having the nursery here! And Lone Oak & Phoenix Pastificio.
Thank you for being here!
No improvements - love it!
We love it.
Love it all!
None
None - great.
Great.
Thanks guys!
Great location!
Hang in there - it's generally slow at first but this has potential for being a popular Farmers Market. Thank you Ecology Center.

Music/Seating (17)

Music.
Music. Signs directing folks.
Music?!
Musicians.
Tables, more music.
Live music, art, dance
Music presentation.
Great music - Thanks!
Tables for eating near the food booths.
Table to sit at.
Tables to hang out & eat at.
Tables for people to sit & socialize. Ask Transition Albany?
More free samples, food truck & tables/chairs, music, weekly drawing for gift certificate
Coffee tables & chairs.

Price (4)
It's very nice, but high.
Love the market - prices sometimes seem just a little high. Stay open later in summer - 8 pm or later.

Negatives (2)
Don't have it at busy intersection.
This market does not belong here - bad for traffic, local business.

Ideas/Comments (12)
Thank you. Allow dogs.
Recycled packaging. Recycling electronics, if possible.
Crafts or recycling bags?
If the market grows, maybe Key Route Blvd would be a good location?
Did join CSA last time; otherwise might have bought more today.
Get an ATM?
All year long!
Publicity!
More post-work hours makes it more practical for more people.
Closer to me, not crossing San Pablo, create area to hang out.
Would like market in morning or weekend.
Bike parking.

III. Cross Tabulations

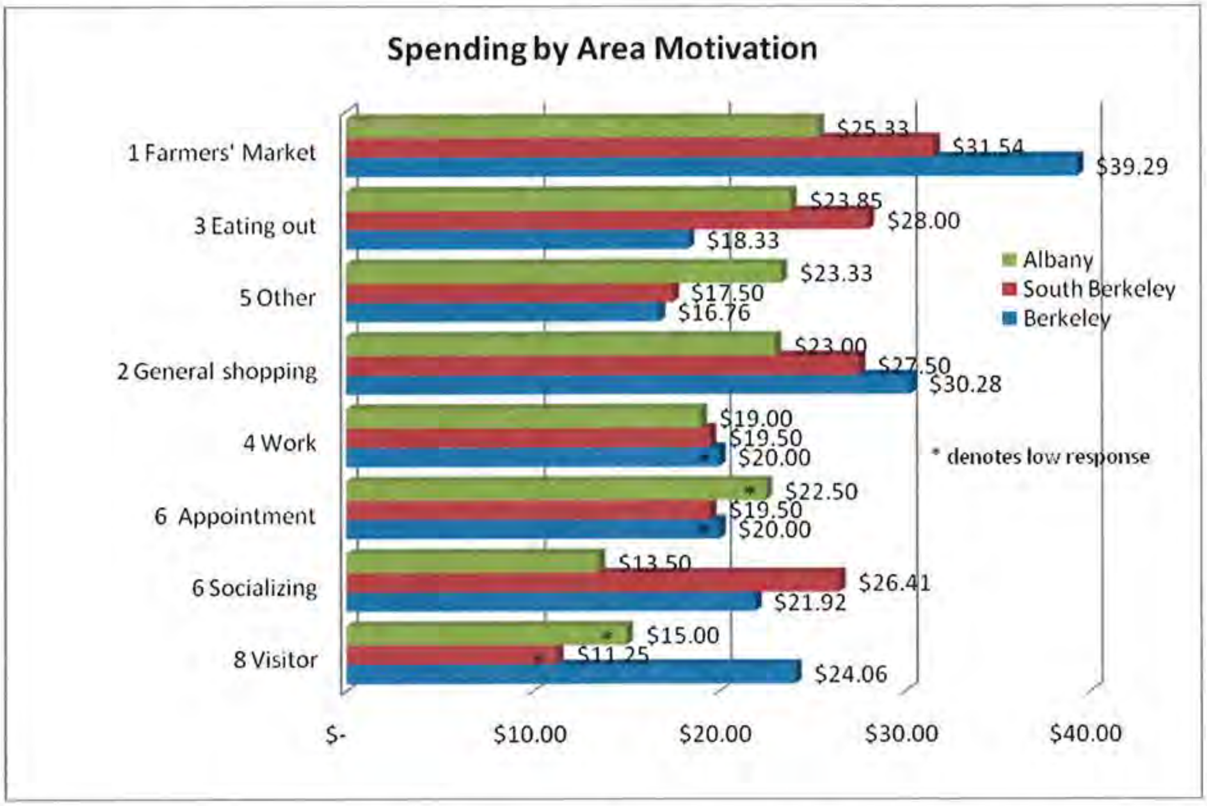
Analyzing the relationships between responses to various questions provides us greater understanding about Market customers. It may lead to yet other questions for further study.

Question 7/Question 5 – Market Spending/Area Motivators

Those coming to the Solano district specifically for the Farmers' Market spend more, $25.33 (versus $31.54 in South Berkeley and $39.29 in Berkeley), than those coming for other reasons. However, the differences are much less pronounced than in the Berkeley markets. Farmers' Market shoppers spend 10% more than General Shoppers, some of whom may really be coming for the Market.

The difference is less than 10% when comparing those coming to eat out, $23.85, (less than South Berkeley but more than Berkeley) and customers motivated by "other" reasons who spend more, $23.33, than in Berkeley markets.

Those who come downtown to socialize spend much less, $13.50, compared to the Berkeley markets. Limited responses for work, appointment and visitors make comparisons inappropriate.



There were 203 total responses, an average of 1.13 responses per customer. The numbers to the left of each motivator indicate the order of impact of each motivator in terms of total spending by those customers. Multiplying the number of people represented in the green Albany lines by the average spending to the right yields total spending. **Market-motivated** respondents spend more than five times ($3,040) that of general shoppers ($575). That in turn is about double the amount spent by those coming due to eating out ($310), work ($285) and other ($280). This is definitely not a tourist market but its location does attract passersby to try out the Market.

Question 7/Question 8 – Market Spending/Products Purchased

Albany and Berkeley markets show concurrence in the order of meat, cheese, baked goods and fruit and vegetables relative to average customer spending. However, in Albany the question was changed from "reasons for visiting the Market" to "products purchased" which allowed for a greater focus on which products people purchased and the spending level associated with each.

While Berkeley has the highest spending level per customer in each of these product areas, Albany was stronger than South Berkeley for the first three categories. **Meat-motivated shoppers spend the most, $60.00** (low response here is supported by the same spending level in Berkeley), ahead of those buying **cheeses, $36.25,** and **baked goods, $31.15.**

Those coming for fresh **fruits and vegetables** spend $26.82, on average, below South Berkeley ($28.35) and Berkeley ($31.58).

Filling out the perspective with the greater product realm in Albany are eggs, bought by six people spending $59.17 each, pasta/sauces $36.25 (equaling cheese), flowers $32.50, plants $28.33 and other $27.93. Those buying cookies or pies averaged only $23.28 total purchases.

There were 330 total responses, an average of 1.83 responses per customer, well below the 2.85 responses in both Berkeley markets. The customer counts within each motivator line multiplied by average spending of those customers gives **total spending.** Spending by those buying the **#1purchased item fresh fruits and vegetables** is double that of those buying **#2 bread/baked goods,** followed by **#3 other (especially sorbet), #4 cookies/pies** and **#5 cheese.** Each of these top five categories has 10% or more of customers purchasing them. These are followed by #6 pasta/sauces, #7 meats, #8 flowers, #9 eggs and #10 plants.

If a promotional program is focused on product, separate from events and entertainment, one should be sensitive to the higher average spending levels for particular motivators. Customers may need reminding about meat, cheese and ice cream since farmers' markets are often synonymous with fruits and vegetables and other farm-fresh items.

Question 7/Question 12 – Market Spending/Market Frequency

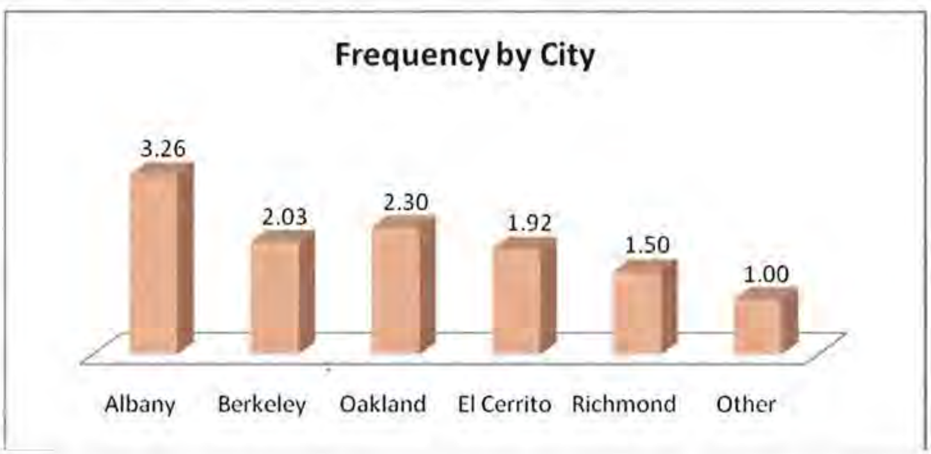
Spending has been shown to be positively correlated with frequency of Market attendance, although it is not absolute in Albany. The chart below shows spending by return visitors to be $24.72, which is 21% higher than the $20.38 spent by first-time visitors. Notably, **one-third of all spending is done by first-time Market shoppers** (37% of all shoppers).

Of those spending $50 or less, 50% come to the Market the majority of the time (43% South Berkeley, 26% Berkeley). Among those spending more than $50 – only 7% of shoppers – 38% come to the Market most of the time (59% South Berkeley, 77% Saturday). This may be due to low numbers, 5 of 13. As in South Berkeley, even somewhat more regular customers may be found to spend little at the Market, and less regular customers may report spending a lot.

First-time shoppers were 37% of all respondents (of both questions), but make up 48% of those spending $10 or less, and 44% of those spending $20 or less, but only 26% of those spending more than $20. First-time shoppers do spend less than repeat customers.

Question 12/Question 3 – Market Frequency/Zip Code

Responses are given with the greatest number of total visits – customer impact – from left to right.



Respondents from Albany (107) have averaged 3.26 visits in the first six weeks of the Market, and have six times the number of customer visits of Berkeley residents (29) who average 2 visits thus far. Oakland shoppers (10) average 2.3 visits and El Cerrito shoppers (12) average 1.9

visits, resulting in the same total number of Market visits. Richmond residents only average 1.5 visits in these six weeks. Customers from other areas were all on their first visit.

If we look at customers who have come a **majority of the time** (3 or more visits), **64% of Albany residents** meet the standard, surpassing any given city's residents at the Berkeley Farmers' Market. Only **31% of Berkeley residents** have shopped the Albany Market a majority of the time, while 50% of Oakland residents (only 5 of 10), 25% of El Cerrito and 13% of Richmond shoppers.

Given the newness of the Market, it is inappropriate to target certain zip codes using this data. It does appear that Albany has a good start on providing a consistent customer base that can be expanded through many promotional efforts.

Question 7/Question 3 – Market Spending/Zip Code

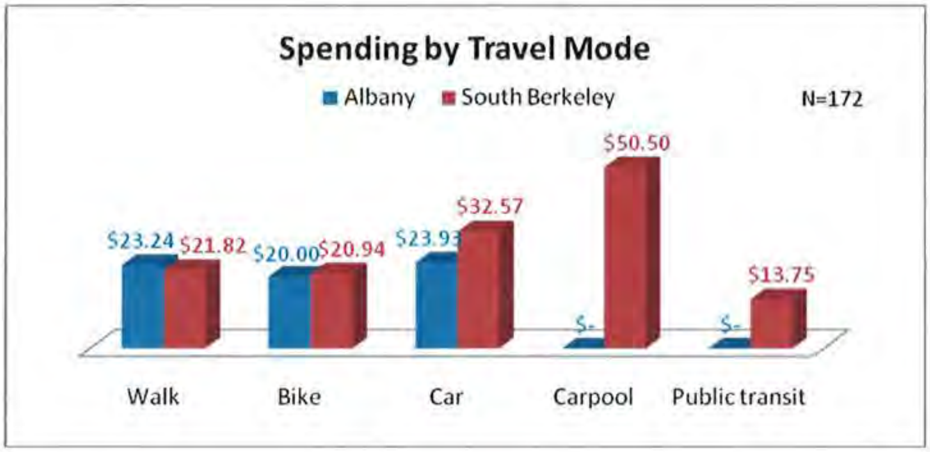
Responses are again given with the greatest customer impact in columns from left to right. Generally, the data reinforce previous observations that spending increases with frequency (see Q7/Q12, previous page), and frequency is related to proximity to market (see Q12/Q3, immediately above). Of course, it is also affected by overall customer income which is lower in some communities.

Spending varies somewhat by where customers live with Albany residents spending on average 16% more, $25.05, than Berkeley residents, $21.55. The other four columns are limited in reliability with 7 to 12 responses each.

Question 7/Question 4 – Market Spending/Travel Mode

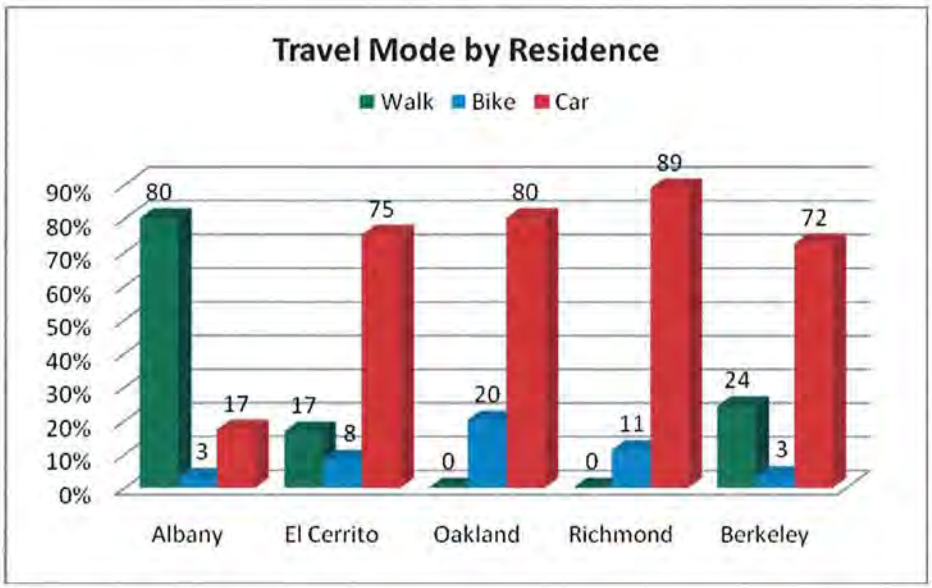
Looking at the chart below, there is no real difference in spending levels between Albany Farmers' Market shoppers who come by foot ($23.24) and car ($23.93). Only eight people came by bike, and none by carpool or public transit.

Perhaps this will change over time to reflect the reality of South Berkeley where customers coming by car spent $32.47, or 52% more than walkers and bicyclists combined, and 10 carpool respondents spent over $50 each, while eight using public transit averaged $13.75.



Question 4/Question 3 – Travel Mode/Zip

Because of small individual numbers, all Berkeley zip codes are combined. Albany and Berkeley data are significant with 105 and 29 responses respectively. Caution should be used with El Cerrito, Oakland and Richmond data, based on 9-12 responses each. None of the respondents claimed to use a carpool or public transit.

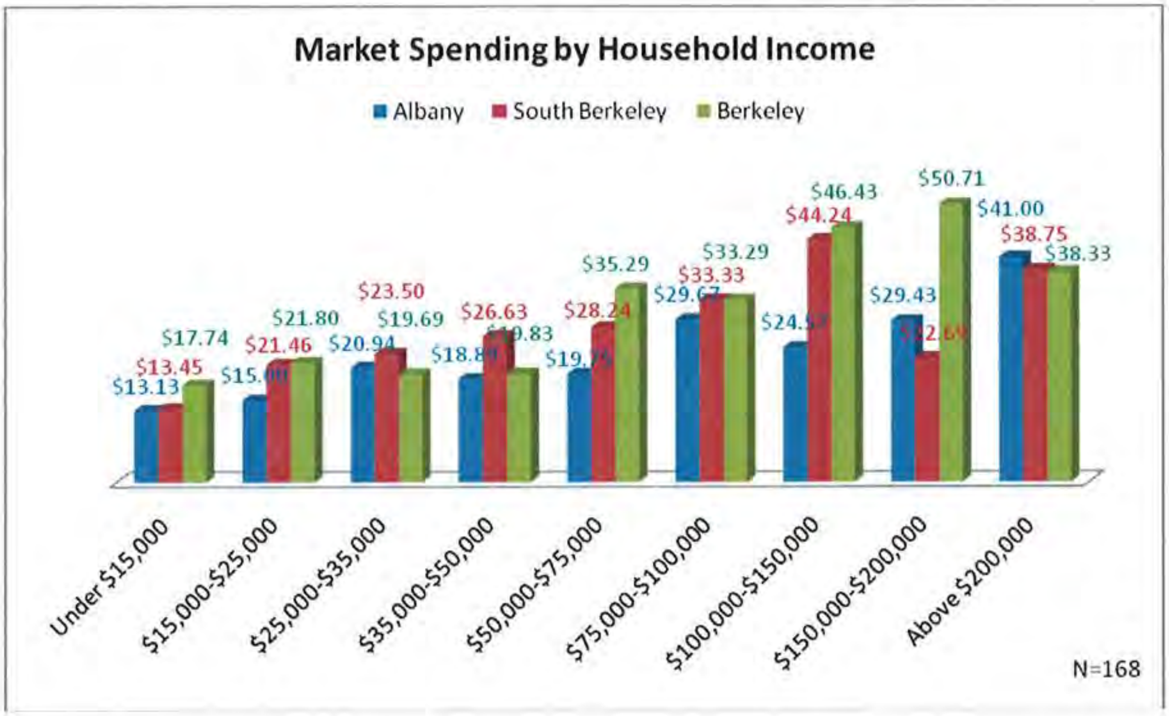


In Q4 we found that nearly 60% of Market customers avoid a personal car coming to Market (48% in South Berkeley). **Five of six Albany residents, or 83%, either walk or bike to Market** (equal to zip code 94704 for South Berkeley).

One-quarter (27%) of Berkeley residents shopping the Albany Market come by foot or bike.

Of course, all these data are dependent on having intercepted a truly representative group of Market customers. The green shopper may be more inclined to respond to this type of survey. To validate the data, a one-question intercept could be done on any market day to capture virtually everyone.

Question 7/Question 15 – Market Spending/Household Income



There is a fairly **positive correlation between household income and spending** in the Albany Market, much as with both Berkeley markets studied recently. Households with **incomes under $25,000 spend an average of $14.17,** while those **between $25,000 and $75,000 spend $19.80.** Households **between $75,000 and $200,000 jump to $27.80** and those **above $200,000 rise to $41.00 in spending.** Generally, spending by people in these broad categories is lower than similar households in the Berkeley markets, likely a function of a new market with 37% first-time shoppers vs. markets with years of customer familiarity.

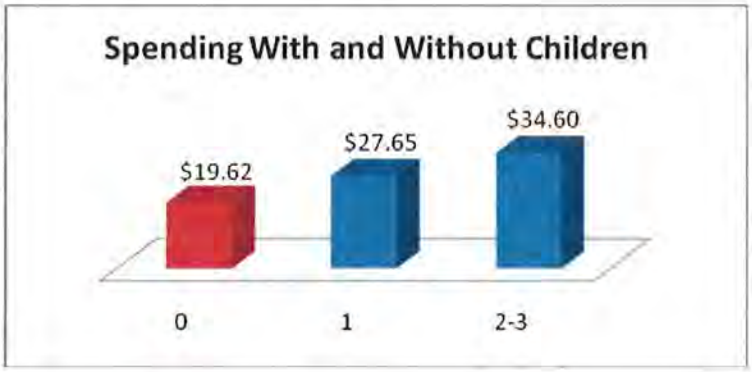
These data may tempt management to target certain income groups, for example, by sending direct mail to higher income households. However, it must be noted that **higher customer counts (55%) cause those from households under $75,000 income to account for 43% of purchases, equaling the impact of those (39%) between $75,000 and 200,000 income who account for 46%.** The 6% above $200,000 make 10% of all purchases.

It is probably more effective to simply target households in the immediate area.

Question 7/Question 2 – Market Spending/Children

While there has been no strong difference in spending between those shopping with or without children at either Berkeley market, that is not the case in Albany.

Among customers shopping without children, the spending level is $19.62 while those with one child spend $27.65 and those with 2 or 3 children spend $34.60. Numbers are substantial in each category. **One-third of customers shop with one or more children,** and combined at $30.59, they **spend 56% more than shoppers without children.**

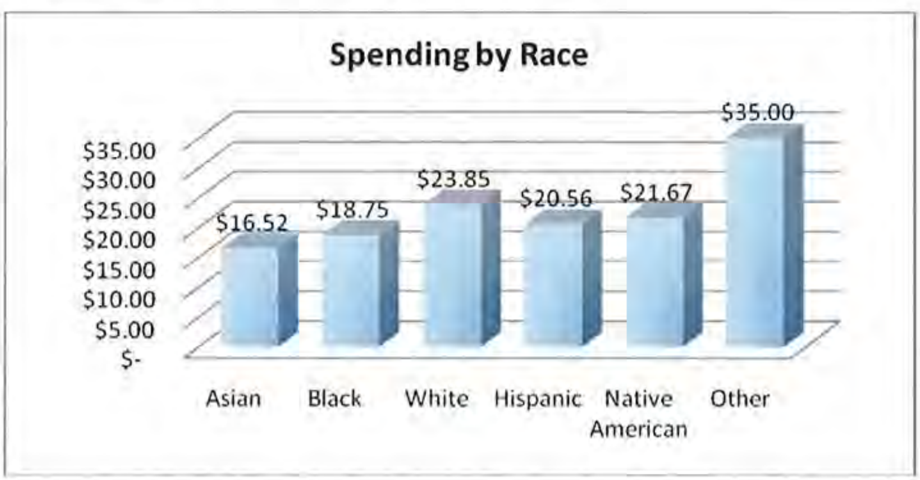


In the South Berkeley consumer study, it was noted that shoppers with two children spent $41.43, more than 50% above shoppers with no child or one child. However, they numbered only 4% of shoppers, and 2-child Berkeley shoppers actually spent less than those without children in their shopping group. Thus, it was not appropriate to come to any logical conclusion.

Now, with data from 34 shoppers with one child and 25 shoppers with 2 or 3 children, it is clear at least in Albany that those shopping with kids actually spend more. This may be a result of kids' influence on their parents, or it may be related to purchases over the dinner hour, or it may simply be that the family has more mouths to feed.

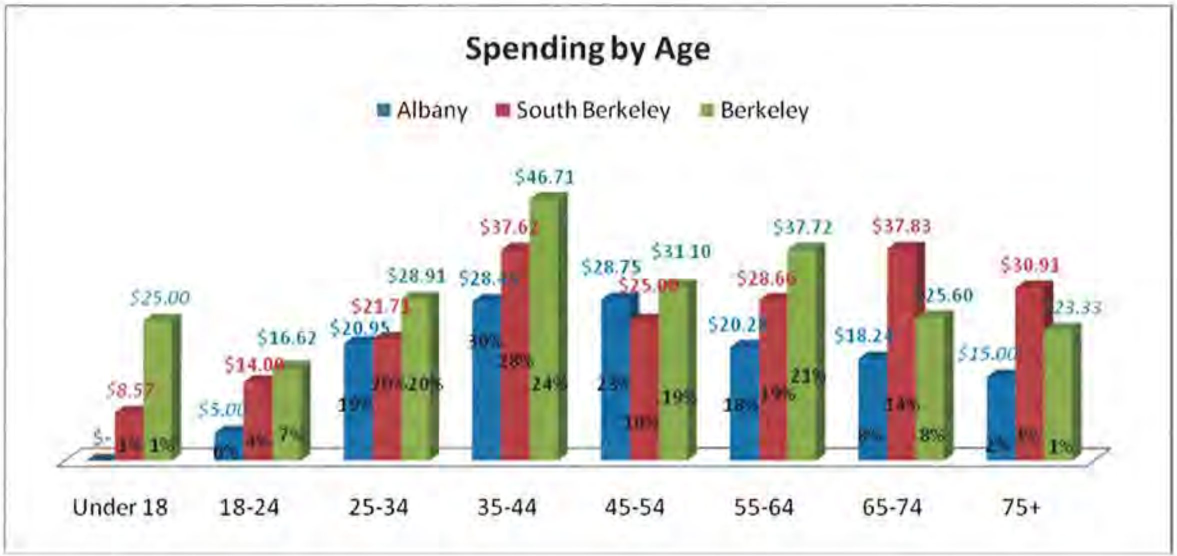
In the future, we might want to note how many adults shopping with children do not respond to a survey. They may be more likely to participate in a quick assessment with a very limited number of questions presented in a highly visual format.

Question 7/Question 17 – Market Spending/Race



Because of the low numbers in the Albany population, there were unreliably small numbers of blacks, Hispanics, Native Americans and other races present among respondents, albeit at higher levels than Asians. Whites outspent Asian survey respondents by 44%, $23.85 to $16.52.

Question 7/Question 16 – Market Spending/Age



Albany has lower spending but similar age-related shopping patterns to both South Berkeley/ Berkeley (data in parentheses). The four most powerful age groups are:

> 35-44 spend **$28.45** ($37.62/$46.71), with **30%** (28%/24%) of all purchases;
> 45-54 spend **$28.75** ($25.00/$31.10), with **23%** (10%/19%) of all purchases;
> 25-34 spend **$20.95** ($21.71/$28.91), with **19%** (20%/20%) of all purchases; and
> 55-64 spend **$20.28** ($28.66/ $37.72), with **18%** (19%/21%) of all purchases.

Seniors are less powerful as in Berkeley, which is not the case in South Berkeley:
> 65-74 spend **$18.24** ($37.83/$25.60), with **8%** (14%/8%) of all purchases.

Collectively, 25-to- 64-year-olds make up:

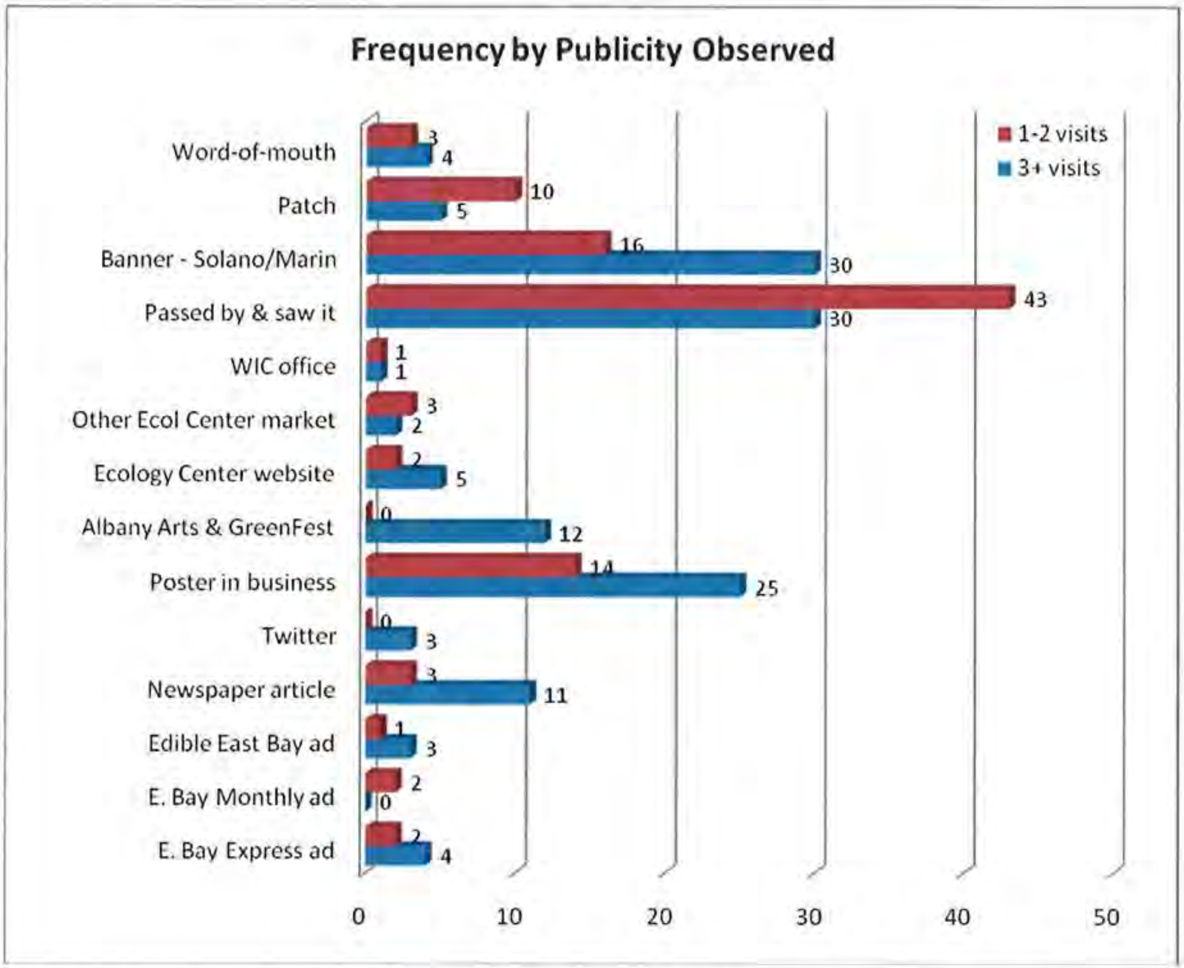
- 85% of shoppers, and make 90% of purchases in Albany;
- 76% of shoppers, and make 78% of purchases in South Berkeley; and
- 75% of shoppers, and make 84% of purchases in Berkeley.

In South Berkeley purchasing is very evenly spread throughout all age groups, including older buyers. In Berkeley the sales are concentrated in the middle four age groups (25 to 64). In Albany, 25 to 64 year-olds also dominate in terms of purchasing, unsurprising given that they make up 85% of the population.

However, seniors 65 and older – 13% of shoppers and 12% of Albany's population – account for the final 10% of expenditures in Albany, as might be expected given smaller household size. Reflecting on population data and customer surveys, the Albany Farmers' Market is from the start an ageless market. Only 18-to-24 year-olds, much less numerous in the population than in Berkeley, seem not to have become connected to the Market, or perhaps they simply avoided the data gathering.

Question 12/Question 6 – Market Frequency by Publicity

Having noted the impact of various publicity efforts in Question 6 (N=152, 1.6 responses per customer), it seemed worthwhile to note if there are any differences in customer frequency at the Market as a result of specific publicity. Because many are low, numbers are specifically used rather than percentages so the reader can beware of the temptation to make too many judgments. New shoppers provided 43% of all responses.



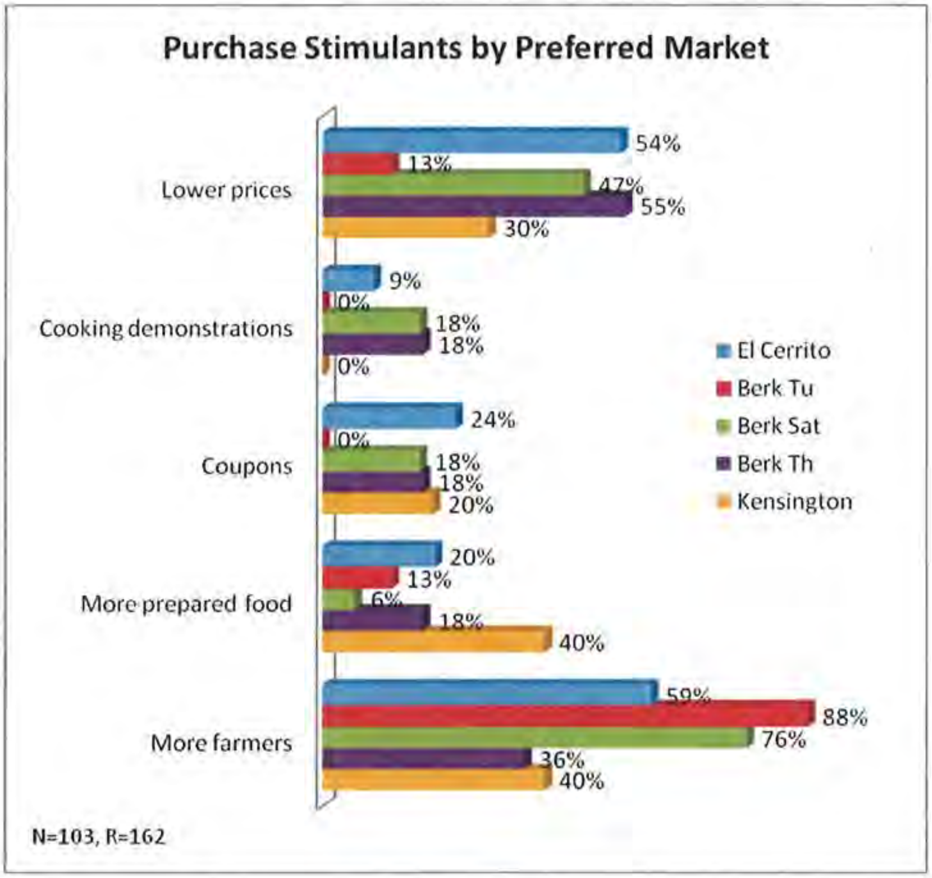
What is striking about regular shoppers (3+ or a majority of Market days) is that they have seen printed publicity about the Market more than new shoppers (1 or 2 visits): *banner* (30:16), *poster* (25:14), Ecology Center *website* (5:2), newspaper *article* (11:3), Edible East Bay *ad* (3:1) and East Bay Express *ad* (4:2). The *Albany Arts & GreenFest* was also effective in creating repeat customers (12:0).

New shoppers have had a greater tendency than regular customers to *pass by & see it* (43:30) or read it in the Albany *Patch* (10:5).

As noted earlier, the three most effective publicity vehicles overall are: the Market's immediate visibility, the banner on Solano and the poster in various businesses. They are far and away the most impactful ways of reaching new customers and reinforcing regular visits.

Question 14/Question 13 – Purchase Stimulants/ Preferred Market

We found in Q14 on page 18 that the top two issues for Albany shoppers are more farmers (56%) and lower prices (49%). However, we hypothesized that prices might be of greater concern to El Cerrito shoppers. That leads to this cross-tabulation with many insights available.



Albany Farmers' Market shoppers have notable differences in the changes they would like to see in the Market based on which farmers' market they have most frequented in the last 12 months. A huge 88% of Berkeley Tuesday and 76% of Thursday customers want to see more farmers in Albany, well above the 56% average. Meanwhile, only 36% of North Berkeley and 40% of Kensington customers felt the same. Perhaps they are more accepting of the smaller number of farmers because those markets are similar. Just above average was the 59% of El Cerrito customers who want more farmers in Albany.

El Cerrito customers are more likely than other Albany shoppers to consider the prices high, by 54% versus 40% of all other shoppers. Only 30% of Kensington and 13% of South Berkeley customers noted the same concern. We have no ability to confirm or deny the hypothesis that the more conventional farmer base in El Cerrito may be a key reason why El Cerrito customers tend to complain about high prices in Albany where organic produce prevails. The 24% of El Cerrito customers who want coupons in Albany is further evidence of their price sensitivity, most starkly compared with 0% of South Berkeley customers.

We must be careful with all the Berkeley market data here because it was not uncommon for people to note two or three Berkeley markets they most frequented last year, but only one market was input into the database.

Question 11/Question 5 – Local Spending/Area Motivation

Solano Spending by Area Motivation

Area Motivation	Average	Total Spending
Albany Farmers' Market	$12.41	$1,440
General shopping	$15.48	$325
Eating out	$15.00	$195
Other	$10.42	$125
Work	$ 8.08	$105
Appointment*	$22.14*	$155
Socializing*	$12.50*	$100
Visitor*	$47.50*	$95

Farmers' market-motivated shoppers spend less individually in the local business district, $12.41, (versus $14.67 with Berkeley market), than other shoppers in conjunction with their visit to the Market; however, their sheer numbers give them clear status as the **#1 customer group in total spending with local businesses** with expenditures exceeding all other motivators combined. General shoppers spend more locally, $15.48 (Berkeley $20.29), but have less than one-quarter of the economic impact of farmers' market-focused customers. Third most popular is coming to eat out; those shoppers spend $15.00 ($23.33 in Berkeley) in local businesses.

Those coming downtown for other reasons spend $10.42 (Berkeley $11.27), and those coming to/from work spend only $8.08 along Solano.

Data was based on 130 respondents answering both questions. Given fewer than 10 responses, several motivations (*) have undependable averages, though socializers spending $12.50 is relatively consistent with $15.20 in Berkeley.

Berkeley (Derby) Farmers' Market Consumer Study March 29, 2011

Tuesday, 2:00 – 7:00
Derby St. at MLK Jr. Way

Prepared by:

Farmers' Markets America
Vancouver, WA
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Berkeley Farmers' Market (Derby)
Consumer Study, March 29, 2011

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Executive Summary and Recommendations

In 1987 the Ecology Center (EC) opened a Derby Street farmers' market on Tuesdays. In 1990 they opened a second Center Street market on Saturdays, followed in 1997 by a third Shattuck Avenue market on Thursdays. All three markets operate year-round. The oldest Berkeley Farmers' Market is the subject of this study. This Tuesday operation is a vibrant, urban, neighborhood market with customer counts generally ranging from 1-3,000 through the course of the year. While the first, the Derby market sits within an area of Berkeley, Emeryville and Oakland now densely populated with farmers' markets on most every day of the week.

Because a similar customer study was completed at the Berkeley Farmers' Market on Saturday in October, many of the results from Derby Street are compared with those of Center Street.

Key insights – by the numbers – from this study include:

- **85%** of market shoppers are local – 59% Berkeley, 21% Oakland and 5% Emeryville.
- The Farmers' Market motivates **59%** of people to the area on Tuesday, just as Saturday.
- **62%** of shoppers spend at least three-quarters of their money on fruits and vegetables, and **84%** of customers spend a majority.
- **61%** of respondents were satisfied (no reason to not buy more); **28%** ran out of cash.
- **9%** are true visitors for the first time.
- **45%** of all shoppers come to the Market more than half the Market days each year.
- This is not a tourist market like Saturday; people come to shop and for community.

Customers report **$27.43 average spending** at the Market (14% less than Saturday), with "loyal" and "good" Market shoppers averaging **$31.54**. Tuesday has a strong base of solid customers, with **65%** spending $20 or more, equal to Saturday's 64%. Spending levels are positively correlated with Market frequency, though not as dramatically as Saturday. While 59% of those spending more than $50 (10% of shoppers) come to Market a majority of the time, only 43% of those spending $50 or less come as frequently. [See Q6/Q12 on page 27].

Shoppers can be grouped according to their frequency in attending the Market:

- ✓ **Loyalists – 29%** who shop 41-52 times per year,
- ✓ **Good customers – 15%** who shop 26-40 times per year,
- ✓ **Fair customers – 24%** who come 11-25 times,
- ✓ **Occasional buyers – 23%** who come 2-10 times this year, and
- ✓ **First-time visitors – 9%** who have just taken the first step.

Relative to promotion effectiveness, and avoiding the ubiquitous "word-of-mouth" response, customers say that **coupons** (21%), **events** (18%) and **e-mail/newsletter** (16%) **will most affect their attendance.** Infrequent shoppers (1-15 weeks) said they will respond to radio (73%), flyers (55%), coupons and sandwich boards (50%). Good customers (26-52 weeks) are more responsive to newspaper (47%), e-mail (45%), sandwich boards, coupons and events [page 33].

Key customer motivations are: fresh fruits and vegetables (93%), atmosphere/socializing (52%), baked goods (30%), ready-to-eat foods (29%), entertainment/musicians (21%), good prices (18%), cheese (17%) and meats (16%). However, the spending level by those with each of these motivations changes the relative order of their importance [see Q6/Q9 on page 26].

From the 39% of respondents who gave reasons as to **why they didn't buy more,** we find five key issues: 72% ran out of cash, 31% can't carry more, 18% complained about variety, and 13% found both prices and lack of time problematic. Surprisingly, parking was not an issue.

The Market is a **melting pot** of people from **all income levels, ages and races.** Median household income for market customers is $45,667, much lower than Saturday's $60,069. Households below $35,000 are 40% of the customer base and above $100,000 only 19% (Saturday they are equal) but those wealthier households spend almost equally in the Market [Q6/Q15, page 29].

All six age categories from 18-24 through 65-74 have at least 8% (10% Saturday) of the Market customer base. As on Saturday, the **three biggest spenders as an age group** are: ages **35-44 at $38.39, 55-64 at $30.45** and **25-34 at $19.81** (because they number 27% of shoppers). They are followed by 65-74 at $38.10 (much higher than Saturday at $25.60) and 45-54 at $26.14. Purchasing is relatively spread out through all age groups, heavily weighted by senior buying power on Tuesday, where 65-74 year-olds spend equal to 35-44 year-olds.

Over three-fourths (78%) of shoppers are white and 8% Hispanic, while blacks (7%) and Asians (6%) are both substantially under-represented.

Two-thirds of shoppers (66%) are adults shopping alone. One-fifth have one or more children with them. This is truly a "green" market with half of its customers coming by foot (25%), bike (21%) or public transit (3%).

The full results presented in the study below provide the Board of Directors and staff with a detailed picture of Tuesday customers at the original Berkeley Farmers' Market. Potential courses of action in the form of recommendations are presented here for consideration, for review with vendors and/or for more thorough investigation with customers:

1. Aggressively expand e-mail mailing list, using small promotion items as incentives.
2. Construct a flag bank at the Market entrance to reinforce a lively, positive atmosphere.
3. Provide easy access to cash through an on-site ATM machine brought to Market by truck.
4. Create pick-up zone at one end of the market to ease customers' burdens.
5. Call waiting list to expand the product and service mix, especially in off-seasons.
6. Repeat price concerns to all vendors as stated by customers.
7. Consider longer hours or widened Market aisle to ease space concerns.
8. Conduct a Berkeley-wide study of non-shoppers, investigating concerns and disincentives.
9. Stay conscious of the young children and work with B-Tech and Independent Study.
10. Consider a vendor incentive program to motivate youth-centric attitudes and behavior.
11. Mention meats, cheese and baked goods with product-based ads and promotions.
12. Implement a BFM Frequent Shopper card.
13. Prepare a trial direct mail coupon postcard reinforcing attendance on an event day(s), focused on select zip code with high frequency and good spending level.
14. Key banner words: real farmers, great atmosphere, baked goods, and ready-to-eat.
15. Find local companies open to be Market Supporters, e.g., reminder e-mails to employees.
16. Host vendor mini-meetings to strategize how to grow customer purchases and frequency, including customer ideas: more farmers, longer hours, artisans and more prepared foods.
17. Study other area Markets to see what they're doing right, especially with ethnic sensitivity.
18. Green the market with a local doorhanger coupon, Berkeley Biker coupons and Bike Produce Carrying Contest (bike shop sponsor), or other creative ideas.

I. Overview

In its 24th year of operation, the original Berkeley Farmers' Market runs every Tuesday from 2-7 p.m. on Derby Street between Martin Luther King Jr. Way and Milvia Street. Present on the day of the study were 21 farmers (complex fee formula) and 12 non-agricultural vendors (6% plus $10). The Market also hosted a Cesar Chavez event that day. After weeks of rain, the customer turn-out was up considerably; people were eager to be out in the sunny, 70 degree weather.

The study goal was to obtain solid customer data while obtaining a reasonable response rate to assure the data's validity. A single-sided, 19-item questionnaire was developed that could be answered in three minutes. The intercepts were done on March 29 toward the eastern end of the Market, next to the market information booth. Survey staff attempted to discern when customers were leaving the Market, and asked them to help the Market by completing the survey. It was presented to them on a clipboard with a pen for self-administration. They were offered a choice of three incentives thanks to donations by Smit Ranch, Queen of Sheeba and Phoenix Pastificio.

Customer counts are done annually at this Market. These may be validated by the count done on March 29 as part of this study. Counts are useful in noting seasonal changes and responses to advertising and promotion activities. Consumer research including counts also can be useful in inspiring vendors to participate because they better understand the demographics of their customer base.

This report on the original Berkeley Farmers Market on Tuesday is meant to stand on its own, but having studied the Saturday market last October, we thought it valuable to note similarities and differences between the Derby and Center Street markets. Comments and figures for the Saturday market are frequently presented here in parentheses for comparison purposes. It is assumed that the reader of this study will have read the October 9, 2010 Saturday study, so comments here about the Saturday market are limited.

The customer counts and intercepts of 320 shoppers were done by a team led by Vance Corum. Many thanks are due Adam Edell, Suzie Rose, and Romina Filippou for their hard work. Corum completed all the data input and analysis.

As with any survey of this nature, care must be taken in reflecting on data and recommendations that are based on counting 2300 adult shoppers, even though we attained a good 20% capture rate with 320, or one-fifth, of the shopping groups out for a Market experience on one particularly beautiful, sunny, late March day.

II. Customer Count

To arrive at a reasonable crowd estimate without allocating staff to sit at either end of the street for the entire market period, we did 10-minute counts in the middle of each hour, i.e., from 2:25-2:35, etc. We then multiplied each number by six to arrive at the hourly estimates below.

MARKET ENTRANCE COUNTS

(by number and percentage each hour)

	West/MLK		East/Milvia		-- Total --	
2:00-3:00	132	6%	210	9%	342	15%
3:00-4:00	192	8%	264	12%	456	20%
4:00-5:00	282	12%	336	15%	618	27%
5:00-6:00	294	13%	204	9%	498	22%
6:00-7:00	150	7%	156	7%	306	13%
	1050	46%	1170	51%	2220	97%
Pre-count					60	3%
Total Customer Count					2280	100%

On March 29, 2011, we estimate that 2280 adults entered the market. **Customers entering from Milvia are 11% greater in number than those entering from MLK (51% to 45%),** in spite of heavy parking use around Berkeley Tech at the east end of the Market.

The pre-count was 60; that is the number of adult shoppers in the market prior to opening. Given those additional 60 people over the first hour count of 342, it is a good opening with 15% of the customer base. However, this is not like many markets where the first hour is the best.

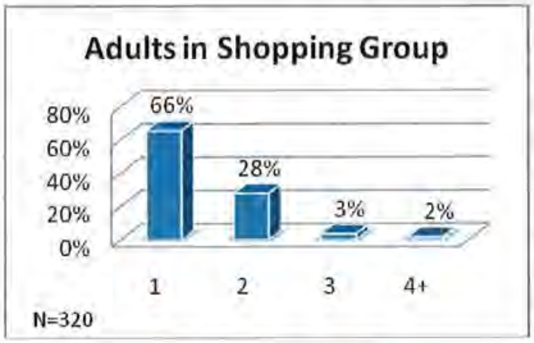
The market appeared to strengthen in numbers from 3:00 to 5:00 p.m., with 47% entering in that timeframe. It maintained a strong fourth hour from 5:00 to 6:00 with 22%, as people were getting off work, and kept a relatively good level of activity in the final hour with 13%.

We divided our total adult count of 2280 by an estimated 1.4 adults per shopping group, based on Question 1, to arrive at a figure of 1,630 shopping groups. This is important for determining the economic impact on market vendors.

III. Consumer Survey

We intercepted 320 customer groups with a 19-question written survey. Based on an estimated adult shopper count of 2280, there were 1,630 shopping groups (using the 1.4 factor in Q1), and thus our 320 customer intercepts represent a 20% capture rate. The response was very positive, more so than at the Saturday market last October where an estimated 14% of customers responded to the survey. This may be due to the more neighborhood feeling of the market with fewer petition gatherers and others trying to grab customers' attention. It may also be a reflection of the willingness of customers shopping alone to participate in a survey; single shoppers were more prevalent on Tuesday than Saturday, 66% versus 53%.

Question 1: How many adults (18 or older) are in your party?



Two-thirds of those surveyed (66%) were adults **shopping alone** (compared to 53% on Saturdays). Another 28% were couples or two adults shopping together (while 38% Saturday). Only 6% were in groups of three or more adults. The average was 1.4 adults per shopping group. These data reflect a fairly strong single shopper trend while one-third shop with one or more companions. Vendors have a good opportunity to engage in longer conversations with a single shopper who isn't distracted by another adult companion.

Question 2: How many children (under 18) are in your party?

Eighty-one percent (81%) of shopping groups had no children under 18 with them, which leaves vendors and management to ponder how to intrigue the **one in five parties** that **have children.**

Many parents want the Market to serve as an education venue, even as entertainment is an obvious part of shopper motivation (Q9). Sampling foods is a key element in satisfying children who will influence adults' inclination to return.

Since the Tuesday market has nearly twice the youth base of Saturday, proportionately, regular child-friendly activities would expand that segment. While markets often don't want to become nanny magnets, it is important to attract the partner-at-home-with-child sector that has money to spend for food and entertainment. Balloon and face-painting artists are common at weekend markets and this market deserves them.

Some Berkeley Tech students cruise through the market leaving school. Teaching staff at nearby Independent Study and Berkeley Tech (see Q19 list) showed interest in developing programs to stimulate student interest. Student tours might lead to students doing community service projects at the market, anything from marketing and consumer research to vendor assistance and management support.

Vendors also should be encouraged to think of how they can use spare moments to entertain kids; the kids of the past are now customers. We build the next generation of customers through inclusiveness, whether a sample of bread, chocolate, pickle, tofu, carrot or strawberry. Many a parent buys a product when their child shows interest within a new environment, and who better to convince a child of the health benefits of broccoli or blueberries?

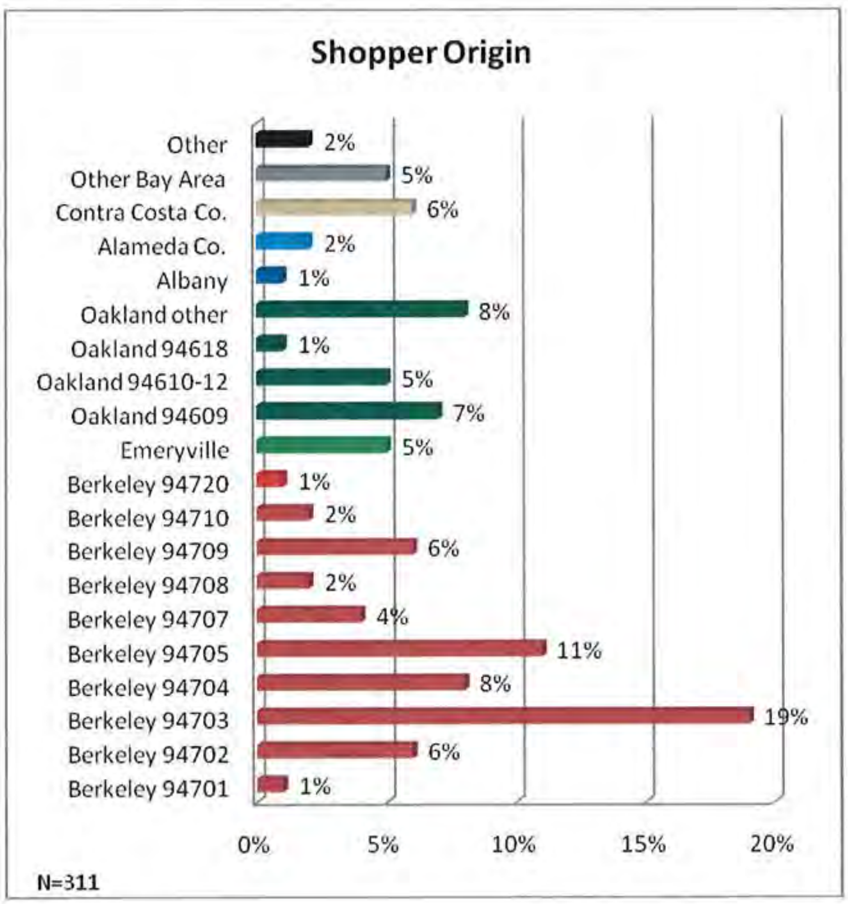
Compared to Center Street, Derby customers with children spent slightly – $2 – more than shoppers without kids [see Q6/Q2 on page 29]. Again, given that these children represent the Market's future, we may want to pay attention to their needs and even survey parents' specific desires. It also might be valuable to pay attention to some customers' desires for a widened aisle to allow for easier passage of strollers and child backpacks. Several people made comments about the congestion.

<u>Question 3</u>: What is your <u>zip code</u>?

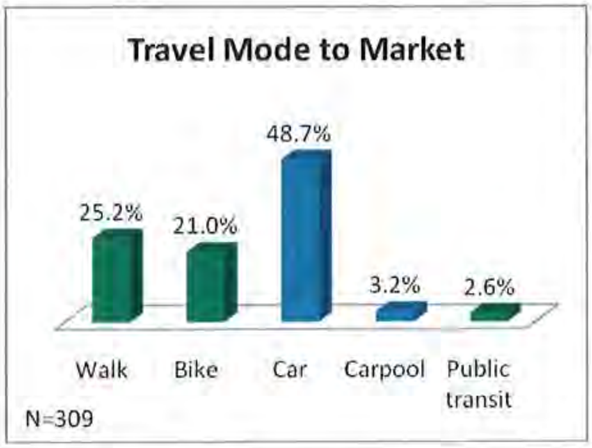
A strong majority, 59%, of shoppers live in Berkeley (red), 21% live in Oakland (green) and 5% in Emeryville (light green). Thus, a total of **85% are very local shoppers.** Another 3% come from elsewhere in Alameda County (blue), while 6% live in Contra Costa County.

Only 5% are from other Bay Area communities including San Francisco, probably due to work. With only 2% from outside the Bay Area, this is not a tourist market.

Berkeley residents come more frequently [Q12/Q3 on page 31] and frequency is positively correlated to spending [Q6/Q12 on page 27].



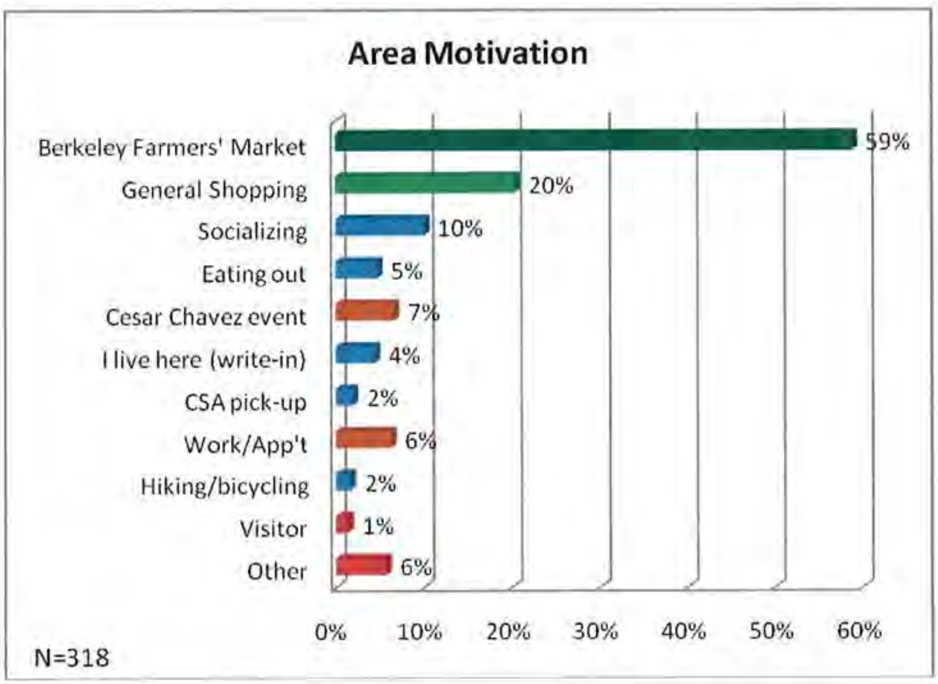
<u>Question 4</u>: How did you <u>travel</u> to the Farmers' Market today?



The means of travel to this market validate the neighborly feel. Nearly half our respondents either come by foot (25%), bike (21%) or public transit (3%). Another 3% are in carpools, so only 49% are coming alone in a car.

Such a "green" farmers' market is most likely with a neighborhood market [see Q4/Q3 on page 28]. Some San Francisco markets may be as green. An Alameda Farmers Market study (Corum, 2005) found 57.2% came by car and 3.4% carpool. While 32.4% walk (very local), only 5.5% bike and 1.4% use the bus.

<u>Question 5</u>: What was your <u>primary motivation</u> for coming to this part of Berkeley today?



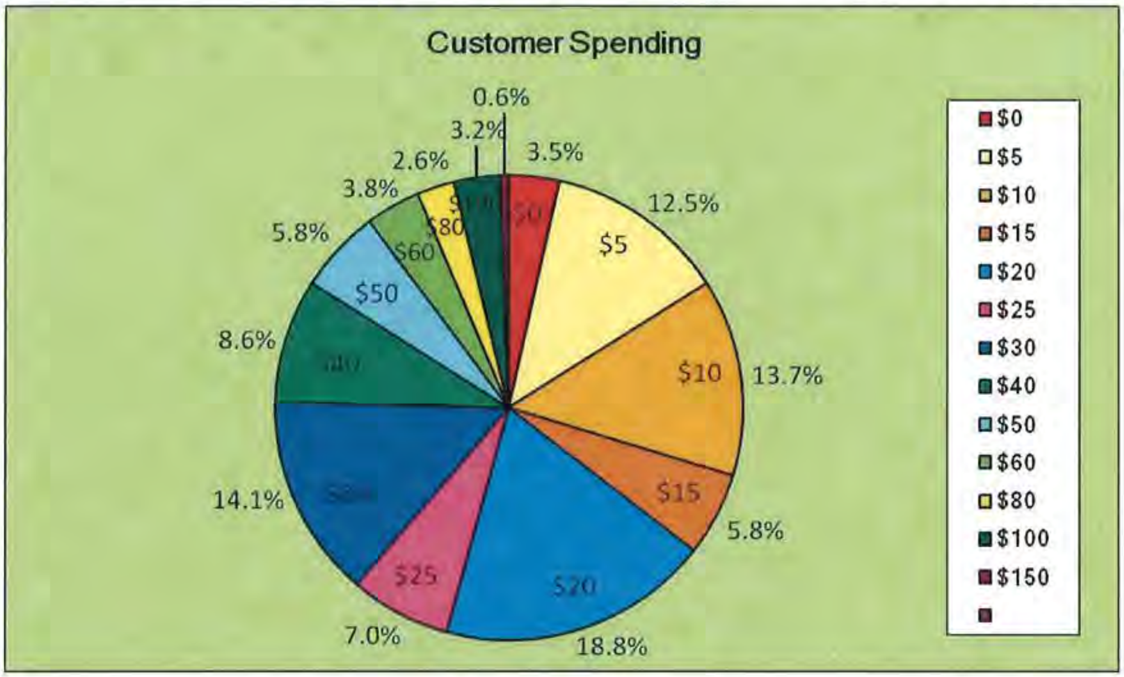
The Berkeley Farmers' Market is the key reason 59% of customers are in this area, the same as at the Berkeley Saturday market. Another 20% say they are motivated by general shopping; since this response was listed well before Market and there is little retail in the immediate area, most of these responses might be considered Market-motivated. **Fully three-quarters of customers come primarily for the Market.** (There were 1.22 responses on average for the 318 respondents.)

An equal number as on Saturday (10%) say that socializing is a motivator, while 5% come to eat out. A full 6% wrote in that they live in the neighborhood or were picking up a CSA box.

Those in the area for work (6%) or the day's event (7%) – both in orange – may represent potential targets for marketing efforts. Getting promotional incentives to local companies for distribution to their employees may yield the better results with long-lasting impact. Various events are important in attracting new customers who might not otherwise attend. Other reasons customers were in the area included: passing through, walking with or meeting a friend, school, going to Berkeley Bowl, picking up a grandson, and looking for an apartment.

This Tuesday market compares closely with West Palm Beach, FL where the farmers' market is the principal reason for 77% of shoppers coming downtown (Corum, 2010). When only allowed one answer, 66% had the same motivator in Montpelier, VT (Corum, 2006), 65% in Manhattan Beach (Corum, 2009), and 56% in Roslyn, WA (rural destination town, Corum, 2010). The Santa Monica Sunday market found 71% (Low, 2010).

Question 6: How much did you (or will you) spend in the Farmers' Market today?



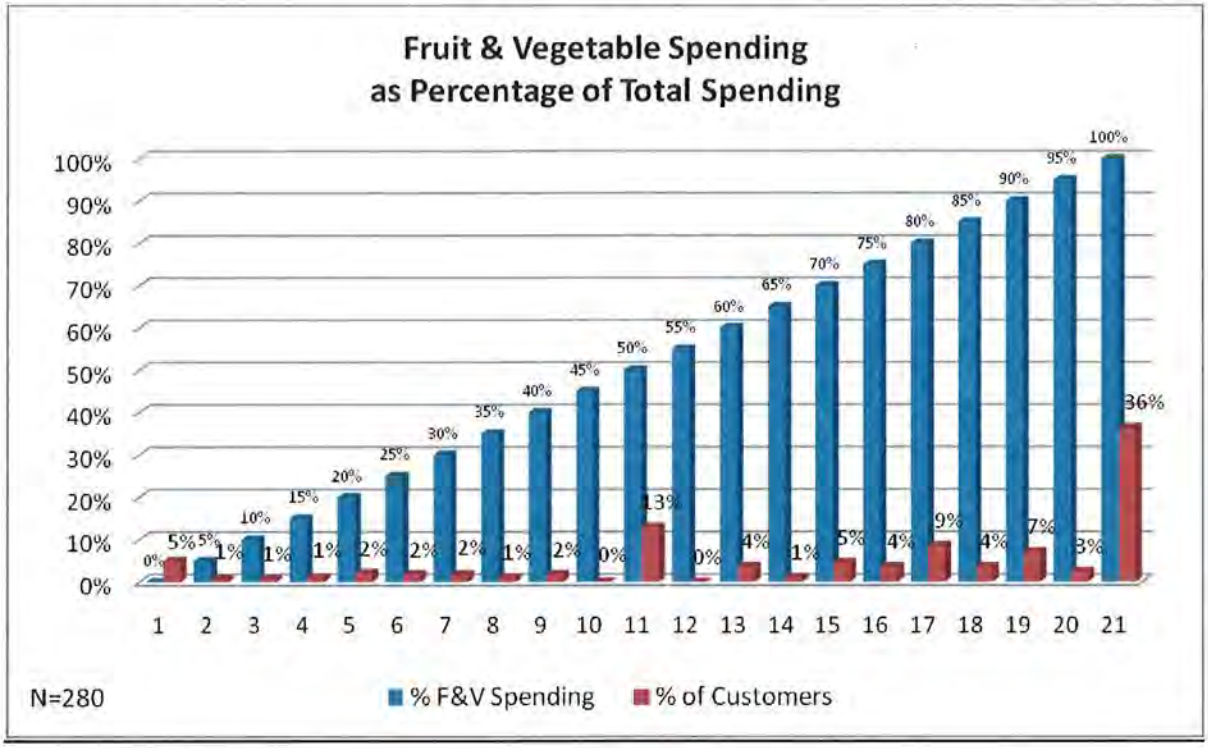
Customers spend $27.43 on average, about 14% less than the $31.83 average expenditure on Saturday. Almost two-thirds of shoppers (65%) spend $20 or more (consistent with Saturday) and 25% spend $40 or more (34% on Saturday). These are solid figures reflecting a strong Market customer base with potential for bringing other shoppers to a higher level of spending.

As a long established market, Derby's 65% at $20+ and 25% at $40+ compares favorably with the 54% who spend $20 in Alameda and 12% spending $40 or more, though six-year inflation is not taken into account (Corum, 2005). Davis had 49% spending $20 or more, and 15% spending $40 or more (Corum, 2005). Only West Palm Beach was higher at $33.60 average, with 73% at $20 or more and 32% at $40 or more (Corum, 2010).

The 9% of respondents who were first-time Market visitors [see Q12 on page 15] makes up one-quarter of the 35% of shoppers spent less than $20. Only 3.5% of shoppers spent nothing, much less than the 8% of Saturday survey respondents; the Market is a comfortable place for people to cruise through and socialize, which brings with it potential sales.

Daily sales can be estimated at $44,700 (multiplying 1630 shopping groups x $27.43 average sale). Using the seasonal Market estimates of 1-3,000 customers, reinforced by this spring day's estimate, we project **annual sales of $1.7 million** (range of 1.4-2.1 million). This figure might be better estimated with summer shopper estimates (and higher average sales). It must be noted that over-estimates are common based on this calculation, likely a combination of 1) customer over-count, 2) non-participation in the survey by non-spending visitors (thus, average spending would be lower) and 3) customer over-reporting of purchases. Many markets use this calculation in comparison with vendor sales reporting to determine probable total sales.

Question 7: Of your total market purchases, what percentage did you spend on fruits and vegetables?



The blue columns represent possible fruit and vegetable spending levels as a percentage of total customer purchases in 5% increments from 0% in column 1 to 100% in column 21. The red columns reflect the percentage of customers in each spending category. Thus, column 11 shows that 13% of customers claim to spend 50% of their total on fruits and vegetables.

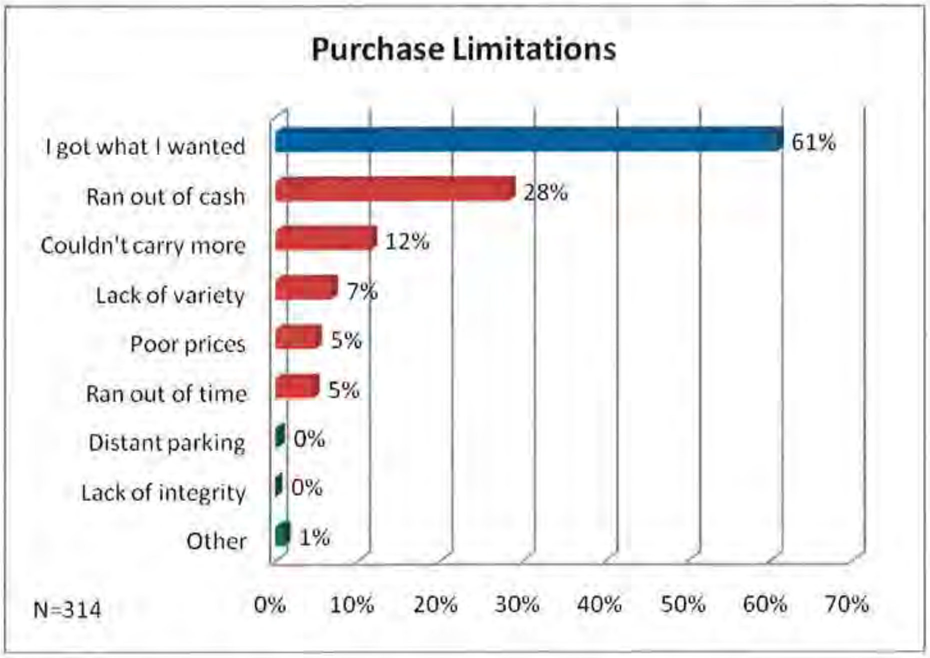
An impressive 36% of customers state that 100% of their Market expenditures for the day were spent on fruits and vegetables (column 21), while only 28% on Saturday said the same. Combining top categories, we see that **46% of shoppers spent 90% or more on F&V** (35% on Saturday), and 62% of shoppers (54% on Saturday) spent at least three-quarters of their money on fruits and vegetables (columns 16 to 21).

Another 22% of shoppers dedicated 50-70% of expenditures to F&V. Thus, over **84% of Derby customers spend a majority of their market dollars on fruits and vegetables** (78% on Saturday).

Of those who spent less than half of their market money on F&V, almost one-third spent absolutely nothing on fruits and vegetables, similar to Saturday customers.

[Note: This chart does not include 11 customers who said they spent $0 in the market (Q6) nor 29 customers who did not answer.]

<u>Question 8</u>: What stopped you from buying <u>more</u> at the Farmers' Market today?



A good majority (61%) of all respondents was satisfied (10% higher than on Saturday); this is a good figure. Respondents gave an average of 1.2 responses. Despite NBC-LA revelations last fall, no one questioned integrity, which supplanted "didn't come to shop" (11% Saturday).

Shoppers gave five key explanations for not buying more:

- 28% run out of cash (a much bigger issue than for Saturday shoppers with 18%),
- 12% can't carry more (lower than 17% on Saturday),
- 7% note the lack of variety (higher than 2% Saturday because of the season),
- 5% find prices to be an issue (the same as Saturday), and
- 5% lack time (also the same as Saturday).

To address these issues, market management might consider these suggestions:

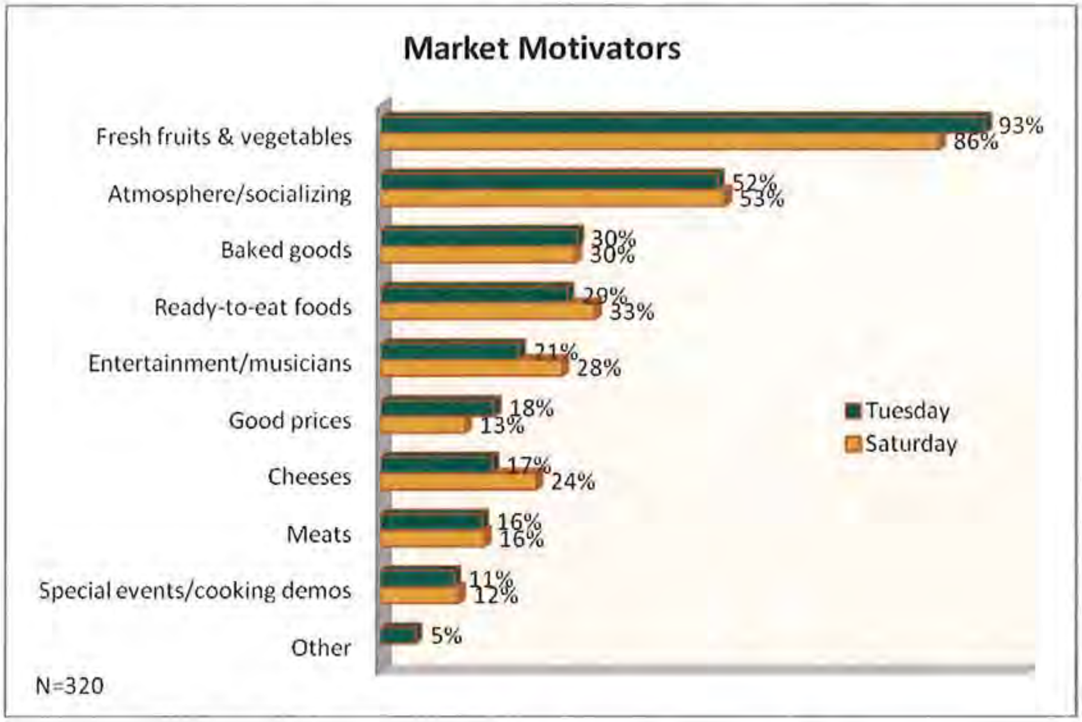
1. Assure easy access to cash through an on-site ATM machine, even though not everyone who "runs out of cash" has unlimited bank funds. Some are simply poor or want to limit their cash available at market.
2. Ease customers' burdens with a pick-up zone at one end of the market.
3. Add unusual items in the off-seasons when product variety is limited. Staff could maintain a list of last-minute vendors to call when there are openings for any reason.
4. Repeat price concerns to all vendors as stated by customers.
5. Lengthen hours to ease time crunch, and space issue mentioned in "Comments" section.

Staff may want to explore various "cash" and "carry" solutions with customers before implementing a plan; they address problems noted two to four times that of any other issue.

With 5% of customers consistently stating that high prices limit their purchases on Tuesday and Saturday, a figure much higher than in dozens of other studies by this author in various states, there may be a larger Berkeley-wide perception that is limiting customer response to these markets. A larger investigation of non-customers would be helpful.

Question 9: What are your reasons for visiting the Berkeley Farmers' Market?

All Tuesday market customer responses are compared with Saturday responses above, and once again customers gave an average of 2.9 responses. The two days show remarkable consistency, which leads to greater confidence in the results, even as there are subtle apparent differences in the two market days. Saturday is more likely to have the entertainment-focused visitor.



Fresh fruits and vegetables is #1, a motivator for 93% of respondents, far ahead of the next most desirable element for 52% of shoppers: atmosphere and socializing. Three-in-ten come for baked goods and ready-to-eat foods.

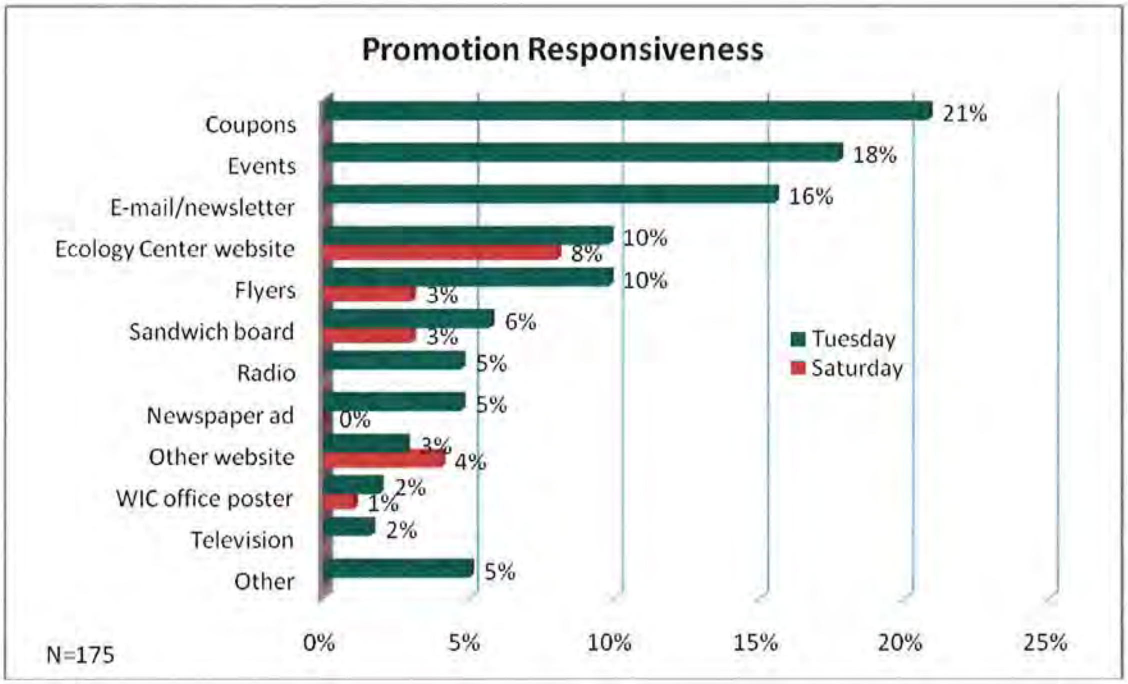
Entertainment is somewhat less a motive (21%) than on Saturday (28%). This may reflect the more produce-focused consumer (93% F&V), a less relaxed weekday attitude, a lower quality of music or some other reality.

The notable 18% response to "good prices" compared to 13% on Saturday may indicate greater Tuesday shopper awareness, a value focus or actual lower prices. This is positive sign relative to the limitation on buying stated above by 5% of customers (Q8). By inference, we can assume that other shoppers do not come for the prices. One-in-six come for cheese (17%) and meats (16%). One-in-nine mention special events/cooking demonstrations as a motivator.

Tuesday shoppers wrote in a number of other motivations including: eggs (most popular), organic, support farmers, habit, chocolate and flowers. "Support local farmers" was not offered as an option because numerous studies have shown it to be a strong motivator, and "fruits and vegetables" is a good replacement when focused on market offerings.

These motivations provide focal points for any Market promotional campaign. They should be reviewed in conjunction with Question 10 below. A price study also could easily be conducted.

Question 10: What advertising, if any, might influence your attendance at this Farmers' Market?



Tuesday customer responses cannot be fully and fairly compared with Saturday responses because we changed the question, "how did you find out about the market," to avoid the typically high response to "word-of-mouth" – 69%. Instead, we chose to focus on potential low-cost promotional activities which would complement the high site visibility (31% of Saturday Market customers "drive by") and long-standing knowledge of the Market within the community.

A strong minority – 46% – did not respond to the question, either displaying their antipathy for advertising or signaling the lack of any need for promotion because of their Market loyalty.

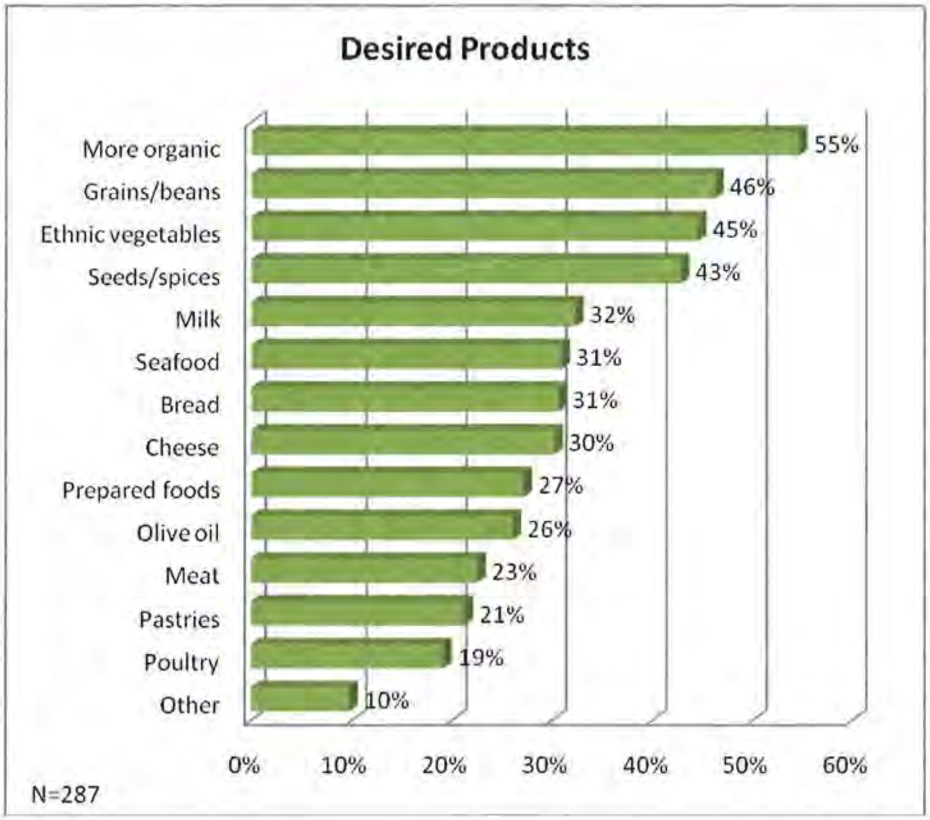
Asked what advertising might affect their attendance, 66 of all 320 respondents (21%) said that **coupons** would be effective, an unsurprising response reflecting price sensitivity. Close behind were **events** (18%) and **e-mail/newsletter** (16%). Drawings for a produce basket or promotional items to solicit customer e-mails allow the Market to expand its Market reminder notices.

With 1.8 ideas per respondent, the Ecology Center website and flyers each had 10%, reinforcing Saturday's 8% website and 3% flyer response to how people first found out. The website might see increased use with a Market sign directing customers to sign up to the e-mail account (for a coupon) and rotating photographs on the homepage. Could Market e-mail sign-up take place on the EC homepage?

Traditional advertising has a low response – 5% radio, 5% newspaper, 2% television – but we can't reject it completely since those methods can reach current non-customers. As for cost effectiveness, a more grassroots campaign can work more effectively to reach new people and reinforce the existing customer base, e.g., sandwich boards and a colorful set of street banners/flags at the Market entrance.

<u>Question 11</u>: What products would you buy if they were sold in this market?

While 10% of survey respondents did not answer this question because of word confusion over many products already being sold, 90% answered the question with no problem, understanding that the Market might be considering additional competition and product categories.



On average respondents indicated a positive desire to have an additional 4.4 products. Together the data indicate customers' preference for more of a one-stop shopping experience.

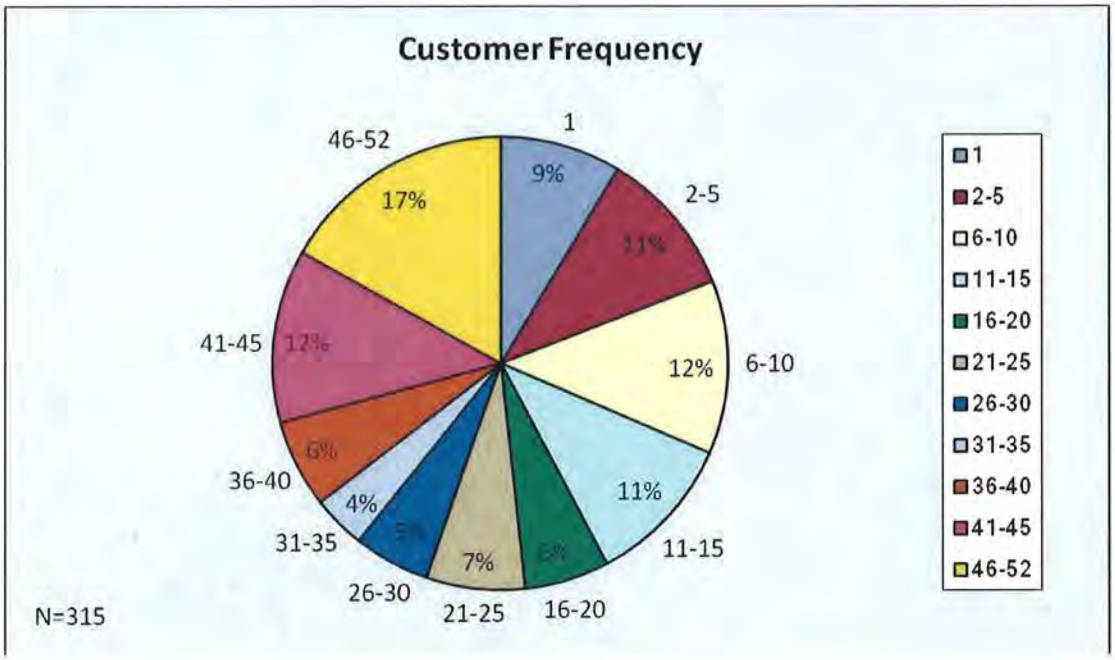
A majority (55%) want **more organic,** consistent with other surveys even when the wording is "more fruits and vegetables." Most of those people also wanted **ethnic vegetables** (45%). The same number consistently wanted both **grains/beans** (46%) and **seeds/spices** (43%).

Nearly one-third or respondents wanted milk (32%), seafood (31%), bread (31%) and cheese (30%).

About one-in-four respondents want more prepared food (27%), olive oil (26%) and meat (23%). One-in-five respondents want pastries (21%) and poultry (19%).

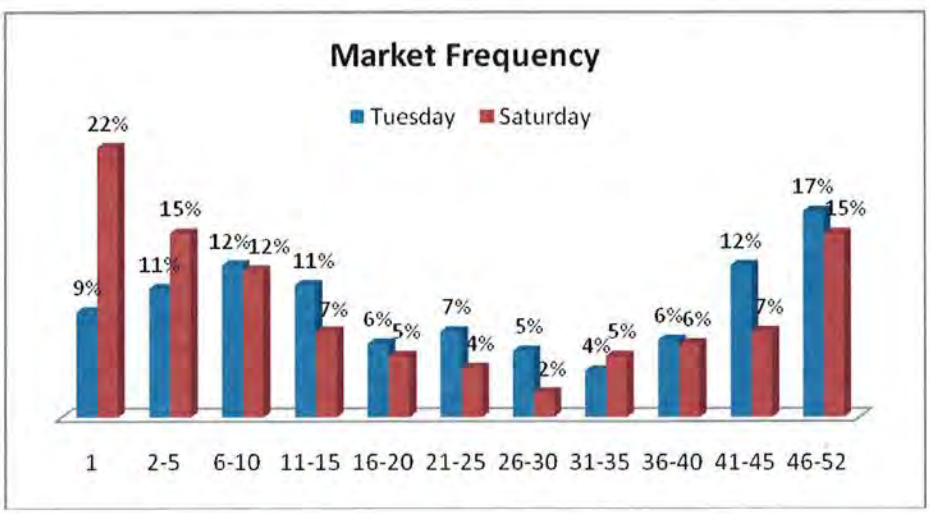
These data can be used to reinforce customer attendance figures in soliciting new vendors. It might also be used to make existing vendors of those products realize that not all customers are aware of their Market presence. Perhaps they need to test a new location in the Market, improved signage, a new display focus, more visible volume, color scheme, staffing or other potential elements that impact consumer awareness and purchasing.

Question 12: How many weeks have you shopped at this Market in the last year, including today?



Combining groups, it can be said that **one-third (32%) of all shoppers are irregular,** making fewer than 10 visits per year, and that about **55% come less than half the time** (1-25 visits). Thus, the **Derby market has 45% good or loyal shoppers** – a majority of market weeks – while Saturday has about 35%.

Changing from a pie chart to column format below, we can observe the key differences in attendance patterns. Tuesday has a higher percentage of consistent regular customers.



Tuesday has many fewer first-time and occasional (2-5 times) buyers but almost every other frequency category shows more consistent attendance than on Saturday, especially among market loyalists shopping 41-52 times this past year, 29% to 22%. Nevertheless, frequency is almost always an area where markets can make improvements.

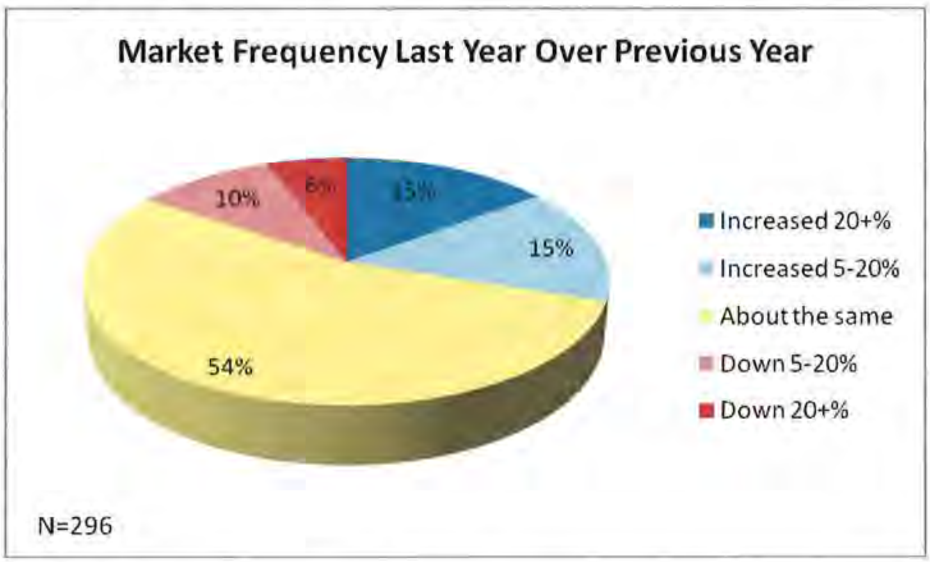
While Saturday may introduce the Berkeley Farmers' Market, Tuesday is a place that shoppers consider home. That feeling was constantly reinforced by customers as they completed the survey.

As with Saturday, two obvious ways to grow the Market are to increase the frequency and the spending level of existing customers. Increased spending is positively correlated with increased frequency [see Q6/Q12 on page 27]. The Market could also address customers' purchasing limitations as suggested above [Q8 on page 11] and consider key products to pique first-time shoppers' interest and reinforce repeat customers.

Not surprisingly, certain Berkeley and Oakland residents are more likely to attend a majority of Market days [see Q12/Q3 on page 32].

Good customers also are more likely to respond to specific promotional efforts – like newspaper ads and e-mail reminders – while new customers are more oriented to radio and flyers [see full lists at Q12/Q10 on page 33.]

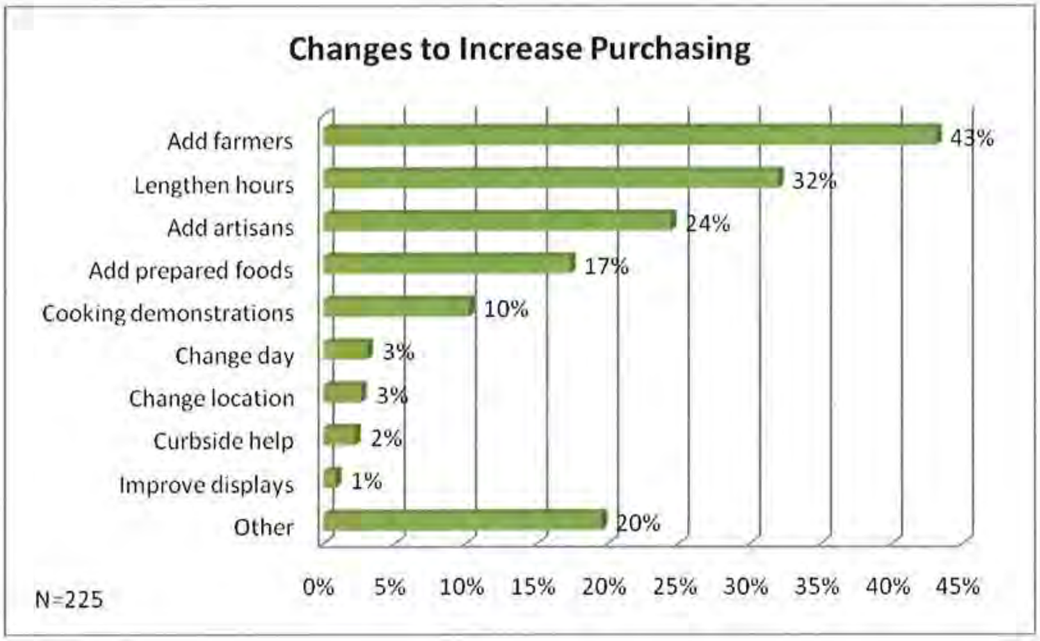
Question 13: How has the frequency of your market visits changed in the last year compared to the previous year?



Over half of the respondents (54%) state that they shopped just as much in the last year as the previous year.

Among those who say that the frequency of their visits has changed, two-thirds say they shopped more (30%) while one-third (16%) shopped less frequently. While this is a good sign, in view of the depressed economy, the Market may want to investigate further the "why" behind 1-in-6 customers coming to Market less than the prior year.

Question 14: What changes would cause you to <u>increase your purchases</u> at this market?



The top four recommended changes that deserve consideration are:

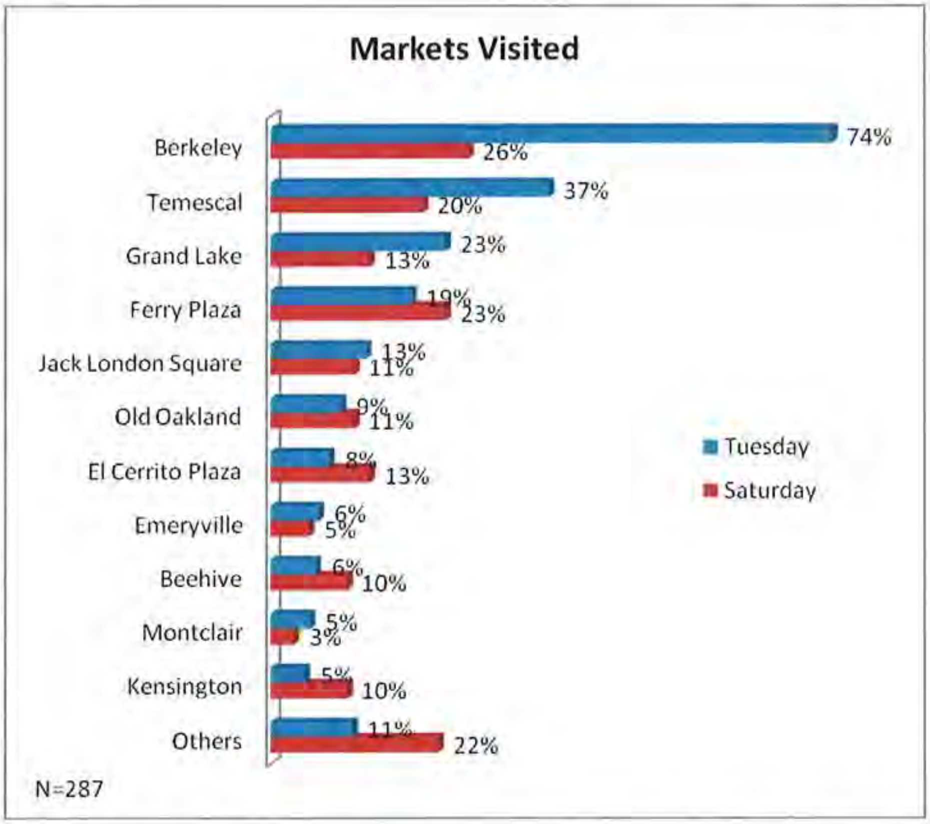
- More farmers – 43%
- Longer hours – 32%
- Artisans – 24%
- More prepared foods – 17%

One-in-10 would like cooking demonstrations. A small number would like the market day and location changed (3%), curbside assistance (2%) and improved displays (1%). Overall, the market seems to be meeting customers' expectations.

Among "other" written recommendations, most key for nine (9) people is "lower prices." Other ideas included: better parking (2), carts and bicycle repair. Specific products mentioned were: soap, palm oil and prepared raw foods.

Some other comments reflected why 30% of survey respondents did not answer this question: "I have only so much to spend," "more cash," "larger paycheck" and "already at max."

<u>Question 15</u>: What other <u>local farmers' markets</u> have you shopped at during the last year?



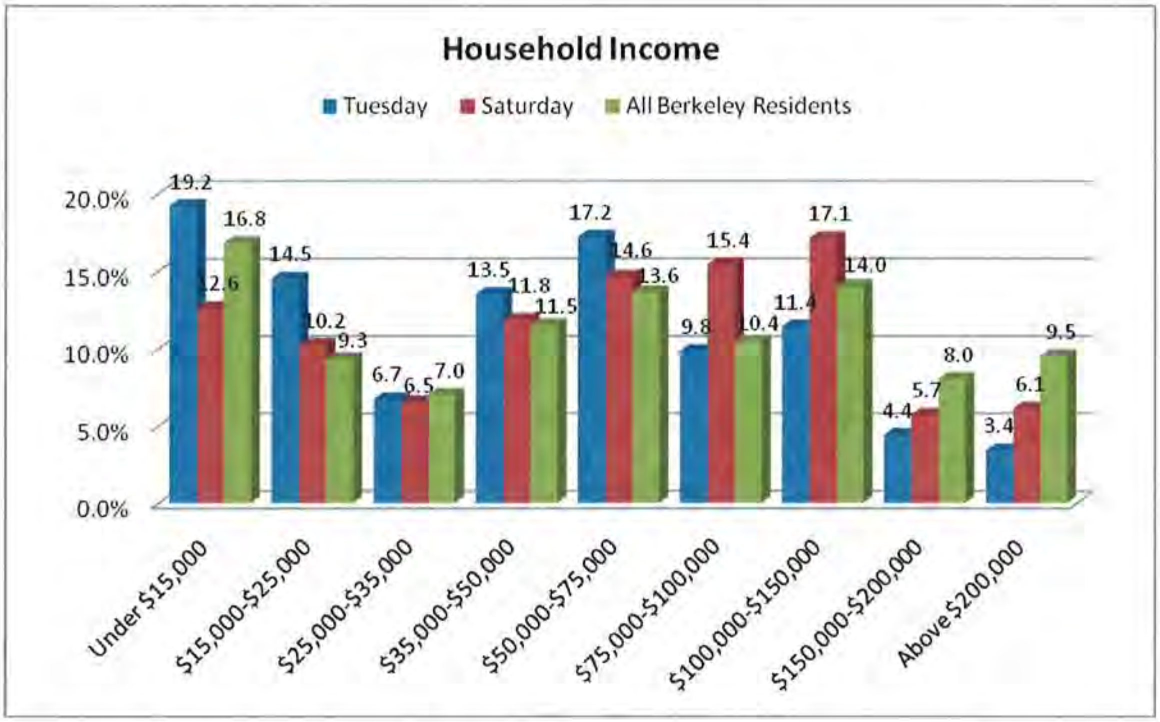
Tuesday customers are three times as likely as Saturday customers (74% to 26%) **to shop another Berkeley market,** not surprising given the larger size of the Saturday market and the greater likelihood of free time on the weekend. Also, Tuesday shoppers are almost twice as likely to visit the Temescal and Grand Lake markets.

Given closer proximity, Tuesday shoppers seem somewhat more inclined to shop the Jack London Square, Emeryville and Montclair markets, yet it is not true for Old Oakland on Friday.

Tuesday customers are only half as inclined to have visited other markets outside the area. The 25 markets written in included Napa to Davis, Pt. Richmond to Santa Cruz.

There is a definite "farmers' market shopper" in the Bay Area, but that shopper is frequently not married to one farmers' market. They may shop at Berkeley Bowl, Whole Foods, Trader Joe's, Costco and elsewhere as well. When they think of farmers' markets and other options, they evaluate the advantages and disadvantages of each (e.g., abundant variety and best hours versus crowded aisle and parking challenges). To maintain and expand our market's customer base, we should be sensitive to purchase limitations noted by customers (Q8). We may want to explore the relative merits of other markets vis-à-vis the Berkeley Farmers' Market to avoid loss of customers.

Question 16: In order to know if we get all income levels...what is your total household income?



The Tuesday market serves a higher portion of lower-income area residents than Saturday. Over 40% of shoppers have incomes below $35,000 (33% of the Berkeley population) while fewer than 20% are above $100,000 (31.5% of Berkeley). The middle three categories from $35,000 to $100,000 have 40.5% of shoppers (35.5% of Berkeley households).

By comparison, an equal number of Saturday Market shoppers – 29% – come from households below $35,000 and above $100,000. Those between $35,000 and $100,000 have 42%.

Generally, groups below $75,000 household income were significantly more represented among Market customers while **income groups above $100,000 are strongly under-represented among customers.**

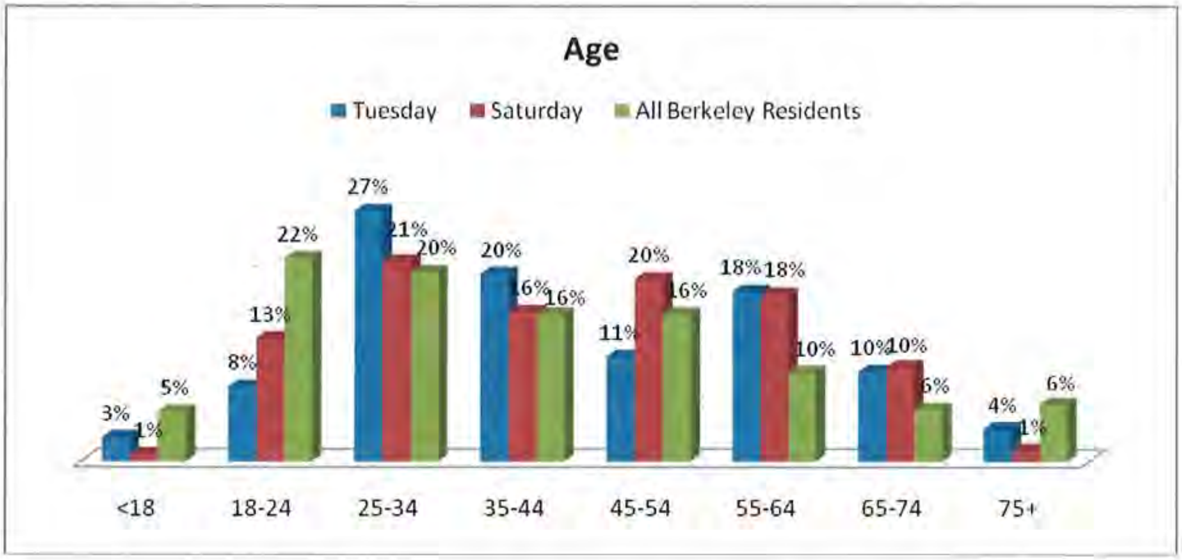
Median household income for Tuesday Market customers is $45,667, substantially lower than Saturday's $60,069, which is just above the Berkeley household median of $59,335 (U.S. Census). Tuesday also has a stronger Oakland and Emeryville draw. Emeryville residents, with a median household income of 61,017, are much more likely to come Tuesday (5% to 1%).

Tuesday's lower median income is probably attributable to Oakland's median household income of $49,695, since Berkeley residents outnumber Oakland residents only 3:1 on Tuesday (59% to 21%) while 9:1 on Saturday (63% to 7%).

With 93% response to this question (94% on Saturday), the income picture is fairly reliable. Only three of the nine income categories had fewer than 10% (3.4% to 6.7%) of Market shoppers, and all three have less than 10% of the Berkeley population. (A fourth category – from 75-100K is too close to be significant.) The Tuesday market reflects a good cross-section of all incomes. As with Saturday, this Tuesday market is a great classless unifier of area residents, 85% of whom are from Berkeley, Oakland or Emeryville (which combined for 71% of Saturday customers).

Question 17: Your age?

The Tuesday Berkeley Market is a melting pot of all ages, just as Saturday. While children were under-represented among actual respondents (typical), we know from Q2 that 19% of respondents had one or more children with them. On the other end, seniors aged 75+ were somewhat under-represented.



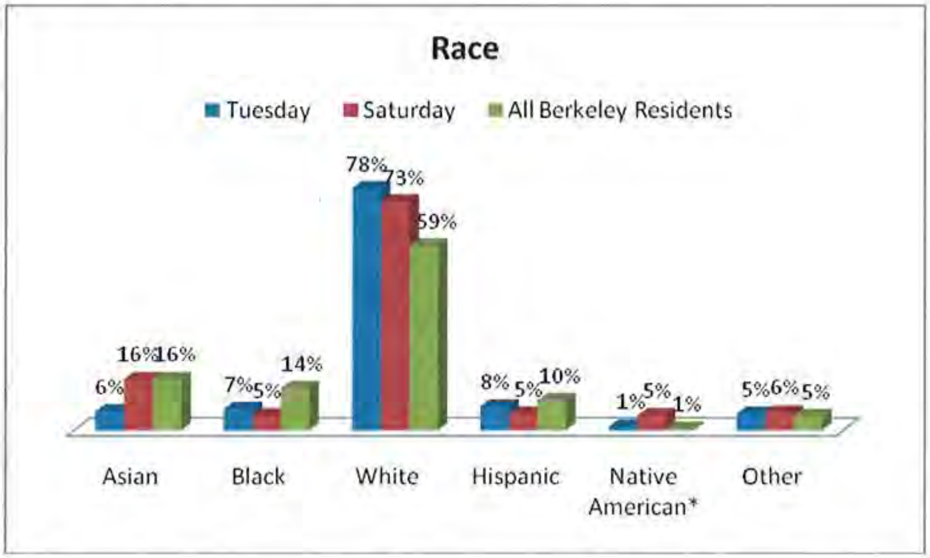
All six age categories from 18-24 through 65-74 have at least 8% of the Market customer base (10% Saturday). Studies from the 1970s through 1990s show farmers' markets to be highly skewed with 35 to 54 year-old shoppers. Not so at least in Berkeley now, if it ever was true.

Tuesday seems particularly strong with customers aged 25-44, while dropping off somewhat among those 45-54. It has strong attendance consistent with Saturday among those 55-74. However, it doesn't appear to have the same youth presence (under 25) as Saturday. This may be that 18-24 is an age when people need to be on the job weekdays.

This **strong age cross-representation** may have been true in Berkeley for many years or it may be what seems more common in markets of the 21st century, their popularity having transcended all age barriers. This could be a result of the expansion of young farmers and employees necessary for market system expansion, as well as the inclusion of various urban-based food businesses led by young entrepreneurs who attract a younger crowd. The 18-24 year-olds are less present (8% vs. 22% of the Berkeley population) than Saturday (13%) because of school. Given the fewer years within that category (7 vs. 10), one can say that if you close your eyes and touch a passerby, you are equally likely to touch anyone in the age range from 18 to 64.

[Note: "Under 18" was assumed to be inclusive of only 15-17 year-olds. Children 14 and under in Berkeley resident data were not represented. The population figures for ages 15 to 75+ total only 88.3% of the total Berkeley population. Therefore, all eight age categories for "All Berkeley Residents" were proportionally increased to total 100% so that the blue, red and green columns are comparable with 100% of the potential buying population. However, another limitation remains: that only Berkeley resident data is used, while Berkeley provides only 59% of the consumer population.]

Question 18: Your race?



Tuesday shoppers were notably more averse to answering this question about race, 23% compared to only 12% on Saturday. Working with the existing data, there was a good representation among all races.

White shoppers are considerably (31%) more present than would be expected based on the Berkeley population (78% to 59%), not to mention Oakland's influence. Hispanic shoppers (8%) were somewhat close to their Berkeley numbers (10%), better than on Saturday (5%). While Black customers were more visible than Saturday (7% to 5%), they still are only about one-half what might be expected. Asian response is even less with 6% while they number 16% of Berkeley residents. Native American numbers, while small, are actually double that seen in the general population. Other races are consistent with their 5% of the population.

These data should be considered when looking at new vendors, culturally appropriate products, event planning and promotional strategy. Note that the green columns above represent only Berkeley residents, encompassing only 59% of survey respondents, so the column chart comparisons are not apples to apples.

Any demographic group may find any of the many East Bay markets more desirable based on day, hours, location, products, prices and other characteristics.

Question 19: Other product or improvement ideas?

Only 33% of all survey respondents provided written comments compared to 57% on Saturday in October, perhaps because people feel satisfied with all the offerings of the Market.

The greatest number of people felt very positive about the market. Others provided ideas about products, seating, greening the market, and prices. A variety of suggestions were made as well as offers to collaborate. All comments were transcribed as written by Market shoppers.

Kudos! (37)

I enjoy this farmers' market the best.
Enjoyed the music!
You're great!
Thanks!
Thanks - love the market!
None, this is a great neighborhood farmers market!
None needed.
No changes necessary - perfect!
No changes - like as is.
Keep rockin' that smile.
I love it as it is. Love
I shop at other markets, too. Love it. Thanks!
I come if I need to. My regular market is Grand Lake but it was too rainy last Saturday.
I'm more frequent this year here because I moved back to Oakland.
Love the Berkeley Farmers Markets!
Love coming here - depends on work schedule.
We love it - it's awesome and prices are great.
I'm happy the way it is (1st time in a year)
I really appreciate that it's GMO-free and mostly organic.
I buy flowers usually too.
Keep it the way it is. This is the best farmers' market in Bay Area IMO.
I am content with the way it is. Stay in low key=simple.
Keep up the good work.
I'm a regular - ads won't matter.
I'm a regular Tues & Thurs.
I'm a nanny walking the kids and hearing the music.

Great market
Great market
It's great.
It's all good.
It's awesome.
It's perfect!
I'm a FAN!
I come to support local/farmers' markets - I love Mr. Paul's The Egg Man! Adding valet bike parking is a great improvement - thank you.
Valet bike parking much appreciated!
Love the arts, like today!!

Products (18)

There is good variety, but more is always better with variety of vendors.
Maybe it would be a bit bigger, otherwise great.
Raw food vendors like Blessings. Prepared soups or veggies would be great.
More ethnic farmers & vendors, especially African-American
More ethnic vegetables.
Asian veg!
More gluten-free bakery products.

Raw milk [Get Full Belly to come on Saturday.]
Grain & bean farmer.
Seafoods
Another cheese company, yogurt back on Tuesday, permanent potato guy.
One more prepared food.
If the people selling the stuff grew/made it, I would buy more.
Olive oil would be great if we could use own container. Keep up the great work!
Ancient Organics Ghee has amazing booth at Sunday Marin Civic Center.
I am mourning Fatted Calf departure.
Better blueberries, preferably organic. More varieties of apples, including heirlooms.

Seating/Music/Demos (13)
Place to eat with umbrellas or shade.
Put the coffee nearer the tables.
Coffee near tables & chairs, & more of them.
Place to sit and hang out on grass.
More flowers & places to sit and eat.
More tables and chairs.
More tables
More seating - benches? at fence. Keeping "non-market" activities at market - political tables, extraneous vendors outside market.
More music, seating, farmers.
More music and art making.
Arts & crafts; how to cook with veg for non-cooks - easy.
Cooking demos - great idea! More gluten-free baking.
Healthy vegetarian cooking displays & lessons with recipes for ingredients sold in farmers' markets.

Green Thoughts (8)
Sell cloth bags. Don't expand too much. Small/intimate=good!
Local produce more important than organic.
Please stay local! X the meat.
Lessen cooking booths; their heat sources induce asthma.
More trash bins for organic compost.
Have farmers sell cloth bags; eliminate plastic.
Offer more "bring container" promotions. Avoid plastic packaging.
Always shop here for F&V, tofu, rather than BB, WF or Andronico's. Thank you BFM. All advertising sounds good. Want raw inexpensive sauces & nut butters. Please no plastic, no Monsanto affiliation at all.

Negatives (5)
I dislike all the animal products you have now - I don't come as much.
Vendors often leave early, hard to get here in time after work - stay open later! Love the events - advertise them better!
I work til 6:15 - lengthen hours.
Parking!
I've always found this market a bit congested. If there were a way to widen or spread it out...
Don't block sidewalk for local traffic.

Price (4)
Bigger bunches, lower price.
Too expensive! Interest in other products depends on price.
Prices are generally more expensive than Oakland. Move vendors to sidewalk to make wider.

Personal Changes (2)
Frequency down because of time - I live in Hayward.
Not typical year, used to shop all the time but work changed.

Artisans (2)
Add crafts on holidays.
Keep it no artisans.

Ideas (15)
I would love to know what farmers carry ahead of time. I would buy all my produce here if I knew what was available. It will save me a trip to Berkeley Bowl or Whole Foods.
Ecology Center member discount!
Ask vendors to post if they won't be here next week and/or produce coming in near future.
Local bulletin board featuring meaningful affordably priced housing among other things.
More info on activities to save organics.
All ideas for change are great! Middle porta-potty.
Nothing specific, but I've started doing most of my shopping here because I got pregnant and had a child. Before baby, I was willing to eat crap, but I'm not willing to feed it to my child! So, maybe offerings/events geared toward new parents, natural parenting, cooking for/feeding children?
Oktoberfest Bakery, play area for kids
Better lighting in winter.
Late nights with music.
More entertainment.
More free samples
Free busing?
Develop a system to allow shopping with a running tab to be paid at a cashier table after completing shopping. Not without problems but it would save a lot of time and shuffeling.
Lower prices. Offer smoothies. Include local B Tech students.

Please Call Me (4) – Contact info supplied to Ben Feldman via e-mail.

- ✓ Plant or tree care workshops. I would do them. Colin Sutton, Golden Bear Tree Care, 510-847-..
- ✓ I teach right here at Independent Study, next to B-Tech, & I would love to get tours set up for my students! Contact info: .. Right now, almost no teens make use of the market because it feels like a strange and different world for them! And they're right here!
- ✓ Support teaching staff at B Tech & students by providing booth. See Mr. S.
- ✓ Call me! 510-693-..

III. Cross Tabulations

Analyzing the relationships between responses to various questions provides us greater understanding about Market customers. It may lead to yet other questions for further study.

Question 6/Question 5 – Market Spending/Area Motivators

Motivators that propel customers to this neighborhood of Berkeley appear aligned with different levels of spending, much as on Saturday in downtown. Those coming for the Farmers' Market spend $31.54 (versus $39.29 on Saturday), only 15% more (30% Sat.) than General Shoppers, many of whom may really be coming for the Market (General was the third choice and FM sixth). Those coming to eat out spend $28.00 on average, far more than the $18.33 on Saturday. Those who come downtown to socialize also spend more, $26.41, than on Saturday, $21.92. People motivated by other reasons – including limited responses of work/appointment, hiking/bicycling, visitor and other – averaged $17.65 in spending. Specifically, visitors spend $11.25 on Tuesday, less than half that on Saturday, $24.06.

There were 380 total responses, an average of 1.2 responses per customer. The numbers to the left of each motivator indicate the relative impact of each motivator in terms of total spending by those customers. Multiplying the number within the blue line by the average spending to the right yields total spending. **Market-motivated** respondents spend triple ($5,740) that of general shoppers ($1,760). That in turn is double that of socializing ($845), which is double that of eating out ($420) and work/appointment ($390). The order of these top five motivators is the same as on Saturday, which should give management great confidence in creating programs and promotional campaigns with key verbiage to motivate shoppers.

"Other" reasons were down from #3 on Saturday to #7 on Tuesday, and visitors were down from #5 to #11 in their spending impact. This is definitely not a tourist/passerby market.

These expenditure levels reinforce that the 59% of **Market shoppers** who come downtown specifically for the Market **have 33% more economic impact on Market vendors than other shoppers,** spending $31.54 while all others combined average $23.79. This is substantially lower than the 83% higher impact on Saturday, because this is a market where most people come to shop, whereas Saturday is more of a happening not to be missed. Nevertheless, a shopper loyalty program might be developed just as on Saturday.

Question 6/Question 9 – Market Spending/Market Motivators

Customer motivators to the Tuesday Market are connected to different levels of spending. The chart below shows that **meat-motivated shoppers spend the most, $35.71** (though much less than Saturday, $56.67), somewhat ahead of those seeking **cheeses, $32.17** (39.25), or **baked goods, $30.16** ($37.76). These top three expenditure levels were in the same order at the Saturday market; following that they differed somewhat.

Ready-to-eat foods helped motivate customers spending $28.50 (29.82 Saturday). Those coming for fresh **fruits and vegetables** spent $28.35 ($31.58); followed by **entertainment,** $28.23 ($30.07); and **atmosphere and socializing,** $27.70 ($30.81). Those coming in part for good prices spend only $23.49 (down from Saturday's $32.50), and special events, $19.17 ($23.28).

There were 911 total responses, an average of 2.85 responses per customer, just as Saturday. The customer counts within each motivator green line multiplied by average spending of those customers gives **total spending.** Thus, the **#1motivator is fresh fruits and vegetables;** 291 respondents or 91% (85% Saturday) state that F&V are a reason why they come to Market. Again substantially behind as a key motivator is the **#2 atmosphere,** followed by **#3 baked goods,** and **#4 ready-to-eat** foods. The economic impact order of these top four motivators replicated Saturday's order, providing encouragement for an advertising campaign.
Very close in terms of economic impact, though in different order from Saturday, were: #5 entertainment, #6 meats and #7 cheeses. Like Saturday, #8 was good prices and #9 events.

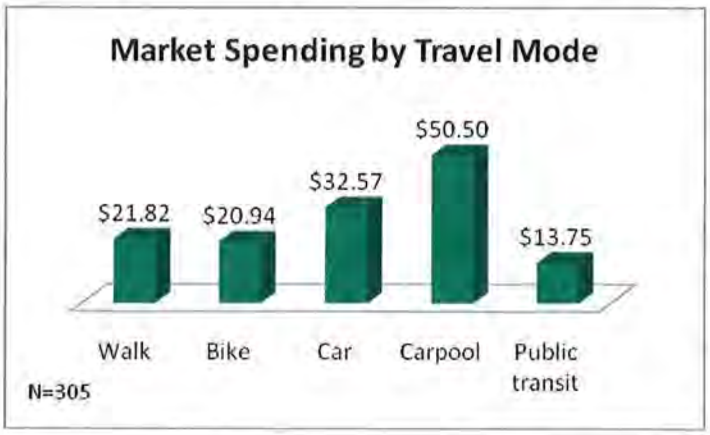
If a promotional program were based on total spending levels of customers by motivator, one should be sensitive to the higher average spending levels for particular motivators.

Question 6/Question 12 – Market Spending/Market Frequency

Spending is positively correlated with frequency of Market attendance, **although not as absolutely on Tuesday** as Saturday. Of those spending $50 or less, 43% come to the Market the majority of the time (vs. 26% on Saturday). Among those spending more than $50 (only 10% of Tuesday shoppers), 59% come to the Market most of the time (vs. 77% Saturday).

Half (52%) of those spending $10 or less have been to the Market under 10 times this year (89% Saturday), while 75% of those spending $100 or more have been to the Market at least three-quarters of the time (100% Saturday). Thus, even somewhat more regular customers may be found to spend little on Derby compared to Center Street, and less regular customers may report spending a lot.

Question 6/Question 4 – Market Spending/Travel Mode



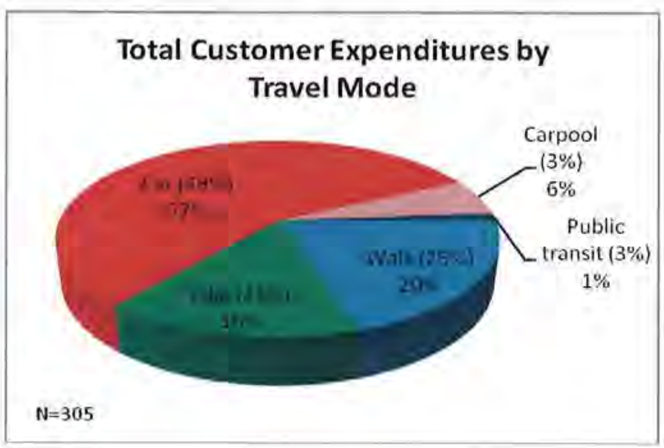
Spending levels appear to be affected by the convenience of customer travel to market. Locals that walk or bike spend an average of $21.42 at the market. **Customers by car spend $32.47, or 52% more than walkers and bicyclists** combined.

Ten carpool respondents provided some insight into higher spending of $50 with carpooling. Not surprisingly, the eight public transit riders spent the least, averaging $13.75.

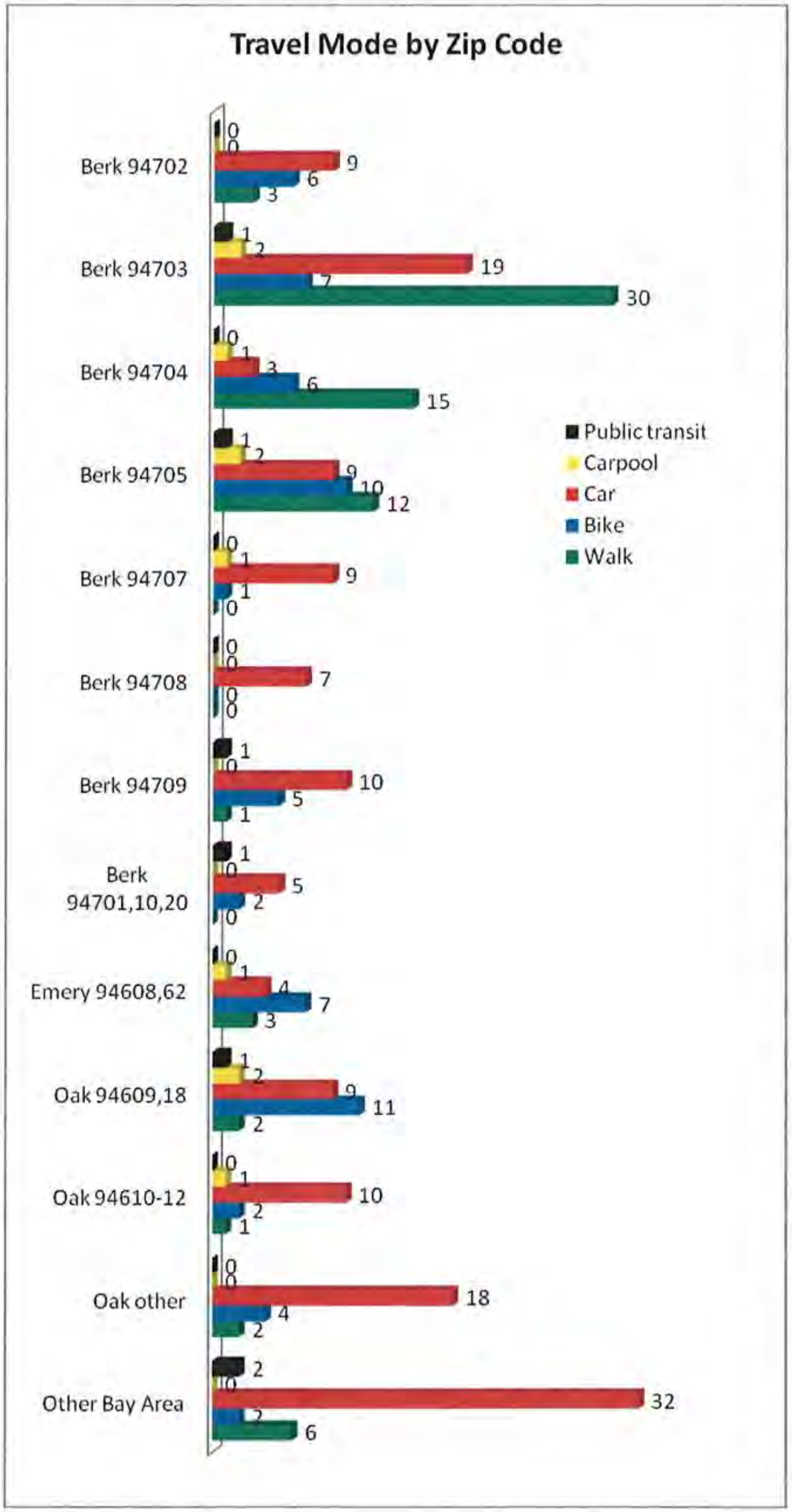
Notably, **the 51% of customers who come by car or carpool are responsible for 63% of the total market sales.** The greener customers don't have comparable buying power; walkers make 20% of all purchases and bicyclists 16%. Carpoolers have nearly 6% impact while public transit riders have just 1%.

To see this a different way, imagine a goal of increasing vendor sales by $5,000. We would need 233 more walkers and bicyclists, or 364 public transit riders, but only 154 people using their personal vehicle.

Greening the market might be done by incentivizing local residents with a doorhanger campaign (email on the back of a coupon), giving Berkeley Biker coupons to bicyclists, a Bike Produce Carrying Contest, or other creative ideas.



Question 4/Question 3 – Travel Mode/Zip



Because of small numbers, actual counts are used for people coming to Market by various means. Also, certain zip codes are joined and "other" responses are omitted due to space.

Public transit (black) is not well used, even lower than people by carpool (yellow) to the Market.

In Q4 we found that half of Market customers avoid a personal car. Of **Berkeley shoppers, 55% either walk or bike,** versus 33% of other shoppers. **The number of non-vehicle customers significantly exceeds expectations for three Berkeley zip codes,** where Walkers (green) and Bicyclists (blue) dominate:

<u>94704</u>: Walk 60%
Bike 24%

<u>94703</u>: Walk 51%
Bike 12%

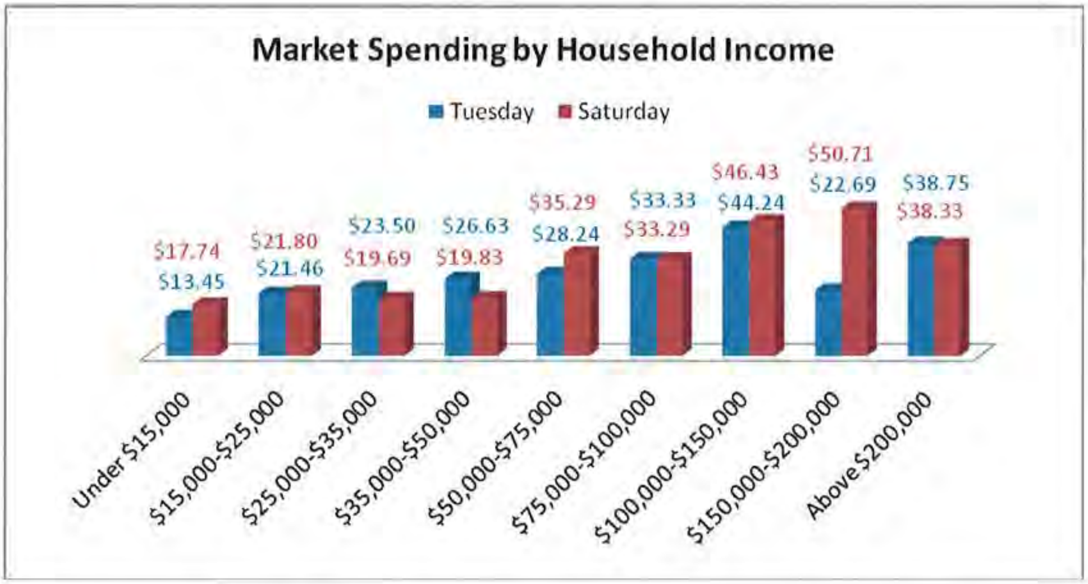
<u>94705</u>: Walk 35%
Bike 39%

Other nearby zip codes also have substantially green Market-goers:

<u>Emeryville</u>:
Walk 20%
Bike 47%

<u>Oakland 94609/18</u>:
Walk 8%
Bike 44%

Question 6/Question 16 – Market Spending/Household Income



There is a direct **positive correlation between household income and spending** in the Tuesday Market which grew all the way **through $150,000 household income,** at which point customer numbers dropped along with a resulting economic impact. Those with household **incomes under $50,000 spend an average of $20.22** (virtually the same as the $19.65 on Saturday), while those **between $50,000 and $100,000 spend $30.00** ($34.25 on Saturday), and those **above $100,000 spend $38.24** ($45.56 on Saturday).

These data may tempt management to target certain income groups, for example, by sending direct mail to higher income households. However, it must be noted that **higher customer counts cause those under $50,000 income to account for 42% of purchases** vs. 31% for $50-100,000 income and 27% for those above $100,000.

Question 6/Question 2 – Market Spending/Children

On Saturday there was no significant difference in spending between those shopping with or without children. It appeared much the same on Tuesday. Overall, **customers with children at Derby spent $2 more than shoppers without kids, $29.02 to $27.06,** not significant. This was due to the 4% of shoppers who had two children and spent $41.43, over 50% more than shoppers with no child or one child (but Saturday 2-child shoppers spent less than those without children in their shopping group).

Question 6/Question 3 – Market Spending/Zip Code

Market spending by the 305 respondents who provided their zip code was $27.97 on average. The full data requested by management come with a warning: given the single digits in the Total Customer column, take care not to assign too much significance to those Average Spent amounts not in bold. Average Spent dollars (bold and non-bold) are reflected in the comments below.

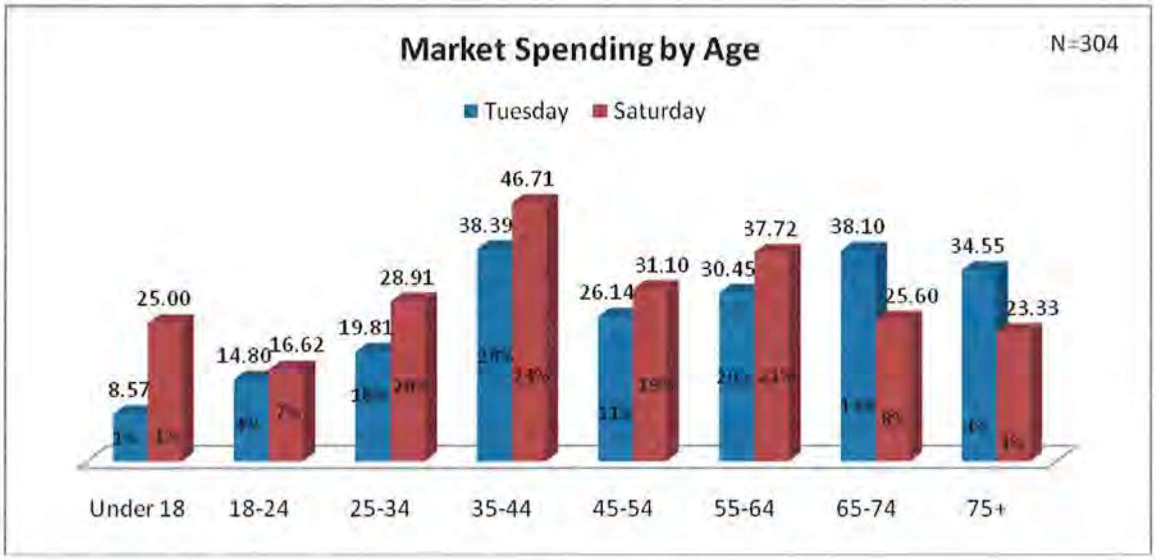
Market Spending by Zip Code

$0	$5	$10	$15	$20	$25	$30	$40	$50	$60	$80	$100	$150	Tot Cust	Total Spent	Avg Spent	
0	1	0	1	0	0	0	0	0	0	0	0	0	**2**	$20	$ 10.00	Berk 94701
1	3	2	2	2	2	2	2	0	1	1	1	1	**20**	**$685**	**$ 34.25**	**Berk 94702**
1	5	8	3	15	5	8	7	4	1	0	1	0	**58**	**1,455**	**$ 25.09**	**Berk 94703**
0	7	3	4	3	3	0	2	0	1	1	0	0	**24**	**$480**	**$ 20.00**	**Berk 94704**
2	8	3	2	7	1	3	2	3	0	0	1	1	**33**	**$835**	**$ 25.30**	**Berk 94705**
0	1	2	0	1	0	3	0	1	0	1	1	0	**10**	$365	**$ 36.50**	**Berk 94707**
0	0	3	0	0	0	0	0	2	2	0	0	0	**7**	$250	$ 35.71	Berk 94708
1	4	1	0	3	0	1	1	2	1	1	1	0	**16**	$500	**$ 31.25**	**Berk 94709**
0	1	0	0	2	2	0	2	0	0	0	0	0	**7**	$175	$ 25.00	Berk 94710
0	0	1	0	0	0	0	0	0	0	1	0	0	**2**	$90	$ 45.00	Berk 94720
0	1	2	0	0	0	1	0	0	0	0	0	0	**4**	$55	$ 13.75	Albany
0	1	0	2	0	0	0	1	0	0	0	0	0	**4**	$75	$ 18.75	Alameda
0	0	0	0	0	0	1	0	0	0	0	0	0	**1**	$30	$ 30.00	El Cerrito
0	1	3	0	7	1	2	1	0	0	0	0	1	**16**	$450	**$ 28.13**	**Emeryville**
1	1	2	2	4	3	5	1	1	0	1	0	0	**21**	**$530**	**$ 25.24**	**Oak 94609**
0	2	1	0	2	2	5	1	1	1	0	0	0	**15**	$410	**$ 27.33**	**Oak 94610-12**
0	0	1	1	0	0	0	0	0	0	1	0	0	**3**	$105	$ 35.00	Oak 94618
0	1	4	0	4	1	6	2	1	1	0	3	0	**23**	$820	**$ 35.65**	**Oak other**
0	0	0	0	0	0	0	1	0	0	0	0	0	**1**	$40	$ 40.00	Alameda Co.
2	0	3	1	3	1	1	3	1	1	0	1	0	**17**	**$490**	**$ 28.82**	**Contra Costa**
1	1	2	0	1	0	3	1	1	3	1	1	0	**15**	$585	**$ 39.00**	**Other Bay**
1	1	0	0	4	0	0	0	0	0	0	0	0	**6**	$85	$ 14.17	Other
													305		**$ 27.97**	

Zip codes with the *highest average spending* were **94707** ($36.50), 94708 ($35.71), **94702** ($34.25), **94709** ($31.25); **Other Oakland** ($35.65), **Contra Costa Co.** ($28.82), **Emeryville** ($28.13) and **Other Bay Area** zips ($39.00).

Zip codes with customers spending *below average* were **94704** ($20.00), 94710 ($25.00), **94703** ($25.09), **94705** ($25.30); **Oakland 94609** ($25.24), **Oakland 94610/11/12** ($27.33). However, stronger customer numbers can make up for lower average spending. Thus, the **greatest Berkeley buying power is in zip codes 94703, 5, 2 and 4.** It would be wise to test a coupon mailer on those zip codes, and on 94707 and 9, to find the most cost-effective zips to target.

Question 6/Question 17 – Market Spending/Age



The Tuesday market has similar age-related shopping patterns to the Saturday market. The three most powerful groups by age are:

> 35-44 spend **$38.39** (vs. $46.71 on Saturday), with **28%** (vs. 24%) of all purchases;
> 55-64 spend $30.45 (vs. $37.72 on Saturday), with **20%** (vs. 21%) of all purchases;
> 25-34 spend $19.81 (vs. $28.91 on Saturday), with **18%** (vs. 20%) of all purchases.

However, the 65-74 year-olds jump in slightly ahead of the 4th largest Saturday buyers:

> 65-74 spend **$38.10** (vs. $25.60 on Saturday), with **13%** (vs. 8%) of all purchases;
> 45-54 spend $26.14 (vs. $31.10 on Saturday), with **11%** (vs. 19%) of all purchases.

Collectively, those 25 to 64 years old, who make up 76% of shoppers, make 77% of purchases on Tuesday, while they number 75% of Saturday shoppers with 84% of purchases. Purchasing is more spread throughout all age groups and more heavily weighted toward older buyers on Tuesday than Saturday.

Figures show **senior buying power on Tuesday** to be **double that on Saturday.** Those 65 and older – while only 13% of shoppers – account for 17% of expenditures on Tuesday but only 9% on Saturday. Their expenditures ($37.13) are 45% stronger than on Saturday ($25.35) and rank a close second to the 35-to-44 year-olds average of $38.39 on Tuesday.

While the younger set appears to have a weaker presence than on Saturday, they still represent a positive sign of interest which should grow with age. Overall, this is an ageless market.

Question 12/Question 3 –Market Frequency/Zip Code

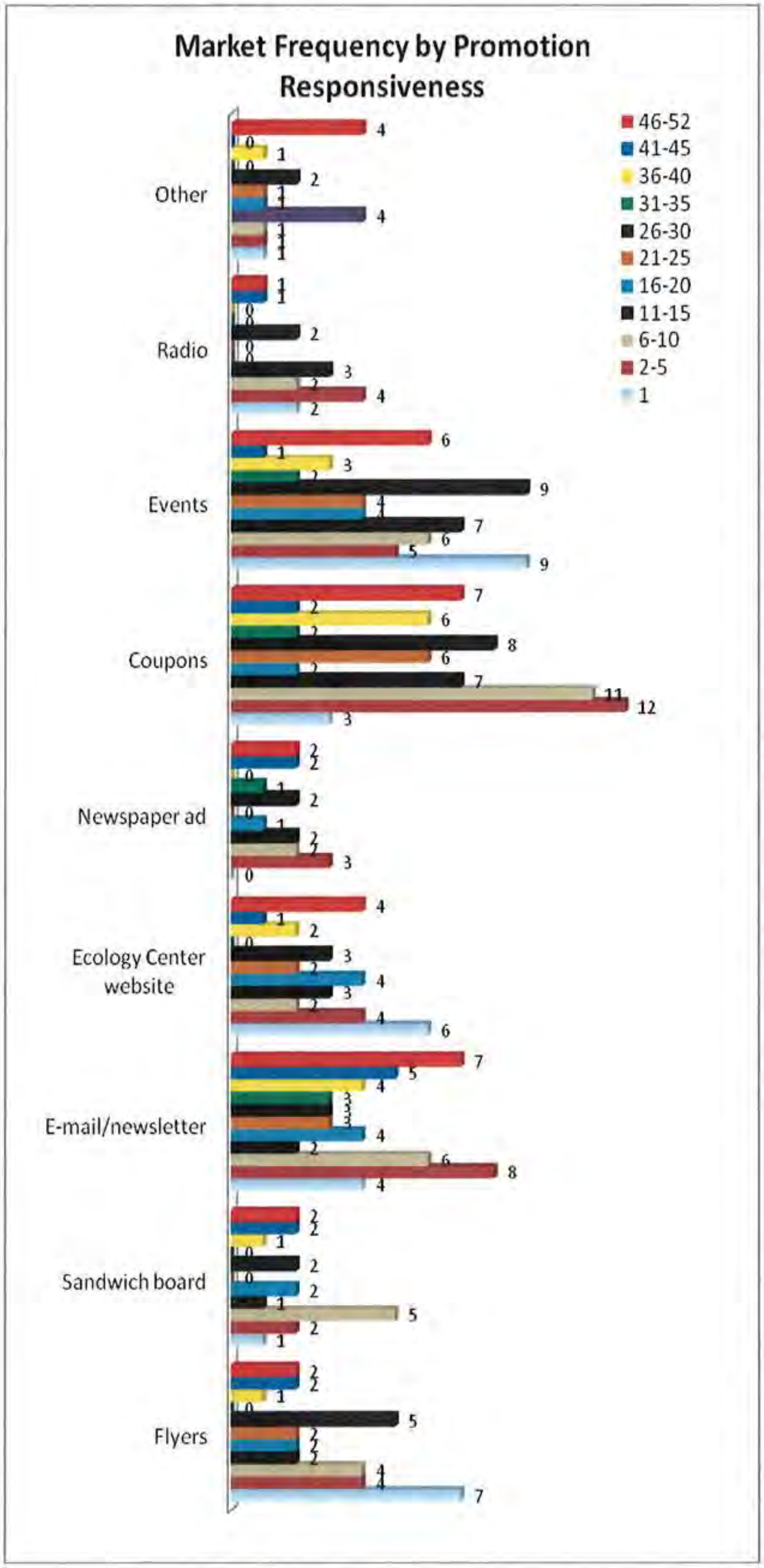
While 45% of Derby customers come a majority of the time (26+ visits per year), Berkeley residents are only somewhat more likely to attend the Market a majority of the time than other Bay Area residents, by 50% to 41%.

The Berkeley zip codes (excluding * with low numbers) with the highest level of customers coming **a majority of Market days** each year are: **94702 – 60%, 94709 – 59%, 94703 – 53%,** and **94704 – 48%.** They are trailed by 94705 – 38% and 94707 – 36%.

Key Oakland zip codes have similar rates of frequent customers: **94609 – 52%** and **94610/11/12 – 47%,** while other Oakland zip codes have 35%. Surprisingly, a notable contingent of Contra Costa residents (red hot) leads the pack with 65% being solid, regular shoppers coming most weeks.

Any promotional campaign should target the key zip codes in bold, being sensitive to actual Market shopper counts in relation to population counts in each zip code.

Question 12/Question 10 – Frequency/Promotion Responsiveness



The intense color blocks reflect customer response we know (Q10). Three promotional vehicles are most highly rated:

Coupons	*21%*
Events	*18%*
E-mail/news.	*16%*

(Q10 had a 45% non-response rate.)

The percentage of good customers (26+ weeks/yr.) who say they will respond to these vehicles are :

Newspaper	47%
E-mail	45%
SandwichBd	39%
Coupons	38%
Events	38%
Flyers	35%
EC website	32%
Radio	27%

For new shoppers (1-15 weeks) the prioritization of promotional responsiveness differs from that above:

Radio	73%
Flyers	55%
Coupons	50%
SandwichBd	50%
Events	48%
EC website	48%
Newspaper	47%
Email/news.	41%

Promotions should be determined by cost and target. A campaign to reinforce regular shoppers will have different promotional vehicles than one to gain new customers.

Attachment

A

Hot Market Reports

click image to go to full report

Hot Market Reports
- Almonds
- Apples
- Cauliflower And Broccoli
- Cherries
- Citrus
- Figs
- Grapes
- Leafy Greens
- Mandarins And Tangerines
- Melons
- Onions
- Other Berries
- Peaches And Nectarines
- Pistachios
- Plums
- Processed Tomatoes
- Prunes
- Raisins
- Strawberries
- Walnuts

Archives

August 2012 (7)
June 2012 (1)
March 2012 (1)
February 2012 (1)
January 2012 (3)
October 2011 (1)
May 2011 (1)
March 2011 (1)
February 2011 (6)

Contact

Center for International Trade Development
State Center Community College District
390 W. Fir Ave. Ste. 303
Clovis, CA 93611

Bus – (559) 324-6401
Toll Free – (888) 638-7888
Fax – (559) 324-6492

International Trade Topics

A New Beginning Booth Ranches Center for International Trade Development CIBER CITD Cuba Don Barton food safety Free Trade Agreement free trade agreements Gold River Orchards grow local international international trade Kenkko Loren Booth Mark Benjamin Neil Galone Northern California Parr Rosson Richard G. Chriss sell global sell globally seminars supply chains Texas A&M Trade Barriers Trade Mission world ag expo WUSATA

Attachment

B

EXPLORE EXPORTING

THE WORLD IS WAITING

Explore Exporting- The World is Waiting Seminar

Customized for food and agriculture businesses, this seminar will give your company inside access to industry experts that explore the core details of why to export.

May 22, 2012 | San Diego, CA

May 23, 2012 | Fresno, CA

May 24, 2012 | Napa, CA

Registration Deadline: May 15, 2012

Cost: **FREE** (includes light refreshments)

Seminar Agenda Topics Include:

- Opportunity analysis of food consumption trends around the world
- Why U.S. food exports are in high demand
- Access to local trade experts, resources and more!

Activity Registration- *please complete and submit via fax or by email*

Primary Contact: ______________________

Company: ______________________ **Products:** ______________________

Address: ______________________ **City:** ____________ **State:** ______ **Zip Code:** ____________

Phone Number: ______________________ **Fax:** ______________________

Email: ______________________ **Website:** ______________________

Seminar Locations- Please choose which location to attend:

☐ **San Diego, CA (5/22/12)** ☐ **Fresno, CA (5/23/12)** ☐ **Napa, CA (5/24/12)**

Is your company currently Exporting? *Check all that apply:*

☐No, I am not exporting ☐ I am new to export ☐Yes, I am currently exporting

How did you hear about us?______________________

A seminar dedicated to educating already existing *food and agricultural* based companies who are new-to-export, or are thinking about entering the global marketplace.

Pre- registration is required for this event. All registrations must be completed and submitted to WUSATA by May 15, 2012 .

Please submit your registration via fax (360) 693-3464 or by email to events@wusata.org.

For more information, please contact:

California Department of Food & Agriculture
Josh Eddy
P: (916) 654-0321 | E: josh.eddy@cdfa.ca.gov

WUSATA
Amanda Hughart
P: (360) 693-3373 | E: amanda@wusata.org

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EXPLORE EXPORTING

THE WORLD IS WAITING

San Diego, CA (5/22/12) | **Fresno, CA** (5/23/12) | **Napa, CA** (5/24/12)

Seminar Agenda:

8:30-8:45am	**Check-in and Networking**
9:00-9:15am	**WUSATA Welcome and California Dept. of Food & Ag Intro** Welcome, overview of agenda and California food and ag trends/facts Speakers: Western United States Agricultural Trade Association (WUSATA) and California Department of Food and Agriculture (CDFA)
9:15-9:30am	**Exporting 101: Why you should export?** Overview and benefits of why to export Speaker: San Diego: Geoff Bogart & Matt Anderson, Department of Commerce Speaker: Fresno: Glen Roberts, Department of Commerce Speaker: Yountville: Daniel Giavina, Department of Commerce
9:30-10:15am	**Outlook for U.S. Food Products: Consumption & Export Trends** Opportunity analysis of global markets and consumption trends for agricultural products. Speaker All Locations: Matt Tripodi, Euromonitor International
10:15-10:30am	**Break**
10:30-11:00am	**Resources available to local food and ag companies** Speaker- San Diego: Pellson Lau & Martin Selander, SBA Speaker- Fresno: Jerry Avila, SBA Speaker- Yountville: Jerry Avila, SBA
11:00-11:30am	**Overview of State and Federal Resources** Discover state and federal resources you can use to prepare your company for export success Speakers: CDFA, California Centers for International Trade Development (CITD), and WUSATA
11:30-12:00pm	**Wrap-up and final Q&A** (Panel) Speaker: All speakers on panel to answer questions
*Napa Location: Will also feature-	**How to Finance Your International Transactions** Speaker: Paul Watts, Ex-Im Bank

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Brought to you by:
WUSATA, California State Department of Agriculture, California Centers for International Trade Development, Small Business Administration (SBA), U.S. Department of Commerce (DOC), Export-Import Bank (Ex-Im Bank), California Farm Bureau Federation and Euromonitor International

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Attachment

C

SCHEDULE OF EVENTS:

Wednesday, April 25

11am	Early Registration	
1-3pm	Food Safety Modernization Act Food Safety Media Training Introduction to GFSI Audits Center for International Trade Development	Barbara Cassens Mary Kathryn Covert Tom Vogel Michael Fay & Matt Tripodi
3:15-5:15pm	Food Safety Modernization Act Food Safety Media Training Introduction to GFSI Audits Terms of Contracts-Incoterms 2012	Barbara Cassens Mary Kathryn Covert Tom Vogel Daniel Gardner
5:15-6pm	Break	
6-7:15pm	IGNITE-Exhibitor & Sponsorship Reception-Silent Auction Opens	
7:15pm	Dine-Arounds (by private invite only) -OR- DOYO (Dine on your own)	

Thursday, April 26

5am 8am 9am	Temecula Sunrise Hot Air Balloon & Champagne Brunch Sycuan Resort & Casino-Golf Tournament Harbor Sailboat Yacht Races	
8:30-4:30pm 8:30-12:30pm	***Full-Day Course***: HACCP Training ***Half-Day Course***: Food Safety Prerequisites	Tom Vogel Anotonio Munguia
9:30-11:30am	Food Recall- Not so Spicy Transportation Concerns in 2012	Alex Coles Ed Zaninelli
11:30-1:30pm	Boxed Lunches at Café Ignite located in the exhibitor's pavilion	

Thursday, April 26 Continued...

2-4pm	Pathogen Prevention in Food Sanitary Food Transportation Act	Linda Harris, PHD Thomas Jones Patrick Brecht, PHD
4-5pm	Break	
5-6:15pm	Gala Kick-Off: Why Winners Win	Robyn Benincasa

Two time World Champion Eco-Challenge Adventure Racer and San Diego Firefighter Robyn Benincasa knows a thing or two about creating Human Synergy, or as Robyn puts it, "that magic that allows groups of ordinary people to accomplish extraordinary things together". For the past 15 years, she and her teammates have studied Extreme Teamwork in the most unique and compelling classroom on earth: The jungles of Borneo, the Himalayan peaks of Tibet, the rivers of Fiji, the rainforests of Ecuador and the epic brush fires of Southern California. It is through these harrowing, life affirming and often hilarious experiences in the world's most grueling challenges that she has emerged with her refreshing and truly unique perspective on what it takes to build the kind of world class teams that succeed against all odds, that truimph in the face of adversity and that go the distance in any endeavor.

6:30-7:30pm	Poolside Cocktail Reception	Silent Auction Closes
7:30-12am	Beyond Gravity, Catch FIRE Dinner Gala	

Friday, April 27

8-9:30am	**SCTC Board Meeting**	
8:30-9:30am	Continental Breakfast	
9:30-10:30am	SCTC Business Meeting & Guest Speaker	Gene Seroka
10:30-11am	Break-coffee & beverages provided in Café Ignite, the exhibitor's pavilion	
11-12pm	DFA Business Meeting & Guest Speaker	
12-1pm	Closing Lunch/ President's Address	Sam Keiper
1:30-4pm	**DFA Board Meeting**	

Educational Opportunities

All educational courses are included in the cost of registration. Additional cost for Full Day HACCP Training and Half-Day Food Safety Prerequisite Course

Introduction to GFSI Audits—— Tom Vogel
The Global Food Safety Initiative's (GFSI) governing principles of "Once Certified, Accepted Everywhere" emphasizes implementing a benchmarked food safety standard for third party audits to increase thoroughness and efficiency and enable suppliers and buyers to spend less time managing multiple, different audits from customers. GFSI audit benefits include: maintaining a benchmarking process for food safety management audit schemes, improving cost efficiency by acceptance of GFSI standards, providing a venue for networking, knowledge exchange, and sharing of best food safety practices and information.

Food Safety Modernization Act (FSMA)—— Barbara Cassens
For the first time, FDA will have a legislative mandate to require comprehensive, science-based preventive controls across the food supply. Under the Act, implementation of mandatory preventive controls for food facilities and compliance with mandatory safety standards will be required. Food facilities will be required to implement a written preventive control plan, provide for the monitoring of the performance of those controls, and specify the corrective actions the facility will take when necessary. This session will be led by an FDA expert, who will show you how FSMA standards will affect your company, the challenges you may face, and how to manage these challenges effectively according to FDA's timelines.

Terms of Contracts-Incoterms 2012—— Daniel Gardner
How can you use incoterms to your advantage? Do you know the difference between ex-works and deliver duty paid in terms of documents, risk transfer, insurance and cost of goods? Did you know the difference of one letter in an incoterm could save your
company thousands? This session will provide an in-depth review of the 11 updated Incoterms to better understand what the seller's delivery obligations are, and it will help you identify the point in the supply chain where the risk of loss shifts from the seller to the buyer. Furthermore, learn how to accurately create comprehensive export documentations to avoid hick-ups in the supply chain.

Food Safety Media Training—— Mary Kathryn Covert
How ready is your organization in the case of a product recall incident? Will your crisis management plan protect your organization? Are you protected? Whether you are interviewed with the Wall Street Journal, CNBC or Business Week, you can shine. Do you know how to handle food safety specific media inquiries? Learn to be confident, comfortable and relaxed in any interview situation AND create the ability to control not only your message but also your exact quotes used by the media. Hear from an expert on how to be "Media SMART" to protect your brand.

Center for International Trade Development——
Matt Tripodi & Michael Fay
Mr Tipodi will you help you discover the factors driving unprecedented growth in global trade and how California specialty commodities and dried products stand to benefit. This presentation will highlight trends and developments affecting the existing and future demand for California's specialty commodities and presents where important opportunities are (and will be) for export growth. In addition, Mr Fay Mr. Fay will be speaking on the newly opened South Korean market as it relates to the dried fruit and nut industry.

Food Recall, Not so Spicy—— Alex Coles
Spice consumption in the U.S. has grown steadily over the last 20 years. Unfortunately, spices are agricultural commodities that can become contaminated with microorganisms or other contaminants present in the environment. Surveys on the microbiological status of spices in different countries have revealed the presence of foodborne bacteria and toxigenic molds, including *Salmonella, Escherichia coli, Staphylococcus aureus, Clostridium perfringens, Bacillus cereus* and even aflatoxigenic *Aspergillus*. Although pathogenic microorganisms have been isolated from spices, they have not historically been associated with outbreaks or recalls related to this commodity. Recent foodborne outbreaks and product recalls due to *Salmonella* and *E. coli* contamination, have however moved this supposedly innocuous product into a new spotlight of outbreaks. Learn about case studies and how to combat this issue.

Transportation Concerns in 2012—— Ed Zaninelli
What's hot today? Is it higher freight rates, volatile bunker levels, shortage of equipment? What's hot tomorrow? The climate is ever changing. This session will review current transportation issues that exporters are facing. Learn about the most current and relevant issues facing our industry, the impact it will have on your business and the best practices for dealing with it.

Pathogen Prevention in Food—— Linda Harris & Thomas Jones
According to the FDA report, "To better control foodborne pathogens in animals and plants, prevention efforts should be implemented across the farm to table continuum." USDA Secretary Mike Johanns explained, "These results demonstrate that through innovative policies and strong and consistent enforcement of inspection laws, we are protecting the public's health through a safer food supply." Learn how to take part in the decline in foodborne illness and how to enhance your food safety systems.

Sanitary Food Transportation Act—— Patrick Brecht
Patrick E. Brecht is based in Petaluma and specializes in forensic investigations of spoilage issues related to transportation. Learn about cases within the dried fruit industry, the legal outcomes of these cases, and how to protect yourself as a packer or an exporter.

Full-Day HACCP Training —— Tom Vogel
Every operation serving or selling food needs to have a food safety system in place that is designed specifically to guarantee the food being served is safe to eat. This course aims to teach you the importance and use of all 7 HACCP principles in order to make you a safer, more effective food service employee. The course is a full day course and holds to FDA and USDA standards of HACCP Plan Implementation. Furthermore, a certificate of attendance will be awarded upon completion.

Half-Day Prerequisite Class—— Antonio Munguia
Before embarking on a HACCP certification, it is essential to understand the fundamentals of a solid food safety prerequisite program. In this half-day course, DFA experts will cover the make-up and implementation of the many prerequisites needed to be
Considered in a safe environment We will equip you with the proper tools and resources that you can then take back to your facility to share with colleagues, identify what prerequisites relate to your organization and begin the implementation process.

Join us for this year's
DFA of California & Specialty
Crop Trade Council 2012 Annual Conference:

Beyond Gravity, Catch Fire
San Diego, California
April 25-27, 2012

We are going beyond the norm and reaching deep within the dried fruit and nut industry to educate, train, motivate, and provide networking opportunities.

What is "Beyond Gravity, Catch Fire?" It is said that the only element to defy gravity is FIRE. Gravity is a force that unites-so let's unite. But more importantly, let the Dried Fruit and Nut Industry be ignited at the 2012 DFA/SCTC Conference through real motivation, real education, and real conversations that create that burning desire to move our business forward; let's catch fire!

www.beyondgravitycatchfire.com

DFA Of California
Specialty Crop Trade Council
CALIFORNIA DRIED FRUIT EXPORT ASSOCIATION

Attendance

Name	Company
Suzan Turner	
Mathieu Esteve	A.P. Esteve Sales
Laurent Esteve	A.P. Esteve Sales
Andre Esteve	A.P. Esteve Sales
Mike Hurley	ACFSQ
Gail Santana	ACFSQ
Thomas Jones	ACFSQ
Randall Brooks	ACFSQ
Richard Cherrix	ACFSQ
Tom Vogel	ACFSQ
Merle Jacobs	ACFSQ/SCTC
Rick Murphy	ACFSQ/SCTC
Amye Wirth	ACFSQ/SCTC
Jeff Emslie	ACFSQ/SCTC
Patrick Ferreira	ACFSQ/SCTC
Peter Friedmann	AgTC
Paul Hall	AIV Microbiology & Food Safety
Dennis Connors	Allen Lund Company
John Mundt	Alpine Pacific Nut Company
Catherine Mundt	Alpine Pacific Nut Company
Kenny Dickens	Alpine Pacific Nut Company
Gordon Tom	APL Limited
Tom Rettagliata	Ashlock Company
Van Soetaert	Baldwin-Minkler Farms
Joe McKenry	Bank of the West
Kevin Wagner	Berberian Nut Company
Giuseppe "Pino" Calcagni	Besana
Doug Youngdahl	Blue Diamond Growers
Susan Brauner	Blue Diamond Growers
Gary Cross	Blue Sky Sales, Inc.
Bill Carriere	Borges of California
Mark Jorgensen	CalDak International
Sabine Przysucha	CalDak International
Chip Litten	CalDak International
Richard Matoian	California Fig Advisory Board
Bruce Higton	California Food Connections
Mark Melkonian	California Fruit Inc.
Ed Yates	California League of Food Processors
Craig Duerr	Campos Brothers Farms

Attendance

Name	Company
Tony Campos	Campos Brothers Farms
Juliet Campos	Campos Brothers Farms
Vie Armas	Campos Brothers Farms
Matt Doyle	Carriere Family Farms
Dan Milinovich	Central California Raisin Packing
Skip Hubbard	Chico Nut Company
Gary Dietrich	Citizen Voice
Houshang Arasteh	Clayton Logistics LLC
Linda Boyd	Coppersmith, Inc.
John Weaver	CropSource International
Amy Myrdal	Culinary Institute of America
Mark Linder	Culinary Institute of America
Gerald Chooljian	Del Rey Packing Company
Kathy Merlo	Del Rey Packing Company
Kerry Lauer	Denham Resources
N. Leon Dermenjian	Derco Foods
Debbie McMillan	Derco Foods
Detrie Smith	Detrie International
Hugh Riedle	DFA Retired
Frank Morgan	Diamond Foods, Inc.
Gary Ford	Diamond Foods, Inc.
Jeff Welker	Dow AgroSciences
Adriana Faestro	Fiddyment Farms, Inc.
Mike Jura, Jr.	Fig Garden Packing, Inc.
Debra McWilliams	Fig Garden Packing, Inc.
Greg Paul	Fig Garden Packing, Inc.
Misty Bowman	Fisher Nut Company
Ron Fisher	Fisher Nut Company
Charlotte Elder	Fisher Nut Company
Susan Wanier	Galaxy Technology, Inc.
Jennifer Martella	Grower Direct Nut Company
Kevin Chiesa	Grower Direct Nut Company
Aaron Martella	Grower Direct Nut Company
Joseph Cutrera	Hapag LLoyd
Doug McClellan	Hazelnut Growers of Oregon
Diane Rubino Ferrara	Hill View Packing Company
Kent Mannee	Hill View Packing Company
Joe Rubino	Hill View Packing Company
Ray Akamine	Hill View Packing Company

Attendance

Name	Company
Dan Reighn	Hill View Packing Company
Dorothy Rubino	Hill View Packing Company
John Buffington	J Buffington Corp
Forrest Landano	James Brooks Company
Bill Cornell	James Brooks Company
Fred Giron	K Line America
Jack Kraemer	Key Technology
John Martin	Mariani Nut Company
Jack Mariani	Mariani Nut Company
John Aguiar	Mariani Nut Company
Martin Mariani	Mariani Nut Company
Steve Sousa	Mariani Packing Company
George Sousa, Jr	Mariani Packing Company
George Sousa, Sr	Mariani Packing Company
Mark Papineau	Martin Associates
Paul Reynolds	Meridian Nut Growers
Mitsuru Hamaishi	Miki Corporation
Sumio Kawanabe	Miki Orchard, Inc.
Shin Kadota	Miki Orchard, Inc.
Hiroaki Eguchi	Miki Orchard, Inc.
Mike Parise	MPA, Inc.
Howard Graybehl	MPA, Inc.
Krikor Bedrosian	National Raisin Company
John Greene	NYK Line
Brian Mayfield	NYK Line
Royce Nicolaisen	Otis McAllister, Inc.
Alanna Grever	Otis McAllister, Inc.
Mike Gnecco	Otis McAllister, Inc.
Everett Golden III	Otis McAllister, Inc.
Jeff Brehm	Otis McAllister, Inc.
Linda Robbins	Pacific Century Trading
Atsuo Funakoshi	Pacific Coast Sales
Steve Martin	Pan American Underwriters
Daniel Castillo	Pan American Underwriters
Berton Steir	Paramount Farms, Inc.
Steven Gardner	PCC Logistics
Jaydee Martin	PCC Logistics
Marcel Van Dijk	Port of Los Angeles
Steve Gregory	Port of Oakland

Attendance

Name	Company
Michael Heeneman	Port of Rotterdam
Bill Lewicki	Port of Stockton
Brian Tormey	Premiere Almonds
Murray Wise	Premiere Almonds
Glen Goto	Raisin Bargaining Association
Michael Mikaelian	Raisin Bargaining Association
Richard Burright	Rio Del Mar Foods, Inc.
Jaswant Bains	Sacramento Packing
Gurpreet Gill	Sacramento Packing
Cameron Black	Sacramento Valley Walnut Growers
Roy Jura	San Joaquin Figs
Keith Jura	San Joaquin Figs
Matt Jura	San Joaquin Figs
Dan Lusk	Satake USA
Jeff Sargent	Satake USA
Shari Fitzpatrick	Shari's Berries
Wayne Duty	Shoei Foods USA, Inc.
David Mazzola	Shoei Foods USA, Inc.
Hidemitsu Honda	Shoei Foods USA, Inc.
Don Soetaert	Shoei Foods USA, Inc.
Sheryl Wheeler	Spycher Brothers
Heidi Almanza	Spycher Brothers
Robert Nunes	Spycher Brothers
Eric Heitman	Stapleton-Spence Packing
Gerry Clark	Stapleton-Spence Packing
Jeanne Coen	Summit Almonds
Mark Bagley	Sun-Maid Growers of California
Barry Kriebel	Sun-Maid Growers of California
John Slinkard	Sun-Maid Growers of California
Michael Cassidy	Sun-Maid Growers of California
Mark Dalrymple	Sunsweet Growers Inc.
Arthur Driscoll II	Sunsweet Growers Inc.
Dane Lance	Sunsweet Growers Inc.
Tim Schneider	T.G.S. Transportation
John Taylor	Taylor Brothers Farms
Ulash Turkhan	Turkhan Nuts
Don Zink	U.S. Food & Drug Administration
Bruce Campbell	USDA-ARS-WRRC
Doug Light	USDA-ARS-WRRC

Attendance

Name	Company
Ron Haff	USDA-ARS-WRRC
Paul Mesple	Valley Fig Growers
Mike Emigh	Valley Fig Growers
Gary Jue	Valley Fig Growers
Tom Formosa	Valley View Packing Company
Richard Onyett	Valley View Packing Company
Cate Bugbee	Wachovia Bank
Shawn McGowen	Wachovia Bank
Andy Broaddus	Wells Fargo
Keith Maland	Wells Fargo
Tom Kermoian	Wells Fargo
Duffy Segale	Wells Fargo
Ed Bolger	Wells Fargo
Tom Higgins	Wells Fargo Insurance
John Quinn	Whitworths Inc.
Richard Wilbur	Wilbur Packing Company
Rick Wilbur	Wilbur Packing Company
Kimberly Wilbur	Wilbur Packing Company
John Friend	Wilbur Packing Company
Emily Friend	Wilbur Packing Company
Pete Turner	Wilbur Packing Company
Jim Wilson	Yang Ming (America)
David Tsen	Yang Ming (America)
Roland Kerby	Zim American Integrated Shipping
Janis Nasser	Zim American Integrated Shipping
John Zoria	Zoria Farms Inc.
Kaz Yanase	Zoria Farms Inc.

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for the

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Project Summary

This document provides a business assessment of the California Agricultural Almanac (CAA). It aims to identify its potential value as currently developed, with the goal of identifying one or more valid approaches for sustaining the site into the future. This assessment has been conducted at the conclusion of Phase I of the project, where the CAA now exists in beta form with all Phase I development completed. The business assessment outlines the project's history, addresses the market and competitive landscape, identifies strengths and weaknesses based on a general site review, reveals insights from dozens of user interviews, and makes recommendations for phase 2 operations.

Definitions

Below is a list of words and phrases that are used throughout this document, defined here for context and clarity.

- **California Agricultural Almanac –** commonly abbreviated to "CAA"
- **GreenInfo –** The SAGE partner responsible for the technical development of the CAA
- **Specialty Crops –** "Fruits, vegetables, tree nuts, dried fruits, nursery crops, and floriculture" according to the USDA. The CAA focuses specifically on showcasing vegetable, fruit, and nut specialty crops. For brevity, this document interchanges the phrase specialty crops with "produce".

Project History

The following section outlines starting purpose and assumptions for audiences, content, and functionality and their evolution over the course of the project.

Starting Point

As stated at the outset of the project, the purpose of the California Agricultural Almanac (CAA) was to enhance the market for the state's extraordinary bounty of Specialty Crops by providing real-time, accessible crop information to the public, and thereby deepening appreciation for what these crops are, where they grown, when they are in season, and how they are affected by weather. The goal of the CAA was to encourage public interest and support of California Specialty Crops by developing a collaborative online application to facilitate the collection and distribution of crop production information.

In terms of the collection of the crop data, it was assumed that the project would identify, obtain, and synthesize existing data sets into aggregated data that could be presented or accessed through temporal and spatial filters. Distribution was to occur through a syndicated web feed of current crop production information including crop icons showing the general locations of crop production throughout California during any given week. The integration of geographic locations would permit the feed to be used in maps, both online and in print, and would therefore foster a better understanding of the relationship between geography and the seasonality of California Specialty Crops.

In summary, the project aimed to create a simple, self-sustaining link between two interested parties for their mutual benefit. Specialty Crop producers and associations would have an efficient, convenient, and timely means to compile real-time crop information for mass distribution. Media outlets, starting with print and online news providers, would have effective, accessible, and timely information to provide to the burgeoning audience interested in locally-grown food.

Evolution of the Project

Fulfilling the original goal of the California Agricultural Almanac - to showcase "what's in season where" for specialty crops in a straightforward, lightweight manner for presentation through existing media - proved to be challenging for a number of reasons.

As investigation of the available sets of crop by place and by seasonality data began, a number of challenges became apparent. Most of these had to do with the lack of data, and/or the inaccessibility of data, and to date, the infeasibility of a system for real-time updates. An outline of all data sets used in the project is included in Appendix A.

Alternatives for defining agricultural places (or landscapes) were explored early in the project and a two level method was developed to create this data. For areas where there was a high level of expert knowledge available (mostly the San Francisco Bay Area), GIS data and expertise from SAGE was used to create customized areas with locally known names (e.g., Bennett Valley) – these were digitized as polygons with precise boundaries, to which crop lists could be attached. For other areas of the state, methods were developed to use the state's Farmland Mapping and Monitoring Program (FMMP) GIS data in creating county-wide agricultural places. This involved using crop-focused land definitions in FMMP, and then hand-revising them where they covered areas that, from satellite photography, were clearly not cropland. The result of this work is a statewide system of Agricultural Places representing almost all of the cropland areas in California. It was not always possible, however, to distinguish cropland used for specialty crops from other field cropland.

For crops themselves, two comprehensive data sets were considered most promising – annual data from the USDA National Agricultural Statistics Service (NASS), depicting over 70 crop types at satisfactory geographic resolution (30 meter grid cells), and the California County Pesticide Use Reports (PURs) which track many crops by farmer using a location-specific address. The NASS data was used in the CAA to provide a first-level approximation of crops within entire counties and to inform crops in some individual agricultural places. The project drew from this data and from more detailed lists of specialty crops to produce crop taxonomy with three levels of categorization, the most detailed of which is a list 127 unique fruits, nuts, and vegetables. This taxonomy has both the more general categories and the right level of detail to allow aggregation of existing disparate lists of crops and to be familiar to discerning consumers.

PUR data is generated because most crops in California use some amount of registered pesticide during some point in the production cycle. These pesticide reports are generated in each county and submitted to the state mostly as scanned documents. The state interprets these into a statewide data set which is released annually to the public. The released pesticide reports data (in tabular format) aggregates individual field reports into township/range and section references. These "cells" were difficult to use for defining individual agricultural places/landscapes, but the pesticide data generally is valuable at a countywide level for generating crop lists with reasonable levels of crop detail, which have been used in the CAA.

Another comprehensive data set is the County Crop Reports, which are compiled by most counties and released annually. The challenges with this data included: it is not specific to areas within counties, there are some limitations in the crop list (e.g. general crop categories such as "miscellaneous vegetables"); and the desire to depict places (the "where") that were less jurisdictional and more fine-grained, more evocative and more in line with local descriptions. However, as much as feasible within the data limitations, the project did manually enter crop by county information into the CAA.

The project also held assumptions that individual Commodity Commissions and the Buy California Campaign could provide the project with additional crop by place by season data and would welcome the opportunity to give real-time data during their peak production periods to the CAA for wider distribution, proved largely unfounded. However, further research in the project discovered that "commissions were not really in the promotion business and that some data was sensitive and proprietary; other data [was] not in geo-coded or geo-codable form."

For place names, the project significantly advanced the general method for identifying where crops are grown in terms of a county only. In addition to showing crops by county, the project established at least for part of the state, a common geography of places, that: (1) were subsets of counties, (2) reflected the place names commonly used in agriculture (e.g. Green Valley), (3) were within a similar range of scale, and (4) were unique (not overlapping). This approach is similar to the methodology to establishing AVA (American Viticultural Areas) and could potentially having similar marketing advantages.

For data on crops and on farms, the project investigated the availability of crop by grower data in another public record source: Certified Producer Certificates (CPC's). By state law, all producers who sell product at farmers' markets are required to file a form with their county Agriculture Commissioners' Office listing their products by anticipated volume and anticipated season. While this data provides a more complete list of crops – the kind of list familiar to informed consumers – almost none of this data is in digitized form let alone compiled and made available on a state-wide basis.

About mid-point through the project, data collection efforts turned to soliciting specific sets of curated farmer data to further refine agricultural place crop data. The Center for Urban Education about Sustainable Agriculture (CUESA) and the Community Alliance with Family Farmers (CAFF) provided farm data for this effort, as did the CalAgTour program, a project of the UC Small Farm Program. These data (plus another data set from Monterey County) provided a good base of farm information, but did not end up informing the places/crop availability tables, due to lack of consistency among sources.

In summary, the primary such data sets the CAA imported (as independent data sets) were: (1) SAGE-defined Agricultural Places; (2) SAGE-defined crop taxonomy; (3) NASS crop data tied to defined agricultural places; (4) Expert-identified data for particular agricultural places; (5) farm data from CAFF which had limited crop information; (6) farm data from CUESA; (7) farm data from the Small Farm Program, with a focus on ag-tourism offerings; (8) farm data from Monterey County; (9) Farmers Market data from the Calif. Farmers Market Federation; and 10) event data from the Marin Agricultural Land Trust (MALT), CUESA and the UC Davis Small Farms Center. The CAA represents the first-ever comprehensive effort to assemble all of this data in one interactive environment.

Given this history, this assessment aims to answer the question "what is next and why?" for the Almanac.

Market Opportunity

The trend in California toward purchase and consumption of locally grown produce has created the need for tools and data sets that educate consumers about their food choices, and connects them with the rich agricultural landscapes of California. Several applications in addition to the California Agricultural Almanac (CAA) attempt to do just this. Similar to the CAA, these tools attempt to showcase different types of agricultural information that often includes the following:

- Produce seasonality
- Farm location and name
- Names of growing regions
- Produce growing location
- Location of CSA's
- Food-related events

Among these tools, there is no dominant application that brings data together in a simple and unified way; and the market for online tools in this space is fragmented. More specifically, there is no site that presents crop and seasonality detail in a visually appealing way. This set of circumstances creates a unique opportunity for the CAA, with refinements - to address the deficiencies in the current market for online tools. To understand the refinements that would have the largest impact, it is helpful to examine further trends in application development amongst CAA competitors.

Categorizing CAA Competitors

For the CAA, a simple way to think about the industry and competitors is by asking the question "would someone rather use another site or product to get the same information that is provided by the CAA?" With this in mind, consumers can turn to several alternatives to the CAA that fall into the following broad categories. *(Note – some examples are given for each category. For further examples and detailed information such as business model, funding, target audience, and positioning, please refer to the accompanying Competitive Analysis excel spreadsheet.)*

- **Online Mapping Tools:** These are direct competitors attempting to do roughly the same thing as the CAA. Examples include www.localharvest.org, and www.findlocalproduce.net.
- **Seasonality Products (Online and Offline):** These are products that would be considered "Substitution Threats" – products that are not exactly the same but have the same consumer use through a different means. The Local Foods Wheel is a good example of this. CUESA, while serving as a partner, also serves as a competitor, since users may consume a subset of the data provided to the CAA through the CUESA website if they so choose.
- **Mobile Applications:** These products are also example of substitution threats, but earn their own category because of their specific use. Most are designed to be used at point of purchase for the purpose of informing the consumer as to what is being

bought. The Eat Real Guide, inSeason, HarvestMark Food Traceability, and the Seasons App are in this category.

- **Local Products:** These are products (online or offline) in specific, local geographies (at the city, county, or regional level). Often they are online applications that do not have plans or potential to go beyond regional boundaries.
- **Farmer Tools:** These are products directed at farmers specifically. Most of the products in the previous categories are aimed at consumers, or, in very few cases, at agencies (non-profits, for example) that might leverage this type of data. Farmer tools include The Agro Atlas, CARD, and Squash and Vine.

Industry and Competitive Trends and Observations

Although it is important to consider all types of competitors, the remainder of this section focuses on the online tools, since most of the relevant competition falls into this type of application. What follows are key industry trends and observations that can inform future CAA development.

Observation 1: Lack of Definition of Agricultural Place Data

Applications focus on single regions but don't provide context for those regions within the larger California agricultural landscape

The trend in consumer behavior toward purchasing local food is paralleled by application development at the city or regional level, which depicts the 'foodshed' for that locality. There is no single entity that is compiling and visually displaying for the entire state of California the extent of information that is contained in the current CAA. This provides an opportunity for the CAA to capture this area of the market and become a leader in all geographies. This is especially the case because the concept of 'local' is most often expressed as a central point (the location of the consumer or the consumer's community) surrounded by a foodshed, the extent of which is determined either subjectively and/or by a simple radius from the point of consumption. Looked at as a geography, these city-centered local foodshed circles have huge overlap. This context of 'local' being a relative concept but with universal applicability, gets at the key potential advantage for a tool such as the CAA, which aims to both show objective crop by place data for the state and to allow users to make their own subjective determination of their local foodsheds preferences from this inclusive state-wide crop by place map.

Observation 2: Lack of Usability

Usability not a major focus on the online applications

Many of the existing applications in the same market as the CAA have not prioritized usability. Mapping features are difficult to use and often not effective in displaying data. Searches are often difficult to execute and sometimes slow performing. *[Note: These claims are based on a review of nearly 2 dozen applications that can be found in the Competitive Analysis spreadsheet.]*
Given these observations, usability has the potential to be a differentiator for the CAA.

Observation 3: Lack of Integrated Data

There is a lack of comprehensive, integrated data for produce (where, what, who, and when)

Many of the applications focus on one or two of the following:

- Where – where does the produce come from (geography)?
- What – what produce is being grown, and what are its characteristics?
- Who – who produces the produce?
- When – when is it in season or more often, when is it available in the destination market

For example, LocalHarvest, a popular mapping tool, has detailed information on what farms are in a given area, satisfying the "who" and partially, the "where", but it does not tackle what is being grown. The Eat Well guide has one of the more user-friendly mapping tools and addresses seasonality ("when"), but the information on "where" is only provided at the state level (for example, it shows that beets are available in California in December, but does not get more granular than this).

In general, there is no leader who is bringing all three of these characteristics together in a meaningful way. To the extent that consumers value the cohesiveness of this data, there is an opportunity for the CAA.

Observation 4: Tenuous Funding

Funding appears tenuous and lacks focus and ability to scale

Funding varies for the different online applications, but there are very few if any products that possess a compelling business model or long-term funding as a non-profit. The exception comes from larger companies (such as Whole Foods and Harvest Mark), who subsidize product development of local food data through the success of their core business. Another exception is the Local Foods Wheel, which has a proven track record in selling its product through multiple distribution channels.

One hypothesis for the lack of strong funding is that many of the efforts are local (for example, focusing on a county or an agricultural area), thereby attracting dollars from a smaller pool of consumers or donors. Another hypothesis is that there is not yet a compelling business model to sustain development of a local foods application.

Target Audience Hypotheses

With an understanding of the trends and gaps in the market for online tools, it is possible to begin refining the target 'general public' audience for the CAA. Prior to conducting dozens of interviews of potential users and partners of the CAA, the SAGE team identified several possible more targeted audiences for the CAA. These audiences are based on groups who either use the CAA currently, or have expressed an interest in using it should certain modifications occur. These audiences are described below.

Classroom Educators

The Educator audience consists of organizations aiming to influence or create food and agriculture related curriculum in classrooms. Examples include the Center for Eco Literacy and The Edible Schoolyard. Most of these organizations focus on grades K-8, although some also extend that focus through high school. These organizations often target teachers and sometimes policy makers who are involved in the making of school curriculum. They are typically non-profit.

Agricultural Groups Focused on Consumer Education

This group of organizations has the broad mission of educating the general public about local, sustainable food systems. Examples of such organizations which engaged directly in the development of the CAA include: the Community Alliance with Family Farmers (CAFF), the UC Davis Small Farm Program, the Center for Urban Education about Sustainable Agriculture (CUESA), and the Marin Agricultural Land Trust (MALT). These organizations aim to connect rural and urban communities through discussion of and education about sustainable agriculture. Many of them have a related aim to promote information about their member farms in order to increase the exposure of and markets for these farms. These organizations may be non-profit or for-profit, and may focus on any or all of the following areas of food systems: social, cultural, economic, and technological. To deliver on their mission, these organizations would benefit from information regarding the farmers, growing methods and geography of specialty crops. They may use this information in different and creative ways.

Farmers

Farmers can also benefit from the CAA. This audience would consist of mostly small to medium sized farms interested in increasing their online presence, identifying new markets, and participating in the creation of more robust farming data by region (yields, crops that are grown, effects of weather, etc).

Consumers

The Consumer audience consists of individuals who fall into 1 of two categories:

- "Foodies" who currently appreciate and understand the dynamics of local food systems, deliberately purchase California specialty crops, and are continuously looking for ways to feel more connected to their food source.
- People who have an interest in understanding more about the benefits of local food systems, and occasionally buy local specialty crops but do not prioritize it. They are

close to converting into the “Foodie” category and having more information on farmers, regions, and produce would encourage them to do so.

There are no assumptions about income, race, sex, or age in this group. The group is primarily defined by behavior, as noted above. They are likely to shop at farmer’s markets, they appreciate food as an important part of our culture, and are likely environmentally conscious. Not considered to be a primary target audience is the general consumer category, still the majority of consumers, and those whose food shopping choices are directed more by other factors such as price, selection, and market location than by ‘local’ purchasing preferences per se.

Ag-Tourists

This group of people is interested in understanding more about sustainable agricultural in California with the specific desire to participate in events that encourage connection between rural and urban lifestyles. Individuals in this group would also fall into the “Foodie” category in the Consumer group. Their interests in “experiencing” food may be broad – visiting farms, attending fairs, planning special events at farms or vineyards (for example, weddings), etc. Similar to the consumer group there are few assumptions about the demographics of this potential audience (however, they may be developed at a later time).

Interview Results

As part of this business assessment, the SAGE team conducted 22 interviews with partners, industry experts, farmers and farm advocates, food consumers, and educators. The purpose of the interviews was to better understand the needs of each group and to narrow down the target audiences discussed in the previous section.

Several themes on the needs of target audiences and the groups represented by interviewees emerged from the interview process that provide direction for the next iteration of the CAA. The relevant themes are highlighted below. For all details from the interviews, refer to the interview transcripts.

[Note for future inclusion – summarize the interviews by needs/findings and interviewee type. This can be included as an appendix.]

Theme 1: Weather Information

Interviewees from many groups (farmers, farm advocates, educators, and ag informants) cited the need to have real-time weather information that was tied to the affect on crop growth. This was an original goal of the CAA, and in fact, weather information is currently in built into the product. The feedback given, though, was that a more direct and substantial connection between weather and crop growth by region is required. For example, with the appropriate local weather information, farmers can determine how to adjust their growing methods, and get a better sense of how prices for their crops might be affected later in the season. Consumers can better understand how weather events affect produce quality and availability. Educators are able to illustrate the effect of different weather patterns on the yields of crops, and use this information as a tool to illustrate the link between weather and food.

Theme 2: Rich Content

Nearly all interviewees commented on the importance of having both rich and fresh content. Rich content implies more than the text descriptions and produce images that are present currently. Videos, photos of farms and landscapes, interviews with farmers are some of the items that were cited that would qualify as rich content. Having this content continually updated satisfies the desire for fresh content as well (see below).

This feedback implies that future iterations of the CAA could benefit from having a more diverse content offering. The implication is that with these additional content types, the online experience can be made more compelling for users.

Theme 3: Fresh Content

Many interviewees cited the desire to have fresh content, and therefore the need (and interest) to return to the site continually to see what is new. The interest and need for fresh content is also supported by the desire for real-time weather information.

As was outlined in the opening section of this document, fresh content was a founding goal of the CAA, but discoveries during the data collection processes made it difficult in practice to find and leverage continually refreshed content. Future iterations will have to address this issue, of course. As many of the interviewers suggested, having user generated content can solve this problem while connecting farmers more directly with consumers.

Theme 4: Where Things Grow is Important

Many interviewees, primarily educators and farm advocates, cited that agricultural "place" detail is important in achieving their mission. More specifically, most interviewees who claimed this wanted "what is grown where" to better captured, both in terms of quality of data and the visual representation. One interviewee added an additional request, citing not only the need for "what grows where" but also for characteristics about the regions themselves, which are currently only briefly described.

Generally, a review of all interviews suggests that the "Where" component is what is most lacking and most desirable of the "What, Where, Who, and When" attributes this document has referred to*. (Note: This assertion is based on the frequency of interviewees asking about "Where" meta-data, and not a direct quote. Therefore, it is an interpretation of what was said by several individuals).*

Theme 5: Farm Production Data

Farmers, educators, and partners alike expressed an interest in understanding more detail about farm production data. Yields, acreage, crops that are grown, and pesticide usage are some of the key pieces of data that are severely lacking according to the interviewees. (It should be noted, however, that one interviewee suggested that a fair amount of data exists in this area, but it is not organized well). This can help new farmers get started, and existing farmers make informed business decisions. It also aids public and private environmental agencies in understanding trends in agriculture and their environmental impact over time.

Similar to farm operation model data, farm production data was not in the list of initial data sets for the CAA. However, while possibly difficult to include, this data could be a powerful piece to integrate, since many people would possibly pay for this information if it was complete and credible.

Target Audience Refinement

Reviewing the market, competitive, and interview data identifies educational agencies focused on consumer education as the recommended target audience. There are three specific conditions that drive this recommendation:

- The idea of "local" is increasingly becoming an important attribute educating consumers about food systems, yet the definition of local subjective and difficult to communicate (see Observation 1 in the Market Opportunity section for further details)
- There are virtually no sites that answer the question "what's in season where" using a map with the agricultural areas present in the CAA. While many sites try to answer this question using other technical means, these attempts often appear either incomplete, confusing, or both. Furthermore, no site in the review is clearly defining agricultural places.
- A common theme amongst interviewees in the educational audience is that "place" information is an important part of their outreach, but it is difficult to communicate this concept in an effective manner. As one key educational partner suggests, the "greatest potential is showing where things are located. Being able to go [to the CAA] and know that this is the comprehensive resource where things are is powerful. The mapping is really useful."

In summary, market and competitive assessment identify a need for better agricultural place data to be used by consumer educators, and this need is corroborated by many of the interviewees in this assessment. Beyond these conditions, targeting consumer educators has other advantages:

- The expressed interest in agricultural place data by educational interviewees provides an environment to pursue partnership opportunities. These potential partnerships can help secure long-term sustainability of the application and the resources needed to keep the site current. In addition, the branding work that may be required in a consumer-facing scenario is lessened, and the requisite outreach can be at least partially handled by the partnering organizations. Similarly, marketing budgets are minimized as well, since the partner organizations (and their partners) offer a natural distribution outlet.
- The most complete data sets in the current (beta) version of the CAA are the place and crop data – the most important data for consumer educators - thus making it less difficult to pursue this target audience compared to other audiences.

Short-Term Recommendations

The recommendations in this section are based on a specific set of circumstances, assumptions, and beliefs that were derived from user interviews, project documentation and discussions, site review, and competitive and market analysis. Furthermore, these recommendations assume that the CAA focuses on targeting educational agencies aimed at consumers, as detailed in the previous section. The circumstances driving the recommendations include:

- There is currently little budget going forward (for either maintenance or new development work). Significant changes in the site's purpose and therefore content and functionality in order to accommodate a refined target audience is not a near term possibility and will require identification and procurement of the requisite funding.
- As is, the CAA has clear value, but it is also confusing for many users in terms of purpose, navigation, and expectation data that is or is not present. It is a risk to leave the site running without some modifications, as many users have described having a negative experience.
- Data is incomplete in some cases, even if it is the best of what's available. For example, fewer than 1500 farms are incorporated, and users are generally unaware that this is a result of both design decision and data constraints
- There are virtually no sites that answer the question "what's in season where" using a map with the agricultural areas present in the CAA. Users find value in this. *[Note from GreenInfo - CAA does indeed have relatively accurate what's in season info for many crops – the key question is why a user wants this. If to visit a farm, then that is a specific audience focus to design around; if to generally know that apples are being harvested, then it's mostly there now.]*
- The site currently does not entice users to visit frequently. The current data sets do not demand frequent updates, and so content can appear stale, even when it is current.

The recommendations that follow are considered short-term and can be done immediately.

Recommendation 1: Focus on Crop and Place Data

The site should be modified to strengthen the initial goal of showcasing specialty crops, and aim to do 1 or 2 things very well and completely. Specifically, this means making sure the Places and Crops data is complete and thorough, and making it clear, where necessary that Event, Market, and Farm data are illustrative but not yet inclusive.. There are several reasons for this approach:

- Focus is re-introduced to the site. It becomes significantly easier to capture the attention of users when they first arrive at the CAA home page.
- A primary need of the target audience is addressed, namely providing definition and context to agricultural places.

- Some sections of the site can be moved out of beta, while others can maintain the beta descriptor, making more obvious the sections that are in progress

Note – the SAGE team discussed removing (temporarily) the Farms, Markets, and Events data from the site, but decided to keep it in the site for two main reasons. First, because the site is still in progress overall, and the target audience is being refined, this provides an opportunity to receive more feedback on sections that may play an important role in the future. Second, it would require a rethinking of the site design (and more development funds), should these sections be removed.

Recommendation 2: Optimize the Home Page

To address the issue of user confusion upon arriving at the CAA, several home page modifications can occur that would likely improve user engagement:

- Remove the Ear to the Ground section as it is an unfiltered list of comments from others. This information only needs to be available to internal SAGE personnel.
- Move the "In the Field" section up since it is relevant to nearly all users
- Update the rotating images and text so it is quicker and easier for users to get a sense for what the site does and how it is used. This has the added benefit of allowing for future search engine optimization
- Identify the Farms, Market, and Events sections as in progress, either with descriptive text, a beta title, or both.

Recommendation 3: Review Analytics Data

Analytics data should be reviewed regularly to understand performance trends and to guide decision-making. The following metrics should be tracked on both a daily and monthly basis (note, this is a minimal set. There are several others that could be tracked in the future). All of this data is currently available in Google Analytics.

- Number unique, new, and returning visitors to the following locations
  - The site home page
  - Places page
  - Crops page
  - In the Field
  - About
- The month over month % change in unique, new, and returning visitors to the following locations
  - The site home page
  - Places page
  - Crops page
  - In the Field
  - About

Recommendation 4: Promote Site through Partners

All partners should be re-contacted and asked to promote the updated CAA site through their communications with their constituents. Ideally, this would include website placement and links in email, facebook, and twitter communications. Once this promotion occurs, the metrics should be analyzed to review changes in site performance as a result of the promotion.

Medium Term Recommendation: Introduce New Crop and Place Content

Note – this is a medium term recommendation since it can possibly require major rethinking of site functionality

To entice users to return to the CAA and make the content more compelling, richer content can be introduced. This includes providing more photos documenting the places where crops grow. Having a user generated content section (possibly for farmers) provides an opportunity to create deeper connections between agriculture and site visitors. Videos of “life of a farmer” or similar ideas can also create a desire in visitors to pay frequent visits to the CAA. The scope of the content can also be expanded beyond specialty crops. Several interviewees cited interest in seeing animal agriculture, for example, and general grazing land is available as a potential data set. Generally, the idea of content should be explored further with the intent of both creating more interesting and relevant content and creating reasons for return site visits.

Tasks for Completion

As with some of the other tasks in this section, the time estimate varies depending on what route is chosen. Unlike some of the other recommendations, this one opens up several process and workflow questions that would have to be solved. Specifically:

- Who is responsible for creating the new content?
- Who is responsible for uploading the content?
    - Is the content user generated, but reviewed and uploaded by a site administrator?
    - Is there a mechanism by which any user can upload content
- What is the review process for any user-generated content that is introduced?

Because of the many processes and issues to be resolved, and the possible ongoing personnel required to manage new content introduction, this recommendation is likely more difficult to implement that previous ones, hence making it a medium term suggestion.

Future Audience Recommendations

Should the CAA achieve significant additional funding, the possibility exists to pursue specific (different) target audiences. These approaches would also provide an opportunity to develop business models or partner relationships that support its long-term development. The recommendations that follow include the educational audience as well as the farmer audience, and should be viewed as independent paths (at least initially).

Platform for Education

Educational partners and institutions have expressed interest in leveraging the CAA for use inside and outside the classroom environment. The target audience in this scenario becomes the developers of curriculum and educational programs. Focusing the CAA in schools provides an opportunity to achieve the CAA's goal of encouraging public interest in and support of California specialty crops. This approach would also dovetail nicely from the current recommended target audience of consumer educators.

This strategy has many advantages. First, the CAA can be used to service different educational groups. With rich content, many different types of lessons can be created to serve the needs of educators. Below are some sample uses suggested by interviewees:

- World history lessons (say, on the floodplain of Mesopotamia) can be compared to similar agriculturally rich land in California. Students can better understand the change from nomadic to urban societies of thousands of years ago by investigating local agriculture of today and what makes different geographies favorable to agricultural development.
- Students can use information that is uploaded about farms to learn more about exactly where food comes from. This information provides an opportunity to learn about what it takes to bring food from its source to our restaurants and homes, enabling lesson development on economics.

If the education route is pursued, one thing to consider is the effect of the Elementary and Secondary Education Act that became the No Child Left Behind Act in 2002. This act ensures "Adequate Yearly Progress", a measure of year over year student achievement, is achieved. This has created incentives for teachers to "teach for the test", to ensure their students meet minimum achievement levels. As a result, there is less flexibility in new curriculum introduction for the public schools in California (roughly 90% of all California schools). Therefore, any education strategy pursued should keep this in mind.

Despite this hurdle, the educational audience still has potential. After school programs not encumbered by the NCLB Act create even further outlets for partnership and reach. These organizations are the many groups that SAGE has relationships with today.

Farmer Tool

The CAA as a farmer tool provides a second viable option for future iterations. As mentioned in a previous section, the survey of competitive applications suggests a dearth of tools dedicated for farmers. Several other dynamics make this target audience attractive.

First, many respondents from the interviews who were farmers or farmer advocates spoke about the need and interest of farms to be located and exposed in as many areas as possible. A source of aggregated farmer information could be a valuable tool in connecting farms with potential consumers.

Secondly, the interviews and other research suggest that there are other specific needs of farmer groups. As previously mentioned, interviewees suggested that there is a strong need for creating - and more easily accessing existing - data sets on production data, including yields, crops being grown, and production methods. This data is already limited, and recent cuts in the USDA funding for statistical reports (see: http://www.nytimes.com/2011/11/09/business/government-counting-sheep-now-only-in-dreams.html) suggest that other methods of providing this information may become valuable. If the CAA could identify methods to house this data reliably it could become valuable on this dimension alone. In a similar way, the need for weather data and its affect on crop production is also significant. Integration of this data would make the CAA more attractive, as no site does this well today. *[Note – In addition to the USDA, UC Davis also produces production data. Should farmers be targeted as a future audience, the a gap analysis should be performed on the difference between the farmer requests and the current USDA and UC Davis reports.]*

The production data is information that can be provided by farmers themselves, or by partner organizations, such as the University of California Cooperative Extensions, who potentially have resources to work with farmers to upload this information. Working with weather agencies can perhaps provide the necessary weather data. Taken together, these amendments provide a platform that could then sustain itself through small fees that allow for data access. Inclusion of this data also makes the site incredibly dynamic and fresh, providing a compelling reason for users to return to the site.

This approach of course requires farmer willingness to release some of their data, and a minimum technical capability to update information online. In discussions with farmers and advocacy groups, it was clear that many if not most farmers are at least comfortable accessing the Internet, both from desktops/laptops and mobile devices such as smart phones. While there would be some hurdles in dealing with some farmer desire to remain anonymous with respect to reporting yield data, there are many ways to handle this while still getting valuable production data.

Appendix A: Data Source Summary

DATA SOURCES IN CALIFORNIA AGRICULTURAL ALAMANAC						page 1
Data Group	**Data Set**	**Source**	**Contents & use**	**Data Format**	**Completeness of Data**	**Updates**
Crops	Crop Descriptions	CUESA, SAGE, others	Tabular, text and graphic images describing all speciality crops in California	Table, images	100% - all specialty crop entries have text descriptions and images	Per SAGE
Crops	Crop Seasons - overall	SAGE	Tabular data indicating months	Table	75%? most crops have nominal season months noted	Per SAGE
Crops	Crop Seasons - by place	SAGE	Tabular data indicating harvest months for individual places	Table	5%? - very little seasonality data by place	Per SAGE
Crops/Places	Certified Producer Certificates	County Ag. Commiss. Offices	Per certified producer and producer's location, a list of all crops by acreage planted and anticipated volume	Tables	15% (Bay Area and a few other places)	Manual, per SAGE
Crops/Places	(Linkage)	n/a	Links between crops and places (x's in a table)	Table	60%? GIS Places need curating for accurate crop listing, as do	Manual, per SAGE
Places	Custom Places	SAGE	Polygons hand drawn for identifiable agricultural places	GIS shape file	15% (Bay Area and a few other places)	As requested, can be edited in system or by GIS/upload
Places	GIS Places	GreenInfo	Polygons for each county showing croplands, defined through Calif. Farmland Monitoring and Mapping Program (prime, statewide, unique, local)	GIS shape file	90?% (All known ag areas outside of "custom places", for areas covered by FMMP	As requested, can be edited in system or by GIS/upload
Places	Cities/Towns/ Counties	GreenInfo/ TIGER	Definition of cities, towns, places	GIS shape file	100% for state	Undefined

DATA SOURCES IN CALIFORNIA AGRICULTURAL ALAMANAC						page 2
Data Group	**Data Set**	**Source**	**Contents & use**	**Data Format**	**Completeness of Data**	**Updates**
Places	NASS	USDA	Raster data showing 70 main crop types, converted to vector for this project	GIS shape file	100% of California	Annual
Places	CPUR	Calif. Dept Pesticide Regulation	Statewide data set of local reporting areas aggregated by a standard grid (Public Land Survey System - Township/Range, etc.)	Tables	Most of California	Annual
Farms	Farms	CAFF, CUESA, Monterey CPC	Point file with basic address information, plus source - CUESA files have extended descriptions and web links	GIS shape file	20-50% of specialty farms?	Manual, as requested
Markets	Markets	Calif. Farmers Market Federation	Point file with basic address information, web site, manager and seasons/hours information	GIS shape file	90+% of all Calif farmers markets	Manual, as requested
Events	Events	UC Davis Small Farms Program, MALT, CUESA	Event feeds from sources - Titles with link to source web site	RSS feeds	n/a	As often as source updates

Appendix B: Competitive Overview

CALIFORNIA AGRICULTURAL ALMANAC COMPETITIVE OVERVIEW				page 1
Name	**Category**	**Website**	**Business Model / Funding**	**Comments**
Local Harvest	Online Mapping Tools	http://www.localharvest.org/	Direct to Consumer sales / Revenue share from CSA software	Direct competition as online map; no inclusion of specific produce or seasonality; business model includes shopping (e.g., you can purchase Florida avocados; sell CSA software and take 2% of sales.
Eat Well Guide	Online Mapping Tools	http://www.eatwellguide.org/	Non-profit	Significant local food focus and printable guides, but lacking data at the produce level; a seasonal food guide links to NRDC; most of the competitive content is in PDF form; interactive map is a "travel map" that shows food vendors in a given geographic area.
Find Local Produce	Online Mapping Tools	http://findlocalproduce.net/	Paid listings	A combination of farms and distributors/ wholesalers; good coverage of the US; tool is difficult to use and doesn't go to the produce (item) level; subscription model - $29 for premium listing.
Epicurious	Online Mapping Tools	http://www.epicurious.com/articlesguides/seasonalcooking/farmtotable/seasonalingredientmap	Advertising	Good tool for statewide seasonality to the item level; doesn't provide farm information; over 5,000 facebook likes and 900 retweets; searches contain information on the item being searched in addition to recipe information.
Whole Foods Market	Online Mapping Tools	http://www.wholefoodsmarket.com/localgrowers/index.php	Supported by store sales	Rich information for Whole Food stores only, not all producers are covered; site does not seem to be promoted
Local Dirt	Online Mapping Tools	http://www.localdirt.com/	Direct to Consumer sales	Direct to consumer sales model, with search capabilities; mapping is built in but not well.
CUESA	Seasonality Products	http://www.cuesa.org/markets/	Non-profit	Website information to the item level; no mapping technology but charts are available for a visual display of seasonal data.
Local Food Wheel	Seasonality Products (online and offline)	http://www.localfoodswheel.com/	Consumer purchase of foods wheel	Great example of a substitution threat that is quite credible; easy to sell and distribute, easy to use, and easy to store; no farm info.
Southland Farmer's Market Association	Seasonality Products (online and offline)	http://www.sfma.net/consumer/inseason.shtml	Unknown	Site containing months that California produce is in season; generally not kept up to date.

CALIFORNIA AGRICULTURAL ALMANAC COMPETITIVE OVERVIEW				page 2
Name	**Category**	**Website**	**Business Model / Funding**	**Comments**
Eat Real Guide	Mobile Apps	http://www.eatrealguide.com/	Sales in App store	GPS use but no real mapping functionality. Allows user to find food at the time immediately before purchase (e.g. "What good food is close to where I am right now"). Also has seasonality information to the item level.
inSeason	Mobile Apps	Website not available	Sales in App store	Identifies what produce is in season now; no mapping functionality or farm data. $0.99
HarvestMark Food Traceability	Mobile Apps	http://www.harvestmark.com/solutions/get-the-harvestmark-food-	Supported by HarvestMark primary business	Meant to be used at purchase time; not just produce focused but not every product has the HarvestMark tracing capabilities; free app.
Seasons	Mobile Apps	http://www.seasonsapp.com/	Sales in App store	Seasonal information about produce but no mapping and no farm data. $1.99
Sustainable Connections	Local Products	http://sustainableconnections.org/foodfarming/guidetoeatinglocal	Paid listings	Local to NW Washington and available via PDF; interactive Google map that isn't done well; farmers have to pay to get listed.
Marin Organic	Local Products	http://www.marinorganic.org/	Non-profit (donations plus some farm store sales)	Local site with good track record that in theory competes with the Ag Almanac mission; taken from the Marin Organic website: donation will: "expand consumer education about the benefits of
Dreaming New Mexico	Local Products	http://www.dreamingnewmexico.org/food/ff-crops#section-1	Non-profit	Has downloadable caricature map in addition to detailed information about local produce in New Mexico. Non-profit.
Buy Pure Catskills	Local Products	http://www.buypurecatskills.com/purecatskillsmap/	Unknown	Interactive map using Google maps; farm and seller information but no data at the item level; Business model not immediately apparent, but donations are accepted for certain programs.
CARD	Farmer Tools	http://www.card.iastate.edu/ag_risk_tools/basis_maps/	Academic	Map makes it easier for farmers to determine where they should deliver their corn and soybeans.
Agro Atlas	Farmer Tools	http://www.agroatlas.ru/	USDA	Not direct competitor but provides ideas for other uses and partnerships; maps "can determine where foreign crops can successfully grow and identify foreign pests, pathogens or weeds that could harm local crops"

Appendix C: Technical Review and Considerations

This section collapses the common themes from all feedback provided to date.

Search Engine Optimization

The feedback provided by one of the reviewers captures well the importance of Search Engine Optimization (SEO) and how the CAA can be improved to achieve greater discovery. That feedback is given in the bullet points below.

- Search engine optimization, or "SEO", is a frequently used industry term that essentially means: Build your web site in a manner that Google search engines define your site in a way that your audience may find it. This is a very complicated practice that people are still studying as the Google algorithm (and Yahoo!, MSN, etc. and other search engines) keep in secret. There is no "right" answer to "SEO" but there are practices you can follow to ensure that when people are looking they can find your site.
- Why is this important? Google represents approx 90%+ of the total searches on the Internet. Also, 95% of people searching do not click on page 2 of search results nor do they look beyond the 5-10th search link.
- Why is this important to SAGE? Example: When I type in "SAGE organization", there are the top links that appear, unfortunately, none of them are SAGECenter.org
- Similarly, when I type in a more "searchable" term such as "sustainable farms information" a lot of web sites pop up including paid ones (the colored ones at the top & side of the page) that people pay for.
- More importantly, the Beta site makes a few critical errors from best SEO practice. The usage of images, flash, maps, etc. vs. text that describes the information that is on the page is prohibitive to the Google search engine "crawler"
- It is extremely important that the site be built so users can find it for obvious reasons.

Performance

Much of the rendering and data loading that occurs after clicking happens slowly. Here are some examples:

- Clicking on the tabs, in particular for the first time after visiting the page. Subsequent clicks also seem to load slowly, but faster than the first.
- Clicking on either "Search on Map" or Pick from a List" takes on any of the tabs takes longer than expected. Data is likely loading in the background, but there are technologies that can mitigate this.

Is it possible to use asynchronous technologies to handle this behavior and make the site appear instantaneous (similar to Google suggest and countless other sites)?

Landing Page Optimization

The current landing (home) page does note immediately illustrate what a user can and should do with the site. To understand what the site is for, a user has to wait for the rotating images to explain the site's capabilities, or click through manually. The "Ear to the Ground" section is not relevant to users who are visiting the site. This should be backend data that is used by SAGE personnel. The tabs are confusing as well. What should a user do with these tabs? This answer should be apparent without having to click around.

Back Button and Session State

Clicking the back button in some scenarios provides unexpected behavior. For example, on the Crops tab, if a user searches for all crops within 100 miles of Russian River, clicks the Blueberries photo, and then clicks back, the expectation is to return to the list of produce. Instead, the site returns to the entry point of the Crops tab. *Note from Green Info Network - this is fairly easy to address, if the desired behavior can be clearly identified.*

Workflow and Number of Clicks

The site requires several clicks to perform an action. In general, there were many comments on user friendliness and ease of use. Below is some direct user feedback that captures the tone of many other users also.

- We had a lot of questions about the "map" layout used for many of the main links in the top navigation bar. Most importantly, we couldn't really see a difference in the content offering between each page. We believe the information could be displayed in a better, user-friendly layout.
- Example: At quick glance, "Places" looks similar to "Crops" and provides very similar information. While we understand the premise behind the "maps" layout, we think it should be a "view feature" vs. the main page presentation of information. It is hard to actually view the details/information without moving forward a few clicks. You will lose audience along the way by doing this.
- A few ideas to make this more interesting/user-friendly to a consumer:
  - Simple listing or ranking of crops, farms, etc. in your vicinity
  - Pictures or product information on a crop
  - Live chat with a farmer option
  - On the main page: "Crop highlight" of the week
  - Standardized listings for each farm
  - Other sites that provide "catalog" listings in a user-friendly format: Zappos.com, Netflix.com, Amazon.com, etc. No reason to reinvent the wheel.
- Regardless of the format, we tend to think of this in terms of problem solving. Say I am a chef looking for a new/specific ingredient for my upcoming winter menu. I might have a specific crop or season in mind. I would want to see what's available in my area and what my options are quickly to scan vs. a topographical map of the state. There needs to be a search option that's readily available vs. a drop down menu.

Naming Conventions

Several users provided feedback on the naming conventions.

- The word "Places" is generally confusing. Others have suggested "Agricultural Regions" to make it clearer.

- The term "Specialty Crops" may be the precise definition of what is shown, but it is not familiar to others. Perhaps produce, or something similar would be more user friendly.
- The use of the word "Almanac" in the site name causes some confusion. Perhaps something more descriptive would set user expectation more appropriately.

Uncategorized Changes

The following are general changes that have been suggested through feedback channels.

- Sorting search results - Sort by "closest to me" - For example I search Berkeley, CA and 25 mi for farmers markets, and >50 show up in some random order. This isn't useful unless I zoom in on the map. *Note from Green Info Network - should be fairly straightforward, if the user has defined a location for themselves)*
- Having the ability to search by county
- The top and bottom links of the page are duplicative (this hurts you from a search engine perspective as well). In addition, they are somewhat confusing. Example: Places: We know the state, but should this focus on regions vs. a map? Northern/Southern/Central?

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Evaluation of Lettuce Genotypes for Seed Thermotolerance

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Abstract**. Thermoinhibition of lettuce (*****Lactuca sativa*** **L.) seed germination is a common problem associated with lettuce production. Depending on lettuce cultivars, seed germination may be inhibited when temperatures exceed 28 °C. The delay or inhibition of seed germination at high temperatures may reduce seedling emergence and stand establishment of lettuce in the field, leading to a reduction in economic yield. To identify heat-tolerant lettuce genotypes, lettuce varieties and germplasm accessions were screened for the ability to germinate under high-temperature stress. Twenty-four to 26 genotypes were selected from each lettuce types (crisphead, romaine, butterhead, loose leaf, and wild species) and their seeds were placed in petri dishes to test their ability to germinate at high temperatures (29 and 34 °C) as compared with controls at 24 °C. Some lettuce genotypes showed thermotolerance to 34 °C (less than 20% reduction in germination) such as Elizabeth, PI 342533, PI 358025, Florida Buttercrisp, Kordaat, Corsair, FL 50105, PRO 425, PI 278070, Noemie, Picarde, Gaillarde, *****L. serriola*** **(PI 491112, UC96US23, PI 491147),** ***L. virosa*** **(PI 274378 D),** ***L. saligna*** **(PI 491159), and primitive (PI 187238 A, PI 289063 C). The germination rates were consistent with the germination percentage at the high temperatures. Seed germination in the field was very low and positively correlated with seed germination at 29 and 34 °C. The highest field germination percentages (greater than 40%) were observed in Belluro, Mantilia, Mid Queen, Headmaster, PRO 874, PRO 425, FL 50105, Corsair, Romaine SSC 1148, Romaine Romea, Green Forest, Grenadier, FL 43007, Squadron, Xena, Noemie, Green Wave, Picarde, and Red Giant. The results of this study indicated that lettuce genotypes differ greatly in their ability to germinate at high temperatures as determined by the percentages and the rates of germination. Our research indicates that thermoinsensitive varieties could be used to expand lettuce production seasons in warm and low land cost areas and reduce the need for seed priming, lowering the production costs. The information may also be useful for growers to better choose cultivars for warm environments and for lettuce breeders to improve the crop for adaptation to global warming and climate change.**

Temperature is a major environmental factor that influences plant growth and development. Lettuce (*Lactuca sativa* L.) is a cool-season crop with optimum growth at an average temperature of 18 °C. Production of lettuce at higher temperature ranges results in yield and quality losses (Jenni, 2005; Jenni and Yan, 2009). At high temperatures, lettuce seed germination is inhibited (thermoinhibition) and the seeds became dormant, which is called thermodormancy (Gonai et al., 2004; Negm et al., 1972; Vidaver and Hsiao, 1975). It has been reported that seed germination at high temperatures is influenced by the environmental conditions, especially high temperatures, during seed development and maturation (Kozarewa et al., 2006; Sung et al., 1998, 2008). Poor seed germination and thermodormancy are major problems associated with lettuce production. Depending on genotype, lettuce seed germination is inhibited at temperatures higher than 28 to 32 °C (Argyris et al., 2008a; Gray, 1975; Kozarewa et al., 2006; Thompson et al., 1979). This inhibition of seed germination at high temperatures causes a reduction in field emergence, stand establishment, and yield (Cantliffe et al., 1981; Valdes et al., 1985). Seed priming has been used to improve seed germination in vegetable crops grown under stress conditions. Germination rates and seedling emergence improved at high temperatures by seed priming in osmotic solutions (Bradford, 1986; Bradford and Somasco, 1994; Samfield et al., 1991). The alleviation of thermoinhibition in lettuce by priming may occur during imbibing the seeds at high temperature (Cantliffe et al., 1981; Valdes et al., 1985).

There are many factors that influence seed germination at high temperatures such as seed coverings and plant hormones. It has been reported that the endosperm layer of thermoinsensitve lettuce genotypes had lower resistance to a puncture test than that of the thermosensitive genotypes (Sung et al., 1998). This indicated that seed covering imposed restriction on seed germination at high temperature (Ikuma and Thimann, 1963; Speer, 1974; Sung et al., 1998). Weakening of the endosperm layer before radicle emergence through enzymatic activity of endo-β-mannanase, a cell wall-bound enzyme, is essential for seed germination to occur at high temperatures (Nascimento et al., 2000). This suggested that seed priming overcomes the thermoinhibition in thermosensitive lettuce cultivars as a result of an increase in enzyme activity in the endosperm layer of the seed. The endosperm layer is considered the region that imposes physical resistance to seed germination at high temperature (Sung et al., 2008). The balance between embryo growth potential and the physical resistance to embryo growth exerted by the covering tissues is required for dormancy release and seed germination to occur (Kucera et al., 2005).

The plant hormones, gibberellic acid (GA), abscisic acid (ABA), and ethylene play a role in the regulation of seed germination in most plants. Seed germination is inhibited by ABA, which increases in thermodormant lettuce seeds (Argyris et al., 2008a). GA is involved in dormancy release or prevention by stimulating the activities of hydrolytic enzymes, which promote embryo growth (Khan, 1994). Ethylene may also play a role in extending the high temperature limit for lettuce seed germination by maintaining lower water potential in the embryonic region to allow growth and radicle emergence (Dutta and Bradford, 1994). Nascimento et al. (2000) observed a close relationship among lettuce seed germination, ethylene evolution, and the activity of endo-β-mannanase enzyme. Ethylene and cytokinin have been reported to be involved in alleviation of thermoinhibition in lettuce seeds (Huang and Khan, 1992; Khan and Prusinski, 1989).

The average temperature worldwide is predicted to increase over time, which impacts the agricultural production and food supplies (Karl and Trenberth, 2003; Wurr et al., 1996). This climate change and global warming may pose serious challenges to California agriculture, especially the leafy green industry. Adapting the leafy green industry to future climate conditions is important to meet the increasing demand for leafy vegetables as the population increases. The increasing need for leafy vegetables will put pressure on the leafy industry to expand the production to the low land cost and warmer areas of California. To expand lettuce production to warmer environments, lettuce germplasm and cultivars need to be evaluated to examine their tolerance to high-temperature stress. Lettuce seed germination is inhibited at high temperatures, which leads to a reduction in product quality and yield. Thus, thermoinhibition is a problem facing lettuce growers, which could be solved by selecting thermotolerant varieties that perform well under stressful conditions. The objective of this study was to screen lettuce germplasm and cultivars for resistance to thermoinhibition or thermodormancy to find lettuce germplasm that germinate well at high temperatures. We screened the lettuce collections at the U.S. Department of Agriculture (USDA) in

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Salinas, CA, for their tolerance to thermoinhibition or thermodormancy and identified the most thermotolerant genotypes from different lettuce types such as crisphead, butterhead, romaine, leaf type, and wild species.

Materials and Methods

Plant material. Five lettuce types were screened in this experiment to test their tolerance to thermoinhibition including crisphead, butterhead, romaine, loose leaf (green and red leaf), and wild species. Initially, we screened more than 3500 lettuce varieties and germplasm accessions for their ability to germinate at high temperature. Twenty-five to 26 genotypes from each lettuce type were selected to be used in further experiments, including genotypes with a high germination percentage at 34 °C and some standard and thermosensitive genotypes. The selected genotypes have uniform seed germination at 24 °C and their seeds were produced in greenhouses at the USDA, Salinas, CA, and stored at –20 °C. This may minimize the effect of the environmental conditions, at which the seeds were matured, on seed germination.

Seed germination. Four replicates of 25 seeds each were placed in petri dishes (100 × 20 mm) over one layer of Whatman #1 filter paper and 4.5 mL of deionized water was added. The petri dishes were covered with lids to prevent evaporation. The petri dishes were placed in incubators maintained at 24, 29, and 34 °C under a 12-h fluorescence light (80 $\mu mol \cdot m^{-2} \cdot s^{-1}$) for 14 d. We used this light intensity because the optimal temperature for seed germination in lettuce was noted to be higher in light than in darkness (Deng and Song, 2012). Seed germination was recorded as the emergence of the radicle after 2, 4, 7, and 14 d or until no additional germination occurred. Percentage of seed germination was calculated and the germination rate was determined based on the method of Meguire (1962) using the following equation: germination rate = $\sum GT1/T1 + \text{——} + GTn/Tn$. GT1 = number of germinated seeds on first count; GTn = number of germinated seeds on last count; T1 = days at first count; Tn = days at last count. The percentage reduction in seed germination at 29 and 34 °C from that at 24 °C was also calculated.

Field germination. Seeds of lettuce genotypes were planted on 10 July 2012 in a field at the West Side Research and Extension Center, University of California, Five Points, CA. The experiment was arranged in a randomized complete block with four replications per treatment. Fifty seeds from each genotype were planted in rows 6 m long. The experimental unit consisted of one row per entry. Seed germination was evaluated after 7 and 14 d. The average maximum and minimum air temperatures for the 14 d were 34.9 and 16.1 °C and the average maximum and minimum soil temperatures at 15-cm depth were 27.2 and 24.9 °C, respectively.

Statistical analysis. Analysis of variance was conducted using the JMP program (SAS Institute Inc., Cary, NC). Treatment means were separated by the least significant difference at the 0.05 level of probability. The correlation coefficients between field seed germination and germination at 29 and 34 °C were determined by the JMP program using genotype means.

Results and Discussion

Butterhead lettuce. All the butterhead genotypes showed a high germination percentage and germination rate at 24 °C (Table 1). Annecy exhibited the lowest germination percentage (83%) and germination rate among all genotypes tested. There were highly significant differences in germination percentage and germination rates among genotypes at 29 and 34 °C. At 29 °C, Annecy, Anthem, Dark Green Boston, and Winter Marvel showed the lowest germination percentage and germination rates compared with other genotypes. The reductions in seed germination at 29 °C in these were 54%, 93%, 70%, and 100%, respectively (Fig. 1). These genotypes were the most sensitive genotypes to thermoinhibition at 29 °C. Significant cultivar

Table 1. Effect of temperature on seed germination in butterhead lettuce.

	Germination (%)			Germination rate			Field
Genotype	24 °C	29 °C	34 °C	24 °C	29 °C	34 °C	germination (%)
Annecy	83 b[z]	37 c	3 h	34.0 d	10.1 cd	0.4 i	2 i
Anthem	100 a	7 d	4 h	50.0 a	2.5 de	0.9 l	1 i
Aquarius	100 a	78 b	11 gh	48.0 ab	28.6 b	2.3 i	40 abc
Arcade	100 a	100 a	11 gh	50.0 a	47.5 a	3.4 i	33 a–e
Averya	97 a	93 a	69 cd	45.7 b	44.3 a	22.0 def	14 ghi
Belluro	100 a	100 a	65 d	50.0 a	50.0 a	18.3 fg	44 a
Bibb	100 a	100 a	39 ef	50.0 a	50.0 a	19.5 efg	8 hi
Big Hoss	100 a	97 a	65 d	49.3 a	48.5 a	30.9 c	19 fgh
Buttercrunch	100 a	94 a	38 ef	50.0 a	46.6 a	19.0 fg	28 b–g
Calibra	100 a	100 a	55 de	49.0 a	46.8 a	7.6 hi	9 hi
Clinton	100 a	100 a	73 bcd	50.0 a	50.0 a	20.2 ef	20 e–h
Dark Green Boston	96 a	29 c	3 h	40.3 c	13.6 c	1.3 i	9 hi
Deciso	100 a	100 a	26 fg	50.0 a	50.0 a	12.3 gh	1 i
Dukaat	100 a	100 a	56 de	50.0 a	50.0 a	26.8 cde	25 d–g
Elizabeth	100 a	100 a	98 a	50.0 a	50.0 a	46.7 ab	14 ghi
Florida Buttercrisp	100 a	100 a	88 abc	50.0 a	50.0 a	41.4 ab	29 b–f
Kitty	100 a	100 a	58 de	50.0 a	50.0 a	28.6 cd	32 a–f
Kordaat	100 a	100 a	88 abc	50.0 a	50.0 a	41.0 b	37 a–d
Magnet	100 a	100 a	69 cd	50.0 a	50.0 a	31.5 c	37 a–d
Mantilia	100 a	100 a	62 d	50.0 a	50.0 a	24.7 c–f	42 ab
Margarita	100 a	73 b	7 gh	50.0 a	35.7 b	3.5 i	29 b–f
PI 342533	100 a	100 a	93 ab	50.0 a	50.0 a	45.8 ab	33 a–f
PI 358025	100 a	100 a	98 a	50.0 a	50.0 a	49.0 a	33 a–f
Summer Bibb	100 a	100 a	4 h	50.0 a	50.0 a	0.4 i	26 c–g
Winter Marvel	100 a	0 d	0 h	50.0 a	0.0 e	0.0 i	1 i

[z]Means with the same letter in the same column are not significantly different at $P \leq 0.05$.

Table 2. Effect of temperature on seed germination in crisphead lettuce.

	Germination (%)			Germination rate			Field
Genotype	24 °C	29 °C	34 °C	24 °C	29 °C	34 °C	germination (%)
Barrier Reef	99 ab[z]	87 ab	0 j	48.1 ab	40.7 bcd	0.0 i	5 jk
Batavian Cybele	100 a	100 a	39 d–g	50.0 a	50.0 a	19.1 bcd	26 c–f
Batavia Gloire	100 a	99 a	71 ab	49.3 ab	46.4 abc	23.2 bc	13 g–j
Batavian Reine	98 ab	100 a	56 bcd	48.3 ab	50.0 a	24.7 b	25 c–g
Bayview	100 a	94 a	0 j	50.0 a	35.0 d	0.0 i	1 jk
Calmar	97 ab	8 e	2 j	47.3 b	4.0 f	0.3 i	0 k
Celtic	100 a	100 a	36 efg	50.0 a	49.0 a	17.0 cde	25 c–g
Command	97 ab	95 a	45 cde	47.8 ab	47.3 ab	5.3 ghi	19 f–i
Empire	96 b	100 a	42 def	47.5 ab	50.0 a	13.1 def	21 e–h
Headmaster	100 a	100 a	15 hij	50.0 a	50.0 a	7.5 fgh	45 ab
Huron	98 ab	100 a	62 abc	48.5 ab	50.0 a	8.2 fg	28 c–f
Marleen	100 a	100 a	44 def	50.0 a	50.0 a	12.0 ef	37 abc
Mid Queen	100 a	100 a	16 hij	50.0 a	50.0 a	8.0 fg	47 a
Premiere	100 a	79 bc	4 j	50.0 a	39.5 cd	2.0 ghi	24 d–g
PRO 839	100 a	100 a	0 j	50.0 a	50.0 a	0.0 i	35 a–d
PRO 874	100 a	100 a	27 fgh	50.0 a	50.0 a	12.9 def	41 ab
Pybas 101	100 a	100 a	50 cde	47.3 b	50.0 a	13.2 def	27 c–f
Salinas	100 a	43 d	8 ij	50.0 a	14.6 e	4.0 ghi	23 d–h
Sinano-Summer	100 a	100 a	79 a	50.0 a	50.0 a	37.8 a	35 a–d
Vanguard 75	100 a	90 ab	4 j	50.0 a	45.0 abc	2.0 ghi	33 b–e
Vista Verde	98 ab	100 a	0 j	48.5 ab	50.0 a	0.0 i	7 ijk
Westlake	100 a	71 c	0 j	50.0 a	11.9 e	0.0 i	1 jk
Winter Select	100 a	100 a	3 j	50.0 a	50.0 a	1.5 hi	4 jk
Wintercut	100 a	100 a	22 h	50.0 a	50.0 a	8.1 fg	11 h–k
Winterhaven	98 ab	47 d	5 ij	49.0 ab	8.8 ef	2.5 ghi	19 f–i

[z]Means with the same letter in the same column are not significantly different at $P \leq 0.05$.
Batavia Gloire = Batavia Gloire du Dauphine; Batavian Reine = Batavian Reine Des Glaces.

differences in the ability to germinate were observed at 34 °C (Table 1). Elizabeth, PI 358025, PI 342533, Kordaat, and Florida Buttercrisp exhibited the highest percentage of seed germination (greater than 80%) and germination rates at 34 °C. These genotypes also showed the lowest reduction in seed germination (less than 20%) at 34 °C from that at 24 °C (Fig. 1). The results showed that these varieties were the most tolerant butterhead genotypes to thermoinhibition at 34 °C. In addition to Annecy, Anthem, Dark Green Boston, and Winter Marvel, the most sensitive genotypes to thermoinhibition at 34 °C were Summer Bibb, Margarita, Aquarius, and Arcade. These genotypes exhibited a substantial reduction (greater than 80%) in seed germination at 34 °C (Fig. 1). Dark Green Boston has been previously considered a thermosensitive cultivar, which was consistent with our results (Sung et al., 2008).

Seed germination in the field was low with the highest germination percentages (greater than 30%) observed in Belluro, Mantilia, Aquarius, Kordaat, Magnet, PI 342533, PI 358025, Arcade, and Kitty (Table 1). There was a significant positive correlation between seed germination at 29 and 34 °C and field germination in butterhead lettuce (Table 7). Thus, seed germination of some lettuce genotypes is inhibited at 29 °C, but others can tolerate higher temperatures (34 °C), which indicated that the maximum temperature for seed germination is genotype-dependent (Coons et al., 1990).

Crisphead lettuce. All crisphead genotypes showed a high percentage germination (greater than 95%) and germination rate at 24 °C (Table 2). There were significant differences in percentage germination and germination rate among all genotypes at higher temperatures. At 29 °C, most crisphead genotypes germinated well except Calmar, Salinas, and Winterhaven, which showed the lowest germination percentage (8%, 43%, and 47%, respectively). These genotypes also showed the largest reduction (greater than 50%) in seed germination at 29 °C (Fig. 2). The results indicated that Calmar was the most thermosensitive genotype followed by Salinas and Winterheaven. At 34 °C, Sinano-Summer, Batavia Gloire du Dauphine, Huron, and Batavian Reine Des Glaces showed the highest germination percentages (79%, 71%, 62%, 56%, respectively) among crisphead genotypes. These genotypes also showed the highest germination rates at 34 °C (Table 2) and the smallest reduction (less than 50%) in germination at 34 °C (Fig. 2). All the other genotypes had lower germination and some of them were completely inhibited with no germination at 34 °C such as Barrier Reef, Bayview, Pro 839, Vista Verde, and Westlake. Sinano-Summer was the only crisphead lettuce with low reduction in germination at 34 °C and it was considered the most thermotolerant genotype (Fig. 2). Salinas exhibited thermoinhibition at 29 and 34 °C and this result was consistent with the previously reported findings (Argyris et al., 2008a, 2008b; Coons et al., 1990).

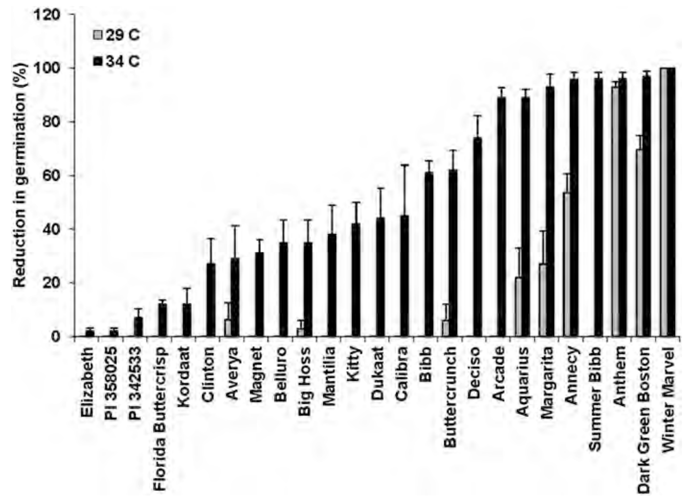

Fig. 1. Reduction in germination percentage at 29 and 34 °C from 24 °C in butterhead lettuce. Results are means ± SE (n = 4). $LSD_{0.05}$ for 29 and 34 °C are 11.9 and 20.9, respectively. LSD = least significant difference.

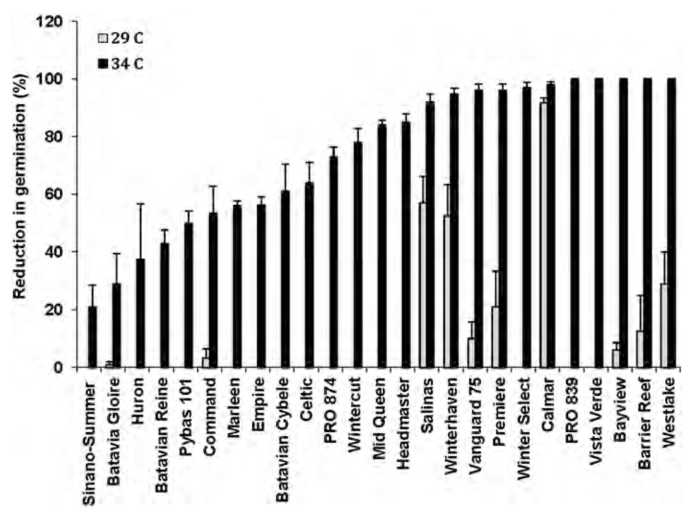

Fig. 2. Reduction in germination percentage at 29 and 34 °C from 24 °C in crisphead lettuce. Results are means ± SE (n = 4). $LSD_{0.05}$ for 29 and 34 °C are 14.8 and 16.7, respectively. LSD = least significant difference.

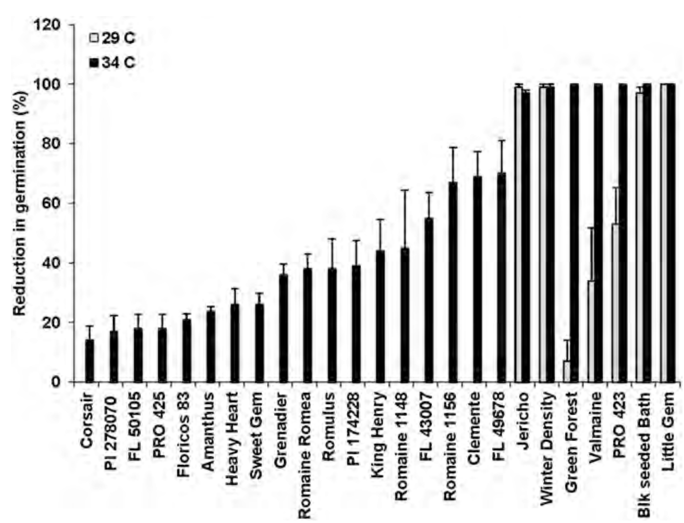

Fig. 3. Reduction in germination percentage at 29 and 34 °C from 24 °C in romaine lettuce. Results are means ± SE (n = 4). $LSD_{0.05}$ for 29 and 34 °C are 12.8 and 20.2, respectively. LSD = least significant difference.

Table 3. Effect of temperature on seed germination in romaine lettuce.

Genotype	Germination (%)			Germination rate			Field germination (%)
	24 °C	29 °C	34 °C	24 °C	29 °C	34 °C	
Amanthus	93 b[z]	100 a	71 a–e	46.5 b	50.0 a	35.3 ab	11 ijk
Black Seeded Bath	100 a	3 d	0 h	50.0 a	1.5 d	0.0 g	2 jk
Clemente	100 a	100 a	31 g	50.0 a	49.0 a	14.8 ef	13 ijk
Corsair	100 a	100 a	86 a	50.0 a	50.0 a	39.7 a	55 ab
FL 43007	100 a	100 a	45 fg	50.0 a	50.0 a	18.6 def	41 c–f
FL 49678	100 a	100 a	30 g	50.0 a	50.0 a	13.0 f	39 c–f
FL 50105	100 a	100 a	82 abc	50.0 a	50.0 a	37.2 a	57 a
Floricos 83	100 a	100 a	79 a–d	50.0 a	50.0 a	35.6 ab	40 c–f
Green Forest	100 a	93 a	0 h	50.0 a	46.1 a	0.0 g	43 b–e
Grenadier	100 a	100 a	64 b–f	50.0 a	50.0 a	31.4 abc	43 b–e
Heavy Heart	100 a	100 a	74 a–e	50.0 a	50.0 a	36.4 ab	32 d–g
Jericho	100 a	1 d	3 h	50.0 a	0.5 d	0.4 g	1 k
King Henry	98 a	100 a	55 ef	49.0 a	50.0 a	27.3 bcd	31 efg
Little Gem	100 a	0 d	0 h	50.0 a	0.0 d	0.0 g	7 jk
PI 174228	100 a	100 a	61 def	50.0 a	50.0 a	23.9 cde	28 fgh
PI 278070 BS	100 a	100 a	83 ab	50.0 a	50.0 a	38.9 a	30 efg
PRO 423	100 a	47 c	0 h	50.0 a	23.5 c	0.0 g	15 hij
PRO 425	100 a	100 a	82 abc	50.0 a	50.0 a	40.3 a	57 a
Romaine Romea	100 a	100 a	62 c–f	50.0 a	50.0 a	31.0 abc	45 a–d
Romaine SSC 1148	100 a	100 a	55 ef	50.0 a	50.0 a	27.3 bcd	48 abc
Romaine SSC 1156	100 a	100 a	33 g	50.0 a	50.0 a	15.5 ef	37 c–f
Romulus	100 a	100 a	62 c–f	50.0 a	50.0 a	27.4 bcd	21 ghi
Sweet Gem	100 a	100 a	74 a–e	50.0 a	50.0 a	36.5 ab	37 c–f
Valmaine	100 a	66 b	0 h	50.0 a	32.1 b	0.0 g	2 jk
Winter Density	100 a	1 d	1 h	50.0 a	0.3 d	0.5 g	2 jk

[z]Means with the same letter in the same column are not significantly different at $P \leq 0.05$.

Table 4. Effect of temperature on seed germination in green leaf lettuce.

Genotype	Germination (%)			Germination rate			Field germination (%)
	24 °C	29 °C	34 °C	24 °C	29 °C	34 °C	
Amazona	100 a[z]	99 a	41 d–g	50.0 a	35.9 c	19.8 cde	8 ghi
Antigua	98 a	100 a	41 d–g	41.4 b	50.0 a	19.2 cde	14 e–h
Australischer Gelber	95 b	30 e	0 k	41.3 b	7.6 f	0.0 h	5 hi
Azura	100 a	92 ab	56 b–e	49.5 a	45.0 ab	22.5 bcd	5 hi
Black Seeded Simpson	100 a	87 ab	1 k	50.0 a	39.6 bc	0.5 h	4 hi
Flandria	100 a	100	29 fgh	50.0 a	50.0 a	13.9 def	5 hi
Funly	100 a	ND	28 gh	50.0 a	ND	12.2 efg	28 cd
Green Wave	100 a	100 a	50 cde	50.0 a	50.0 a	22.8 bc	42 ab
Greengo	98 a	49 d	14 h–k	38.3 b	12.1 ef	1.2 h	0 i
Loros	100 a	100 a	26 gh	50.0 a	50.0 a	4.0 gh	20 d–g
Neva	100 a	100 a	49 def	50.0 a	50.0 a	23.8 bc	27 cd
Noemie	100 a	100 a	98 a	50.0 a	50.0 a	47.5 a	42 ab
Ocean Green	100 a	100 a	5 ijk	50.0 a	50.0 a	1.7 h	21 def
PI 177420	100 a	100 a	70 bc	50.0 a	50.0 a	26.1 bc	27 cde
PI 187238 E	100 a	79 bc	73 b	50.0 a	25.4 d	30.2 b	36 abc
Royal Oak Leaf	100 a	11 f	14 h–k	50.0 a	5.0 f	3.1 h	3 hi
Simpson Elite	100 a	31 e	0 k	50.0 a	15.5 e	0.0 h	8 ghi
Slobolt	100 a	69 c	2 jk	46.5 a	27.1 d	0.6 h	10 f–i
Squadron	100 a	19 ef	12 h–k	48.5 a	7.0 f	6.0 fgh	44 a
Tendergreen	100 a	100 a	38 efg	50.0 a	50.0 a	6.6 fgh	19 d–g
Tiara	100 a	100 a	22 g–j	50.0 a	50.0 a	6.7 fgh	30 bcd
Two Star	100 a	100 a	0 k	50.0 a	50.0 a	0.0 h	5 hi
Versailles	100 a	100 a	23 ghi	50.0 a	50.0 a	8.4 fgh	5 hi
Waldmann's Green	100 a	72 c	14 h–k	50.0 a	34.7 c	7.0 fgh	24 cde
Xena	100 a	100 a	61 bcd	50.0 a	50.0 a	30.1 b	44 a

[z]Means with the same letter in the same column are not significantly different at $P \leq 0.05$.
ND = not determined.

The highest germination percentages (greater than 30%) in the field were observed in Mid Queen, Headmaster, PRO 874, Marleen, PRO 839, Sinano-Summer, and Vanguard 75 (Table 2). There was no significant correlation between field germination and germination at 29 or 34 °C among crisphead genotypes (Table 7).

Romaine lettuce. Germination percentage and germination rates for romaine lettuce genotypes are shown in Table 3. There were significant differences in percentage germination and germination rates among genotypes at 29 and 34 °C. Seeds of Little Gem, Jericho, Winter Density, and Black Seeded Bath exhibited thermoinhibition at 29 °C as indicated by the lowest germination percentages and germination rates of the romaine genotypes tested. These genotypes also showed the largest reduction in seed germination at 29 °C compared with other genotypes (Fig. 3). In addition to these genotypes, Green Forest, Valmaine, and PRO 423 exhibited substantial reductions in seed germination at 34 °C (Fig. 3). These genotypes were more sensitive to thermoinhibition at 34 °C than the other genotypes. The most thermotolerant genotypes were Corsair, PI 278070, FL. 50105, Pro 425, Floricos 83, Amanthus, Heavy Heart, and Sweet Gem, which showed the smallest reduction in seed germination (less than 30%) at 34 °C compared with other romaine genotypes (Fig. 3). Green Forest exhibited thermotolerance at 29 °C and thermoinhibition at 34 °C. This indicated that the maximum temperature for thermoinhibition depends on lettuce cultivar and germplasm.

The highest field germination percentages (greater than 50%) were observed in PRO 425, FL 50105, and Corsair (Table 3). The field tolerance of these genotypes was consistent with their thermotolerance at 29 and 34 °C. There was a significant positive correlation between field seed germination and germination at 29 and 34 °C among romaine genotypes (Table 7).

Green leaf lettuce. The effect of temperature on seed germination percentage and germination rate in green leaf lettuce is presented in Table 4. High germination percentages (greater than 95%) were observed in all genotypes at 24 °C. At 29 and 34 °C, there were significant differences in percentage germination and germination rates among green leaf genotypes. The most sensitive genotypes to thermoinhibition were Royal Oak Leaf, Squadron, Australischer Gelber, Simpson Elite, and Greengo, which had significantly lower germination percentages (less than 50%) and germination rates at 29 °C than other green leaf genotypes (Table 4). The reduction in germination percentages at 29 °C in these genotypes was 89%, 81%, 69%, 69%, and 50%, respectively (Fig. 4). The differences in germination percentages and germination rates among lettuce genotypes were greater at 34 °C than at 29 °C. Noemie was the most thermotolerant genotype followed by PI 187238 E and PI 177420. These genotypes had the highest germination percentages and germination rates at 34 °C as compared with the other genotypes (Table 4). The reductions in seed germination in these genotypes at 34 °C were 2%, 27%, and 30%, respectively (Fig. 4).

The largest field germination percentages (greater than 40%) were observed in Squadron, Xena, Noemie, and Green Wave (Table 4). There was a significant correlation between field seed germination and germination at 34 °C among green leaf genotypes (Table 7).

Red leaf lettuce. Cultivars and genotypes of red leaf lettuce also differ in their tolerance to thermoinhibition. All red leaf lettuce genotypes exhibited high germination percentages and germination rates at 24 °C (Table 5). However, at 29 and 34 °C, there were highly significant differences in germination percentages and germination rates among genotypes. At 29 °C, most of the red lettuce genotypes exhibited high germination percentages and rates except Big Red, Red Flower, Prizehead, Red Rage, Red Prize, Ibis, Merlot, Red Tide, and Hyper Red Rumple Waved, which showed the lowest germination

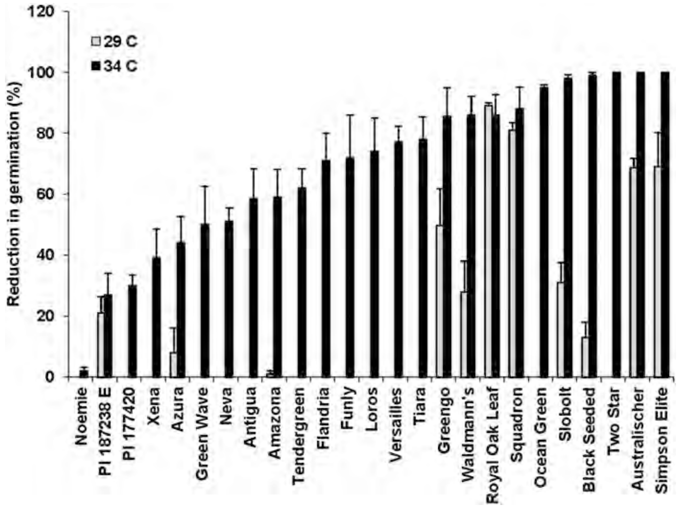

Fig. 4. Reduction in germination percentage at 29 and 34 °C from 24 °C in green leaf lettuce. Results are means ± SE (n = 4). $LSD_{0.05}$ for 29 and 34 °C are 13.7 and 20.6, respectively. Black Seeded = Black Seeded Simpson. LSD = least significant difference.

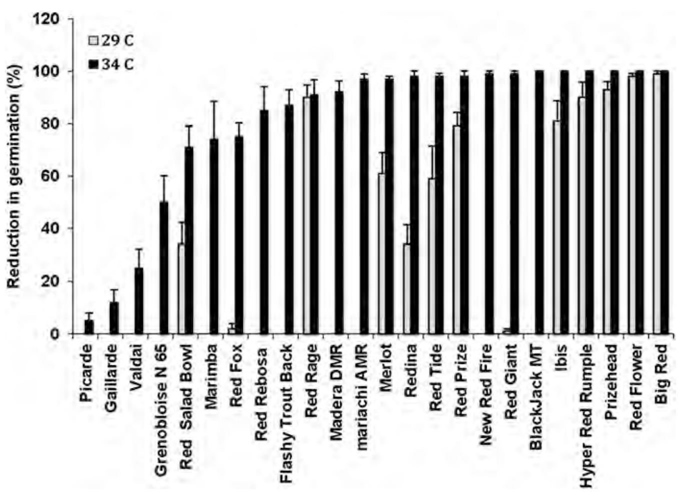

Fig. 5. Reduction in germination percentage at 29 and 34 °C from 24 °C in red leaf lettuce. Results are means ± SE (n = 4). $LSD_{0.05}$ for 29 and 34 °C are 12.9 and 15.1, respectively. LSD = least significant difference.

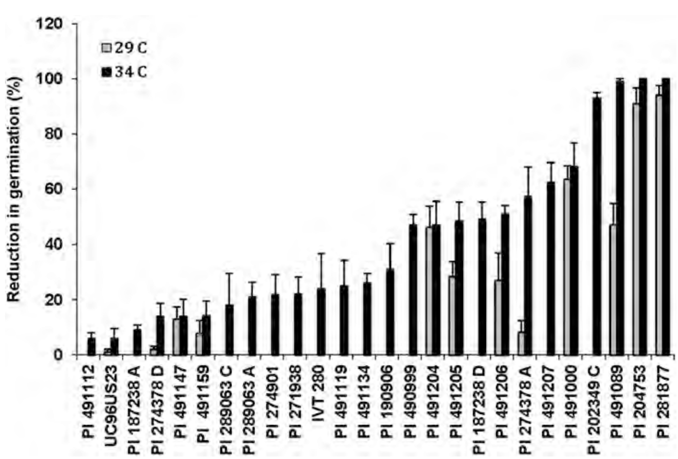

Fig. 6. Reduction in germination percentage at 29 and 34 °C from 24 °C in wild species. Results are means ± SE (n = 4). $LSD_{0.05}$ for 29 and 34 °C are 10.8 and 18.3, respectively. LSD = least significant difference.

percentages and rates. However, at 34 °C, most of the genotypes showed very low germination percentage and rates except Picarde, Gaillarde, and Valdai (Table 5). The reduction in germination percentages at 34 °C from that at 24 °C in Picarde, Gaillarde, and Valdai was 5%, 12%, and 25%, respectively (Fig. 5). These red leaf genotypes were considered the most tolerant to thermoinhibition at 34 °C.

The highest field germination percentages (greater than 30%) were observed in Picarde, Red Giant, Medera DMR, Marimba, Grenobloise N 65, Gaillarde, and Black Jack (Table 5). Picarde showed the highest germination in the field and at 34 °C. There was a significant positive correlation between field seed germination and germination at 29 and 34 °C among red leaf genotypes (Table 7).

Wild species. There were significant differences in germination percentages and rates among primitive and wild lettuce species at 29 and 34 °C (Table 6). PI 281877, PI 204753, and PI 491000 had the lowest germination percentages and rates at 29 °C. The reduction in germination percentages in PI 281877, PI 204753, and PI 491000 at 29 °C was 94%, 91%, and 63, respectively (Fig. 6). These genotypes were the most thermosensitive genotypes at 29 °C. In addition to these genotypes, PI 491089 and PI 202349 C exhibited thermoinhibition at 34 °C as determined by germination percentages and rates (Table 6). Genotypes with high tolerance to thermoinhibition were PI 491112, UC96US23, PI 187238 A, PI 274378 D, PI 491147, and PI 289063 C as indicated by high germination percentages (greater than 80%) and germination rates at 34 °C (Table 6). The reductions in seed germination in these genotypes were 6%, 6%, 9%, 14%, 14%, and 18%, respectively (Fig. 6). This shows that all three wild species (*L. serriola*, *L. saligna*, and *L. virosa*) and primitive lettuce have thermoinsensitive genotypes. The observed thermotolerance in UC96US23 (*Lactuca serriola*) was consistent with previous results of Argyris et al. (2008a, 2008b).

All of the wild species showed very low germination in the field (Table 6). The highest percentage germination (33%) was observed in PI 289063 A. There was no significant correlation between field seed germination and germination at 29 or 34 °C among wild species (Table 7). This variation in seed germination could be the result of field conditions, which were not optimal for germination like in the laboratory or growth chambers. Disease and insect damage may also lower germination percentage. It has been observed that poor field emergence at high temperature in broccoli was the result of an inhibition of root growth (Jett et al., 1996). The presence of high salt in the irrigation water or in the upper soil surface may lower seed germination (Coons et al., 1990).

The observed variations in the sensitivity to high-temperature inhibition of seed germination among lettuce genotypes may depend on lettuce cultivars and germplasm (Coons et al., 1990; Gray, 1975; Thompson et al., 1979). The regulation of seed germination in

Table 5. Effect of temperature on seed germination in red leaf lettuce.

Genotype	Germination (%) 24 °C	29 °C	34 °C	Germination rate 24 °C	29 °C	34 °C	Field germination (%)
Big Red	89 b[z]	1 e	0 f	37.1 b	0.3 g	0.0 e	5 jk
BlackJack MT	100 a	100 a	0 f	50.0 a	50.0 a	0.0 e	30 c–f
Flashy Trout Back	100 a	100 a	13 ef	50.0 a	50.0 a	6.1 de	22 e–h
Gaillarde	100 a	100 a	88 ab	50.0 a	50.0 a	43.5 a	33 b–e
Grenobloise N 65	100 a	100 a	50 c	50.0 a	50.0 a	23.4 c	34 b–e
Hyper Red Rumple	99 a	10 de	0 f	49.5 a	1.2 fg	0.0 e	2 k
Ibis	100 a	19 d	0 f	50.0 a	7.6 ef	0.0 e	0 k
Madera DMR	100 a	100 a	8 f	50.0 a	50.0 a	1.9 e	39 abc
Mariachi AMR	100 a	100 a	3 f	50.0 a	50.0 a	1.5 e	8 ijk
Marimba	100 a	100 a	26 de	50.0 a	50.0 a	11.1 d	37 a–d
Merlot	100 a	39 c	3 f	50.0 a	19.5 cd	1.5 e	11 h–k
New Red Fire	100 a	100 a	1 f	50.0 a	50.0 a	0.5 e	25 d–g
Picarde	100 a	100 a	95 a	50.0 a	50.0 a	46.8 a	49 a
Prizehead	100 a	7 de	0 f	50.0 a	3.5 efg	0.0 e	22 e–h
Red Salad Bowl	100 a	66 b	29 d	47.0 a	25.7 c	11.4 d	3 jk
Red Flower	100 a	2 e	0 f	50.0 a	1.0 fg	0.0 e	3 jk
Red Fox	100 a	98 a	25 de	50.0 a	47.1 a	12.5 d	12 h–k
Red Giant	100 a	99 a	1 f	50.0 a	43.6 a	0.3 e	43 ab
Red Prize	80 c	18 d	2 f	40.0 b	8.8 e	0.6 e	3 jk
Red Rage	100 a	10 de	9 f	50.0 a	1.4 fg	1.0 e	15 g–j
Red Rebosa	100 a	100 a	15 def	50.0 a	50.0 a	6.8 de	6 jk
Red Tide	100 a	41 c	2 f	50.0 a	16.5 d	1.0 e	1 k
Redina	100 a	66 b	2 f	50.0 a	33.0 b	0.5 e	19 f–i
Valdai	100 a	100 a	75 b	50.0 a	50.0 a	36.3 b	25 d–g

[z]Means with the same letter in the same column are not significantly different at $P \leq 0.05$.

Table 6. Effect of temperature on seed germination in wild species lettuce.

Genotype	Species	Germination (%) 24 °C	29 °C	34 °C	Germination rate 24 °C	29 °C	34 °C	Field germination (%)
IVT 280	VIR	100 a[z]	100 a	76 abc	50.0 a	48.7 ab	24.0 efg	1 ef
PI 187238 A	PRI	100 a	100 a	91 ab	50.0 a	50.0 a	30.8 b–e	14 bc
PI 187238 D	PRI	100 a	100 a	51 de	50.0 a	50.0 a	23.2 e–h	13 bcd
PI 190906	PRI	100 a	100 a	69 cd	48.5 ab	50.0 a	19.8 gh	15 bc
PI 202349 C	PRI	100 a	100 a	7 g	50.0 a	50.0 a	2.3 i	19 b
PI 204753	PRI	95 a–d	8 h	0 g	46.8 a–d	2.1 i	0.0 i	5 ef
PI 271938	VIR	100 a	100 a	78 abc	49.3 ab	50.0 a	22.0 fgh	7 c–f
PI 274378 A	VIR	94 bcd	86 d	41 ef	42.8 e	34.9 d	5.7 i	2 ef
PI 274378 D	VIR	100 a	98 abc	86 abc	43.8 cde	45.5 bc	31.0 b–e	8 cde
PI 274901	VIR	96 a–d	100 a	75 bc	48.0 ab	50.0 a	36.1 abc	17 b
PI 281877	SER	100 a	6 h	0 g	50.0 a	3.0 i	0.0 i	4 ef
PI 289063 A	PRI	100 a	100 a	79 abc	50.0 a	50.0 a	38.9 ab	33 a
PI 289063 C	PRI	100 a	100 a	82 abc	50.0 a	50.0 a	25.1 efg	13 bc
PI 490999	SAL	98 abc	100 a	52 de	48.8 ab	50.0 a	24.3 efg	0 f
PI 491000	SAL	93 cd	35 g	31 f	46.0 b–e	15.8 g	15.1 h	1 ef
PI 491089	SER	100 a	53 f	1 g	48.5 ab	5.4 i	0.1 i	0 f
PI 491112	SER	100 a	100 a	94 a	48.0 ab	50.0 a	37.9 ab	1 ef
PI 491119	SER	100 a	100 a	75 bc	50.0 a	50.0 a	29.7 c–f	3 ef
PI 491134	SER	100 a	100 a	74 bc	50.0 a	50.0 a	27.5 d–g	5 def
PI 491147	SER	100 a	87 cd	86 abc	50.0 a	41.8 c	33.5 bcd	5 ef
PI 491159	SAL	91 d	88 bcd	79 abc	43.5 de	21.5 f	23.8 efg	5 ef
PI 491204	SAL	100 a	54 f	53 de	50.0 a	10.1 h	26.0 d–g	2 ef
PI 491205	SAL	99 ab	71 e	51 de	48.5 ab	33.2 d	23.7 efg	1 ef
PI 491206	SAL	100 a	73 e	49 ef	49.0 ab	28.6 e	24.0 efg	0 f
PI 491207	SAL	98 abc	100 a	37 ef	47.3 abc	50.0 a	15.3 h	0 f
UC96US23	SER	100 a	99 ab	94 a	48 ab	44 c	43 a	nd

[z]Means with the same letter in the same column are not significantly different at $P \leq 0.05$.
VIR = *L. virosa*; SAL = *L. saligna*; PRI = primitive; SER = *L. serriola*.

Table 7. Correlation coefficients of percentage seed germination (24, 29, 34 °C and field) among lettuce genotypes.

Lettuce type	Germination	24 °C	29 °C	34 °C
Butterhead	29 °C	0.39*		
	34 °C	0.30	0.65**	
	Field	0.37	0.57**	0.41*
Crisphead	29 °C	0.28		
	34 °C	–0.10	0.42*	
	Field	0.28	0.38	0.33
Romaine	29 °C	–0.14		
	34 °C	–0.18	0.75**	
	Field	–0.20	0.73**	0.68**
Green leaf	29 °C	0.36		
	34 °C	0.24	0.48*	
	Field	0.30	0.20	0.57**
Red leaf	29 °C	0.40		
	34 °C	0.18	0.47*	
	Field	0.30	0.65**	0.52**
Wild species	29 °C	0.28		
	34 °C	0.18	0.72**	
	Field	0.20	0.35	0.23
All lettuce types	29 °C	0.28**		
	34 °C	0.12	0.56**	
	Field	0.27**	0.46**	0.34**

*, **Significant correlations at 5% and 1% levels of probability, respectively.

lettuce by temperature may involve plant hormones such as ABA and GA. High temperature stimulated ABA synthesis and inhibited GA synthesis in imbibed *Arabidopsis* seeds (Toh et al., 2008). The increase in ABA levels in seeds of the Salinas cultivar that exhibited thermoinhibition indicated that ABA plays a key role in thermoinhibition of lettuce seeds (Argyris et al., 2008a; Nambara et al., 2010). 'Salinas' also exhibited thermoinhibition at 29 to 34 °C as observed in this study. The observed increase in thermotolerance in UC96US23 was associated with a decrease in ABA biosynthesis at high temperature (Argyris et al., 2011). Seed covering may also be involved in regulation of seed germination by imposing a restriction on seed germination at high temperature (Ikuma and Thimann, 1963; Speer, 1974; Sung et al., 1998). The stimulation of activities of hydrolytic enzymes is required to promote seed germination and embryo growth (Khan, 1994; Nascimento et al., 2000).

The results of this study indicated that seeds of cultivars and germplasm of various lettuce types (crisphead, romaine, butterhead, green and red leaf, and primitive and wild species) differed greatly in their ability to germinate at 29 and 34 °C. However, at 24 °C, seeds of most lettuce genotypes germinated rapidly and uniformly. Some lettuce cultivars and germplasm exhibited thermoinhibition at 29 °C, whereas others exhibited thermotolerance at high temperature (34 °C). The maximum temperatures for thermoinhibition may depend on lettuce genotype. Despite the variations in field germination, seed germination in the field positively correlated with seed germination at 29 and 34 °C. This evaluation of seed germination at 29 and 34 °C helped in identifying lettuce cultivars and germplasm that tolerate high-temperature stress. Selecting lettuce cultivars with good germination at high temperatures is essential to ensure uniform stand establishment and subsequent uniform maturity at harvest.

Most U.S. lettuce production is carried out in the central coast of California with transit to the San Joaquin Valley for a short period in spring and fall and a switch to southern California and Arizona for winter crops. Land costs in the coastal production areas are usually several times higher than in the inland regions. However, production seasons in these low land cost areas are limited by heat stress and thermoinhibition. Seed priming is commonly used to prevent thermodormancy and ensure uniform emergence, even in coastal production areas. Thermoinsensitive lettuce varieties could help expand the production seasons in warm and low land cost areas nationwide and reduce the need for seed priming, lowering the production costs. As the costs of land, labor, fuel, fertilizer, pesticides, seeds, packing material, cooling, transportation, and overhead including food safety continue to rise, it is essential to reduce production costs of leafy vegetables to benefit producers as well as consumers.

The results from this study may help growers choose lettuce varieties to be grown in a warm environment. These data may also help lettuce breeders to improve the crop for resistance to heat stress. A breeding program usually starts from germplasm screening to find the source of beneficial traits. Because the development of a new lettuce cultivar may take up to 10 years, there is an urgent need to breed thermodormancy-resistant cultivars for adaptation to global warming and climate changes.

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BEST MANAGEMENT PRACTICES FOR THE STATE OF CALIFORNIA

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INTRODUCTION

This document is a preliminary compilation of management practices for eleven invasive species: the light brown apple moth (*Epiphyas postvittana*), the European grapevine moth (*Lobesia botrana*), the brown marmorated stinkbug (*Halyomorpha halys*), the bagrada bug (*Bagrada hilaris*), the glassy-winged sharpshooter (*Homalodisca coagulata*), the Asian citrus psyllid (*Diaphorina citri*), the Diaprepes root weevil (*Diaprepes abbreviatus*), the red palm weevil (*Rhynchoporus ferrugineus*), red imported fire ants (*Solenopsis invicta*), *Phytophthora ramorum*, and the European brown garden snail (*Helix aspersa*). Initially, this document included only the light brown apple moth, the European grapevine moth, the glassy-winged sharpshooter, the Asian citrus psyllid, the Diaprepes root weevil, red imported fire ants, *Phytophthora ramorum*, and the European brown garden snail. The additional pests were included in order to examine how well the management practices of similar species overlapped (such as stink bugs, weevils, leaf-roller moths). To be of greater use to California growers this list should be extended to include more types of pests and species of greatest concern.

The practices listed in this document have been determined by an extensive literature review of journal articles and management manuals. These encompass practices used in California, the greater United States, and abroad. Detailed direction is lacking from this document, which provides only a summation and justification for each practice. Little distinction between potted plants and field plants are made. It would be useful to make such distinctions in future documents so growers understand which practices can help their particular operation. The intent of this document is to be utilized as a starting point for generalized nursery management practices and is meant to show commonalities in pest exclusion techniques for many different pest groups.

Under no circumstances is this document to be implemented in its current form. This document requires updating for current regulations, and editing for those practices which are not acceptable in California. Because regulations are constantly changing, this document will need to be updated frequently. Regulations from one county to another vary, so growers should be kept up-to-date on their local regulations. Separate drafts for each county may be a more comprehensive format.

The editing of this document should be done by those that are intimately acquainted with pest statuses in California and their management during different life stages. For this reason, those that are currently involved in management programs and pest/pathogen research would be best suited to the purpose.

The attached chart is an alternate table of contents. In no way are the practices listed explained in full. Mandatory practices were not noted due the frequent change and varying pest statuses.

1.0: Sanitation, nursery layout, and cultural practices

Some management practices can work to prevent and manage many pests, both invasive and endemic. These practices are an important part of managing pests and diseases.

1.1: Weakened plants become more susceptible to disease and infestation. Keeping the nursery free of weeds and debris can have many benefits. Weeds and plant debris can harbor pathogens and pests which can spread to nursery stock and affect the health of plants. Many plants will drop leaves that become infected with pathogens as a defence mechanism. Leaving those infested leaves or other plant material on the ground exposes nearby plants to the pathogen. Pests and diseases can persist in cull that is allowed to sit for a long time. Cull should be incinerated, buried or composted frequently. Disposing of litter properly ensures that pest colonies and many diseases are destroyed before they can affect stock. Keep loading docks equally free of debris to prevent contamination of incoming and outgoing stock (97).

LBAM: These practices are required in light brown apple moth quarantine areas (61).

1.2: Avoid heat and moisture stress. Healthy plants are more resilient to pests and diseases. Over-watering plants or extended periods of leaf wetness makes plants more susceptible to foliar diseases and root rot. Avoid overhead watering, minimize standing water and extended leaf-wetness. Group plants of similar moisture needs together, and minimize runoff. Take cuttings early in the morning to reduce stress to plants, and avoid taking cuttings on wet and windy days when there is more risk of fungal and bacterial infection. Manage environment in propagation areas by keeping adequate air movement, optimal temperature and humidity. (97).

1.3: Manage water flow into the nursery and minimize standing water. The presence of algae indicates a poorly drained area. Keep irrigation equipment clean and store them off the floor. Test irrigation water for pathogens such as *Phytophthora ramorum* (97). Filter and/or disinfest used and contaminated water (97). Water from infested areas can harbor pathogens. Map water flow into the nursery from other areas and divert excess water away from root systems. If it is unknown whether surrounding land is infested, diverting water and soil movement can prevent the entrance of unknown pathogens and reduce moisture conducive to fungal growth (16).

PR: *Phytophthora ramorum* is a water-borne fungus-like organism. Extended leaf wetness due to poorly timed irrigation makes plants more susceptible to fungal infections like *P. ramorum*. It is also important to conduct annual tests of untreated irrigation water to confirm the absence of pathogens. (72)

RPW: Flooded orchards and high soil moisture contribute to the spread of infestations (5). Moist soil is used as a refuge (6)

1.4: Sanitize or sterilize equipment and propagation beds to eliminate any pathogen or pest reproductive bodies which could contaminate the next generation of plants (72). All propagation surfaces and pruners should be disinfected after each use. Workers should wear clean clothes and shoes, especially after entering an area known to be infected. Use disposable gloves while handling plants and change them between lots (97).

LBAM: Cleanable surfaces can be swept or hosed clean to avoid harboring pests (61).

EGVM: All mechanized farm and/or vineyard equipment or conveyances leaving vineyards, fields and/or other infested areas at any time must be either (1) pressure washed to ensure that all plant litter, debris and/or all types of waste have been removed, or (2) steam treated in accordance with PPQ Treatment Manual schedule T406-d and applicable conditions of 7 CFR Part 305 (101).

1.5: Disinfest media if it is being reused and make sure commercial media has been tested for pathogens, pests, and weed seeds (97). Avoid using bark from areas infested with *Phytophthora ramorum*, for the substrate can be contaminated. Properly composting media and plant debris can effectively disinfest these materials. Mix and store all media components on cement slabs, not on soil where contamination of these components can occur. Store compost in a separate area that is easy to clean, and make sure it is free of standing water, insects, pathogens, weeds, mosses, and liverworts. Use new pots, flats, and trays or disinfect those that are reused. Keep pots off of bare soil as well (97).

1.6: Mixing hardy plants with more susceptible plants creates barriers to pathogens (100). Provide breaks between block to increase airflow and reduce the likelihood of pathogen dispersal. Avoid monocultures, which encourage colonization of pests and create a source of inoculum for diseases. This can be done in the nursery by alternating plants of different genera or families (72).

1.7: Keep records of incoming and outgoing stock as well as field history and progeny. This will help track infestation timing from year to year and correlate them with plant stages. These records are essential for tracking the movement of potentially infected material. When receiving stock from other facilities, be aware of their management methods and records (97). This practice is required for some quarantined pests (61). Any exotic pests or pathogens should be reported to nursery inspectors (97).

1.8: Frequent in-house scouting and visual inspections to detect new infections/infestations allow time to treat new problems before they become serious (61). Inspections should be performed by employees trained to recognize pests and infections.

1.9: Conserve natural enemies such as ladybeetles, mantids, parasitoid wasps, birds, lizards, and small mammals. Minimize pesticide use to avoid killing important enemies. Conserving natural habitats where they can live is important. Natural enemies often require undisturbed areas where they can breed (61).

1.10: Rotate pesticide families to reduce the chance of pesticide resistance. Invertebrate pests and pathogens can sometimes adapt to chemicals in only a few generations. Changing the chemical class they are exposed to as often as possible slows their adaptation and preserves the effectiveness of all chemical treatments. If effective chemical treatments are unavailable look into other methods like thermal therapy and tissue culture techniques (97).

1.11: Prevent plant blow-down by creating wind breaks. Structures and tall plants can be used to shield stock from strong winds. This reduces damage to stock and helps prevent wounds that can provide a site of entrance for pests and diseases (4).

1.12: Maintain proper fertilization is necessary to keep plants healthy Deficient or excess fertilizer can make plants weak and create ideal conditions for certain pests and pathogens. Fertilizer is used as a supplement for plants which need nutrients not found in their soil. Application timing and moisture level are factors which affect the effectiveness of fertilizer treatments.

2.0: Exclusion
Implementing these practices decreases the risk of introducing pests and diseases.

2.1: Create physical barriers to exclude pests and pathogens. These can be high fences of shade cloth, tall alternative feeding plants for the pest, or isolating them in a well-sealed greenhouse. Barriers should be placed in accordance with migration and prevailing winds. Yellow sticky tape can be used to create barriers and determine pest pathways, but is not effective in reducing populations. Trap cropping, plots of alternate host plants, have been employed for some pests. Concrete or gravel barriers between potted plants and the soil can prevent infestation from soil-borne pests. If possible grow high risk and susceptible young plants in greenhouse enclosures. Keep a secure perimeter around the nursery which excludes animals and unauthorized personnel (97).

LBAM: Alternative hosts on nursery borders can harbor infestations of LBAM and increase the risk of infection. Tarps can screen stock from infestations. Isolating high risk plants using physical barriers, like greenhouses or tarps, can prevent infestations. (61).

EGVM: (25).

BMSB: Putting fine mesh bags around young fruit can protect them from feeding damage (96).

GWSS: Shade cloth or tall plants. Tall cypress or juniper plants, each being non-preferred host plants, can provide food for GWSS without providing oviposition sites. However, these plants will require occasional treatment to manage trapped adults (59). Surround WP, a particle film which repels GWSS when applied to grape leaves, has had some success (79).

ACP: Minimize borders of farm/nursery by planting more blocks to give the pest less access to stock. Keep nurseries under cover if you can by using shade cloth, tarps, or growing stock in enclosed greenhouses (7). Particle film can be useful when applied to citrus leaves. However the film is less effective after rain (37).

DRW: Contact between native soil and potted plants can result in an infestation of RIFA. Barriers like gravel have do not minimize the risk as much as concrete, which can be lain over infested areas. Plants grown inside of greenhouses have minimal risk of infestation.

RIFA: Contact between native soil and potted plants can result in an infestation of RIFA. Barriers like gravel have do not minimize the risk as much as concrete, which can be lain over infested areas. Plants grown inside of greenhouses have minimal risk of infestation (44).

PR: Barriers can be tarps or two meter breaks between high risk plants and other stock. Planting high risk plants and non-host plants also reduces susceptibility. Potted plants should be separated from the ground by barriers such as raised benches or gravel, which also protects plants from splash (72) (73).

2.2: Any pest or pathogen which has a life cycle in the soil can be spread via contaminated equipment. Cleaning mechanical equipment rids it of fungal spores, nematodes and animal eggs. The presence of plant debris, mud, or soil on incoming vehicles carries the potential of pest/disease introduction. Clean trucks between shipments. Make sure staff wears clean clothes every day ad that boots and other shoes are properly cleaned between different production areas. Make sure visitors maintain the same sanitation measures as staff and do not allow them to wander unescorted (97).

BB: Bagrada bugs lay their eggs in the soil.

DRW: (33)

RIFA: (44)

PR: (72)

EBGS: Snail eggs can be found in the soil, but their eggs desiccate in dry soil (11).

2.3: Make sure all stock you receive from growers, trade, sales, landscapers, etc. is clean in order to exclude pests and pathogens. Nursery stock which is already infected/infested can lead to unhealthy plants which cannot be sold and may contaminate other plants (61). Importing stock that is rootless, leafless, and free of potting media reduces the chance of introducing pests and pathogens to the nursery (97). An isolation area specifically for incoming plants could be created for this purpose.

Do not accept unsolicited plant material. Check shipments to make sure you are receiving only the material which was ordered. Plants which may have been accidentally included could harbor unexpected pests and pathogens (97).

PR: The use of clean nursery stock is required in *Phytophthora ramorum* quarantine areas. Isolate material suspected of infection for two months. Isolate incoming stock and suspend use of fungicides for two months to determine if symptoms are being suppressed by previous treatments before mingling with other stock (72).

2.4: Wild-collected plants may harbor pests or pathogens. Many pests and diseases are not readily apparent and the plant may be asymptomatic. Grow material out first in an isolated area to detect any disease. When possible buy nursery stock domestically from an accredited source and visit the source nursery. Self-propagation of new plants can prevent introduction of pests and pathogens. Make sure the propagation areas are isolated and restricted to authorized personnel (97).   In some areas inspection by the USDA is required for wild-collected plants.

PR: The symptoms of *Phytophthora ramorum* can be masked or take some time to appear. Isolate incoming stock and leave it untreated long enough to determine if symptoms have been suppressed by previous treatments (72). When receiving high risk incoming stock, isolate it from the rest until it can be certain that it is without pest and disease, so nursery stock is not exposed.

2.5: Personnel capable of recognizing disease symptoms and infestations should inspect all incoming stock to be certain it is uncontaminated. Nursery stock coming from quarantined areas have a high risk of being contaminated. Periodic training of personnel is recommended for any new disease or pests or when new host plants are identified. Inspecting nurseries before importing stock from them can help spot problems before they reach the nursery (97). If possible refuse all returns, especially those from quarantined areas. If unavoidable, isolate material and inspect plants. Alert regulatory officials if contamination is detected (72).

2.6: Be aware of contaminants and disease or pest outbreaks in neighboring nurseries. Monitor plants outside the nursery to anticipate infection/infestations. Border plants can harbor a myriad of pests and diseases which can spread to stock (61).

2.7: Treat plant wounds to prevent infections and infestations. This is especially imported when pruning. Pretreating the plant before pruning and propagation minimizes danger to the plant.

RPW lay eggs in injured plant tissue. Treat plant wounds to minimize oviposition by females (34).

PR: Because *P. ramorum* can easily enter plant wounds it is especially imported to treat them before taking cuttings. Clean shears often.

2.8: EBGS: Make it difficult for the pest to climb plants by trimming tree skirts and wrapping trunks with copper foil (94). Removing shade can also have a positive effect by removing daytime hiding places (29). Bags, brush, and debris are excellent places for snails to hide (94).

2.9: Training programs are available to help employees identify and treat pests and diseases. [List them here] Periodic refreshers are recommended as new pests and diseases or new hosts of pests and diseases are periodically identified.

2.10: Use Degree-days or other pest/pathogen modeling systems to time preventative pesticide applications. Degree days take into account changing temperatures on pest emergence and can help predict pathogen outbreaks. Accepted Degree-day models exist for some pests.

LBAM: (98)
EGVM: (94)
BMSB: (99)

3.0 Trapping and monitoring

Frequent visual inspections are an important part of any pest/pathogen management plans. There are a number of monitoring techniques which are effective for pests and pathogens.

Training in identification, management, and other aspects of the disease or pest are available for nursery employees for LBAM, *P. ramorum*, and GWSS.

3.1: Sticky traps are an accurate means of determining pest presence and in some cases pest density. Trap color has an attractive effect on some insects, and yellow is commonly the most attractive color. By using yellow sticky traps one can monitor for more than one pest at a time. Sticky traps alone can be used to monitor for some species.

GWSS: Sticky traps are only an efficient monitoring tool when the pest is in high densities. Use at least 2 traps per half acre (59).

ACP: Yellow or lime-green are the most attractive colors to ACP (7). However they are only effective for monitoring presence, and are little use in determining pest density (38).

3.2: Beat or tap sampling can be used to monitor pests which live or feed on plants above ground. Using a white sheet provides the most visibility for fast visual counts.

GWSS: Most effective in cool weather (59)

ACP: This is fastest and most accurate means to monitor this pest. Three taps on a branch onto a white clipboard (85) (7) <TAP METHOD PROCEEDURE>

BMSB: Beat sampling is an effective way of monitoring adults and later instars (40)

3.3: Sweep net monitoring can be used for pests found in shrubs and herbaceous plants including many weeds and grasses found on the border of nurseries and under trees in orchards. Sweep nets can also be useful in crops which can withstand repeated sweeping. It is best to make a standard form for sweeping so as to create a less biased result.

GWSS: Most effective in cool weather when the leaf hoppers are less active (59).

ACP: (22) (7).

BMSB: This is a useful monitoring device in soybean fields and border plants.

BB: The only sampling method for bagrada bugs consists of laborious sweep net sampling (102).

3.4: Blacklight traps can be used to monitor night-flying insects. However, since there are many night-flying insects which are attracted to blacklights, many non-target pests will be caught as well. If this method is employed the traps catches must be sifted through often by an employee who can identify the insect very well.

BMSB: BMSB is easily distinguished from indigenous stink bugs and other insects, which makes this method a less time-consuming option.

3.5: Trapping and detection using pyramid traps and emergence traps.

DRW: Tedders trap (20) Though they only detected presence and gave no idea of densities (70). Pyramid traps (28).

3.6: Tissue and soil sampling are useful for detecting more discrete pests and pathogens.

EGVM: Stripping the bark from grape vines to look for larvae can detect infestations and give one time to treat or destroy infected vines before more damage is done to the crop. This is time consuming and expensive procedure which can usually not be conducted during the growing season (25).

PR: Tissue and soil samples can be sent to a lab to confirm the presence of *P. ramorum* (73). <INCLUDE COLLECTION PROCEEDURES>

RPW: Destructive sampling detection in trunks of palm plants.

3.7: Pitfall traps can be used to detect insects that crawl along the ground. A bait is usual needed when using this monitoring technique.

RIFA: Traps work better with bait (44). Carbohydrate baits work better than protein-based baits.

EBGS: bait raps with beer or sugar water (29).

3.8: EBGS: Monitor by using cover boards. Use an easy-to-handle sized piece of wood and elevate it one inch off the ground. Dispose of snails by crushing them (29). Boards can also be made of cardboard; it is important the boards material can remain moist.

3.9: ACP: Vacuum sampling can be used to monitor and determine densities. It is however expensive (7).

3.10: RPW: Bioaccoustic measurements can be taken to detect larvae in as early as 1 ½ weeks after infestation. In 3-4 weeks infestation can be determines with high accuracy (14) (64).

3.11: RPW: Vane traps are more effective than bucket traps. They should be placed 2m above the ground and baited with aggregation pheromone ferrugineol (4-methyl 1-5-nonanol) (39).

3.12: Pheromone lures are needed to monitor for some pests. Pheromones are attractive chemicals that

LBAM: A pheromone lure on a yellow sticky trap is an effective way to monitor (61).

EGVM: A pheromone lure on a yellow sticky trap is an effective way to monitor. Use regulated E, Z-7, 9-12AC at a 0.5mg rate (25). There should be one trap per five acres with a minimum of 2 traps per farm (42).

BMSB: Pyramid traps with pheromone lures placed throughout the field can detect the presence of the pest, however there is no model to predict the pest's density (1) (2).

4.0: Minimizing the spread of infection

Once a pest or pathogen has entered the nursery, certain steps can be taken minimize its spread to other areas.

4.1: By separating infested material from clean stock one can often prevent the spread of the pest or disease to other retail stock. In general, this measure is most practical for smaller nurseries.

LBAM: Combine isolation and pesticide application to prevent reinfestation of isolated stock. (61).

EGVM: (42)

DRW: (60)

RPW: Infested material should be put in separate cull piles for destruction (14).

PR: Isolate any material you suspect to be infected with *P. ramorum* until the cause of infection has been determined.

4.2: Destroy infested plant material if there are only a few infested or diseased plants, or if there are many high risk plants in the nursery.

LBAM: Keep separate cull piles for infected plants (61). <INCLUDE PROPER MEANS OF DESTRUCTION>

EGVM: Infested clusters of grapes should be harvested and destroyed. EGVM larvae can live on, among, and inside grapes. Keep separate cull piles for infected plants (25).

GWSS: Destroyed plants must be bagged and sent to a landfill. Infected plants work as inoculum of Pierce's Disease. The removal of infected grape vines and almond trees reduces the risk of infecting other plants (41)(84).

ACP: Removing symptomatic trees also removes inoculum of citrus greening (7).

PR: An infected plant can act as inoculum for the disease, which puts other plants at risk (72). Destroy plants immediately if *P. ramorum* infection has been confirmed

Cull piles for infected plant material should be kept separate from other plant debris. Direct runoff from cull piles away from susceptible plants and waterways to reduce the risk of spreading infection (72).

RPW: Remove according to quarantine regulations. Removing infested palms directly after detection prevents adult weevils from emerging. This is the best means of managing infestations available. However it is difficult to effectively destroy infestations in removed stock and remove debris from the soil to prevent reinfestation (14).

4.3: Eggs and larvae of some pests are harbored by the leaves of a host plant. Defoliating plants deny the pest host material, and destroys any stages of the pest which is already living on the leaves.

LBAM: (61)

4.4: Landscape plants in the nursery can harbor disease and pests and provide a pool of infection/infestation. Removing them from the landscape can make retail plants less likely to become infected/infested.

GWSS: Citrus and grape families in close proximity have the greatest risk (83).

ACP: (7).

PR: (72). Wild susceptible species, such as poison oak, act as inoculum (17) (88).

BB: Any Brassicas in weedy areas along farm borders can harbor populations (75) (76)

BMSB: Though these are polyphagus, there is a preference for legumes. Removal of these from borders limits populations (76)

4.5: After visiting an infested area, wash and/or sanitize shoes, tools, and vehicles to prevent spreading soil and water-born stages of the pest/disease.

RIFA: The transport of eggs or queens through soil can spread an infestation, but sanitation is not needed. Incorporate granular insecticides into potting mixes or employ regular soil drenches to prevent infestations (28).

PR: Fungal diseases can be transmitted with microscopic spores, some of which can survive harsh conditions. Sanitizing is the only way to insure their destruction (72). Spores can survive desiccation as well (15).

EBGS: Snails lay eggs in the soil. This means there is some risk of spreading them by moving soil, but sanitation is not necessary.

4.6: Fabric mulches can be used in infested orchards to reduce the ability of Diaprepes larvae to reach the soil and pupate. Mulches such as this can also hinder the emergence of adults (21) (65).

5.0: Treatments

This is a short list of treatment techniques to combat infection/infestations. If using pesticides follow the application rates and direction on the label.

5.1: Spot treat with pesticides as an alternative to treating large areas. Limited pesticide applications help preserve natural enemies.

LBAM: Use tortricid-labeled control agents. Spot treat actively infested plants (61).

EGVM: Any detection warrants immediate suppression. The first foliar treatment should be applied before flowering (25).

BMSB: An insecticidal regime alternating pyrethroids and carbamates offers some control, but should not be used in the long term (71)

BB: Broad applications of pesticides are best, early in the season when bugs emerge. Imidacloprid are the best mean of control (3). Foliar contact insecticides manage established populations best (75). However sprinkling crushed Bagrada bugs around the plants has offered some control, as has a mixture of chili, soap, garlic and paraffin (93).

GWSS: If in a quarantine area, apply foliar treatments in the presence of a CAC inspector. (41). Apply pesticide only if more than one is found per tree (91).

ACP: Check with local officials to determine if it is safe or advisable. Flush can be used to estimate the presence of different life cycles (81). Foliar treatments are most effective when applied to earlier instars. Manage flush by hand, pheromone, fertilizer or irrigation in order to time pesticide applications, for both preventative and control treatments (7). Quantifying flush (36).

DRW: Foliar treatments can control adult weevils. If abiding by the Voluntary Preventative Treatment Protocol, initial applications of pesticides must be conducted in the presence of a CAC inspector (60). Soil drenches in potted plants can help control larvae (60) (80).

RPW: Soil drenches and the application of systemic insecticides to the trunk. Check local regulations for instructions.

RIFA: Contact insecticides and soil drenches can be used for infested pots and ant hills (28).

EGBS: Pesticide sprays don't work, but generous sprinkles of bait can control snails if they return to the same place every night (11). Baits do not survive high-moisture (94)

5.2: Commercial biological controls are available for many pests.

BMSB: A predatory wasp is now available (68) (95) (31). *Metarhizium anisopliae* strain FRM 515 has had some effect on stinkbugs (43).

BB: *Metarhizium anisopliae* strain FRM 515 has had some effect on stinkbugs (43).

ACP: (7) (35)

DRW: (60) Nematode application (86) Wasps and nematodes for biocontrol. Beauvaria bassiana for adult control. (33)

RPW: There are nematodes, mites, bacteria and viruses which are know to control the weevil, as well as some wasps (67). (32) (62)

RIFA: *Beauvaria bassiana* in combination with a bait (12) (77). *Pseudacteon tricuspis*—an endoparasitoid (13). Nematodes? (19) (46). Microsporidia (74).

EBGS: Where baits are not used predatory snails can be released (94). Ducks are also a good means of control, but they will eat seedlings as well (29).

5.3: Mating disruption is the best means of control. Males find females to mate with by following pheromone scent trails. This confusion technique reduces the risk of nursery stock infestation or egg deposition.

LBAM: (61)

EGVM: (25) (90) In addition to pheromones an electrostatic powder has also been used to confuse males by reducing their ability to sense the pheromone (69).

5.4: Baits are an effective means of control.

RIFA: 80-90% control was achieved with baits, the remainder is eliminated with mound drench treatments (28). Baits are most effective in spring and summer (10).

LBAM: Attraction pheromone and permethrin were effective (88), but more research is needed (2000).

EGBS: Baits are used to deliver chemical control, but the likelihood of a snail finding the bait is a matter of chance (11)

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5.5: Chemically treat plants before taking cuttings to reduce the risk contamination.

GWSS: Vector; precautionary measure?

ACP: Vector; precautionary measure?

PR: Infected plants are not always symptomatic. If possible, protect open wounds from infection (72).

5.6: EBGS: Manual removal of snails is the most sure-fire way of dealing with infestations. They are most effective during the summer aestivation period in conjunction with chemicals (11). Water late in the afternoon to draw out the snails, and search for them by night with a flashlight (29).

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X = verified	**Tortricidae Moths** LBAM = Light brown apple moth EGVM = European grapevine moth		**Stink Bugs** BMSB = Brown marmorated stinkbug BB = Bagrada bug		**Leaf-hoppers** GWSS = Glassy-winged sharpshooter	**Psyllids** ACP = Asian citrus psyllid	**Weevils** DRW = Diaprepes root weevil RPW = Red palm weevil		**Ants** RIFA = Red imported fire ant	**Water born fungi** P.r = Phytophthora ramorum	**Mollusks** EBGS = European brown garden snail	
1.0 Sanitation, nursery layout, and cultural practices												
	LBAM	EGVM	BMSB	BB	GWSS	ACP	DRW	RPW	RIFA	P.r	EBGS	
1.1 Keep nursery and loading areas clean, litter and weed free, and properly dispose of waste.	X	X	X	X	X	X	X	X	X	X	X	Pg. 3
1.2 For plants, avoid heat and moisture stress	X	X	X	X	X	X	X	X	X	X	X	Pg. 3
1.3 Divert soil and water pathways from infected areas away from nursery								X		X		Pg. 3
1.4 Properly disinfect surfaces that come in contact with plants and soil including equipment, propagation beds; workers should wear clean clothes and shoes and use gloves while handling plants	X	X					X		X	X	X	Pg. 3
1.5 Use clean media and sterilize used pots, trays, and flats.	X	X	X	X	X	X	X	X	X	X	X	Pg. 4
1.6 Avoid monocultures by mixing susceptible and hardy plants		X	X	X	X	X	X	X	X	X		Pg. 4
1.7 Keep records of incoming and outgoing stock as well as nursery maintenance and field history.	X	X	X	X	X	X	X	X	X	X	X	Pg. 4
1.8 Conduct frequent in-house inspections	X	X	X	X	X	X	X	X	X	X	X	Pg. 4
1.9 Encourage natural predators and parasites	X	X	X	X	X	X	X	X	X		X	Pg. 4
1.10 Rotate insecticides/fungicide chemical families	X	X	X	X	X	X	X	X	X	X	X	Pg. 4
1.11 Prevent plant blow-down by creating wind breaks	X	X	X	X	X	X	X	X	X	X	X	Pg. 5
1.12 Deficient or excess fertilizer can make plants weak and create ideal conditions for certain pests and pathogens.	X	X	X	X	X	X	X	X	X	X	X	Pg. 5

2.0 Exclusion												
	LBAM	EGVM	BMSB	BB	GWSS	ACP	DRW	RPW	RIFA	P.r	EBGS	
2.1 Create physical barriers to exclude pests.	X	X	X		X	X	X		X	X		Pg. 5
2.2 Clean mechanical equipment to prevent the spread of soil-borne pests and pathogens				X			X	X	X	X	X	Pg. 6
2.3 Make sure all stock you receive is clean in order to exclude pests and pathogens. Create an isolation area to store new stock.	X	X	X	X	X	X	X	X	X	X	X	Pg. 6
2.4 Plants collected from the wild could carry pests and pathogens. Self-propagation of new plants can prevent introductions.	X	X	X	X	X	X	X	X	X	X	X	Pg. 6
2.5 Visually inspect all incoming stock; Inspect before shipping and upon receiving shipments.	X	X	X	X	X	X	X	X	X	X	X	Pg. 7
2.6 Monitor high risk plants on borders and be aware of nearby nursery pest status	X	X	X	X	X	X	X	X	X	X	X	Pg. 7
2.7 Treat plant wounds to prevent infection/infestation. Pretreat plants before taking cuttings								X		X		Pg. 7
2.8 Minimize contact of branches and soil and keeps areas clear around stock to keep pest from climbing plants											X	Pg. 7
2.9 Training is available for many pests and diseases which will help employees recognize and manage problems	X				X					X		Pg. 7
2.10 Treatment timing can be determined for many pests and diseases using Degree-days	X	X	X									Pg. 7

3.0 Trapping and Monitoring												
	LBAM	EGVM	BMSB	BB	GWSS	ACP	DRW	RPW	RIFA	P.r	EBGS	
3.1 Conduct a trapping and detection program using yellow sticky traps					X	X		X				Pg. 8
3.2 Beat/tap sampling			X	X	X	X						Pg. 8
3.3 Sweep net monitoring			X	X	X	X						Pg. 8
3.4 Black light traps			X									Pg. 8
3.5 Trapping and detection using pyramid traps and emergence traps				X			X					Pg. 8
3.6 Tissue and soil sampling		X								X		Pg. 8
3.7 Monitoring and detection using pitfall traps								X	X		X	Pg. 9
3.8 Monitor using cover boards											X	Pg. 9
3.9 Vacuum sampling						X						Pg. 9
3.10 Take bioacccoustic measurements to determine infestations of trunks												Pg. 9
3.11 Use vane traps								X				Pg. 9
3.12 Pheromone traps	X	X	X					X				Pg. 9
4.0 Minimizing Spread												
	LBAM	EGVM	BMSB	BB	GWSS	ACP	DRW	RPW	RIFA	P.r	EBGS	
4.1 Isolate infested plant material	X	X					X	X		X		Pg. 9
4.2 Remove and destroy infested/diseased nursery stock	X	X			X	X		X		X		Pg. 10
4.3 Defoliate and destroy leaves if an infection is suspected	X											Pg. 10
4.4 Remove potential hosts from the landscape			X	X	X	X				X		Pg. 10
4.5 Wash and/or sanitize shoes, equipment, and hands after entering an infected area									X	X	X	Pg. 11
4.6 The use of fabric mulches to prevent pupation and emergence of insects with life stages in the soil							X					Pg. 11
5.0 Treatments												
	LBAM	EGVM	BMSB	BB	GWSS	ACP	DRW	RPW	RIFA	P.r	EBGS	
5.1 Spot treatment with pesticides	X	X	X	X	X	X	X	X	X	X	X	Pg. 11
5.2 Use commercial biological control agents	X		X	X		X	X	X	X		X	Pg. 12
5.3 Mating disruption	X	X										Pg. 12
5.4 Baits	X								X		X	Pg. 12
5.5 Chemically treat susceptible plants before taking cuttings										X		Pg. 12
5.6 Manual removal											X	Pg. 12

CANGC 2010 SCBGP Grant Science Advisory Committee

Name	Representing	Participation
David Fujino	California Center for Urban Horticulture	grant principal investigator
Linda Dodge	Plant Sciences Dept., UC Davis	grant project manager
Michael Colvin	Pest Exclusion Branch; Nursery, Seed and Cotton Programs, California Dept. of Food and Agriculture	Regulatory Representative
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John Seeger	Four Winds Growers	Stakeholder
Mary Helen Seeger	Four Winds Growers	Stakeholder
Karen Suslow	Hines Growers LLC (now at NORS-DUC)	Stakeholder
Roger van Klaveren	Generation Growers	Stakeholder

Use of Scouting as a Pest Management Practice by California Nurseries

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Photo Source: UCCE Santa Cruz

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Introduction

Scouting is a fundamental practice in the management of pests and disease in California nurseries. Practically all nursery owners and managers claim they practice scouting. Although scouting may be universal, the objective of a scouting program, the scouting tasks performed, and the level of resources a nursery invests in scouting are unique decisions largely dictated by economics. For a nursery owner to consider their scouting program to be cost effective one of two beneficial outcomes or a combination of the two outcomes should occur. First, scouting efforts should sufficiently reduce the risk of lost revenue caused by pest-related scrap or quarantine. Second, scouting efforts should help minimize chemical treatment costs such that total pest management costs are lower. The purpose of this project is to use data and testimony, collected from the owners and managers of a set of California nurseries, to understand how scouting is practiced in the industry and what influences decisions about scouting. This report will identify the economic risks associated with pest and disease infestation and how scouting is used to mitigate these risks. This report will include discussions of how scouting is practiced by each nursery and the opinion of owners and managers on scouting as a pest management practice.

Case Study Participants

The evidence presented in this report was collected via survey (Appendix A) and in depth interviews with owners and managers from four independent nurseries around Northern California. The selection of participating nurseries was done so as to include operations of different production size and product diversity that reflex the diversity of the California horticultural industry. The main selection criterion was the size of the nursery as determined by the number of acres of production (Table #1).

Each of the nurseries provided information about their production and sales volume for 2012. In addition information was provided on the nursery's scouting program including the objective of scouting, the labor and non-labor resources dedicated to scouting, the level of training scouts receive and specific tasks associated with scouting. Case participants also shared information about how scouting fits into their overall pest management strategy.

Table 1: Production and Sales in 2012

	Nursery #1	Nursery #2	Nursery #3	Nursery #4
Acres of Production	230	12	9	50
Cultivars Produced	1,277	700	720	2,500
Total Gross Revenue (In $1,000)	9,750	750	951	6,100
Number Units Sold (In 1,000)	1,422	109	74	1,195

Economic Risks of Pests and Diseases

Damage or unsold product, or scrap, is a fact of life for California nurseries and in some years can be quite high. For example, Nursery #1 and Nursery #2 had production scrap that equaled over 50 percent of the number of units sold in 2012 (Table #2). Scrapped product, both production scrap and market scrap occurs for various reasons one of which is pest and disease damage.

In economic terms scrap is equal to lost revenue. Therefore, the objective of any nursery's pest and disease management strategy is to reduce scrap, or lost revenue, caused by pest and disease damage. Given this, it was interesting that only two of the four case nurseries, Nursery #1 and Nursery #3, kept records of the amount of scrap linked to pests and disease infestations. For the other two nurseries, Nursery #4 reported pest and disease related production scrap at 5 percent of total scrap in 2012 on their survey response. When asked to verify this number during the interview the head grower for Nursery #4 stated this was a rough estimate and that they did not keep track of scrap caused by pest and disease and added "this would be good to know". Nursery #2 could provide no data as they don't keep track of the quantity or share of pest-related scrap.

Table #2 Volume of Production Scrap and Production Scrap due to Pests and Diseases in 2012

	Nursery #1	Nursery #2	Nursery #3	Nursery #4
Number units scrapped (In 1,000)	761	56.6	10.3	55.2
Share of scrap to units sold	53%	52%	14%	5%
Share scrap from pest and disease	18%	?	40%	5%
2012 quarantine	Yes (*P. ramorum*)	Yes (*P. ramorum*)	No	Yes (LBAM)

Testimony from each nursery highlights the multiple ways, including different forms of scrap, in which pest and disease infestation can cause economic loss. The first source of loss is through production scrap or the death of plants before they reach the market. The second source is damage that slows plant growth and causes a crop to miss the primary market window when customer demand is highest. This results in larger volumes of unsold product or market scrap. The third source is the loss of future sales that comes from a nursery establishing a reputation of having pest and disease issues. This form of loss can be significant for nurseries that supply customers in other states. Pests and disease issues can act as interstate trade barriers as destination states refuse to allow product to cross state lines. Finally, loss can occur due to a quarantine or complete shutdown of the entire nursery where no product can be sold or shipped due to infestation by one of several regulated pests.

Production Scrap

All nurseries expect a certain portion of production scrap when growing a crop. For example, Nursery #1, prior to the economic downturn of 2009, was starting 1,000 plants in order to have 850 plants sellable at the time of delivery. When sales were strong they would target production scrap at 15 percent. Since 2009 they have shifted their strategy to attempt to decrease production scrap. Nursery #1 monitors production scrap caused by pest and disease infestation. They expect damage from mollusks, insects, weeds, and diseases to account for 18 to 20 percent of production scrap annually. Of the four nurseries observed Nursery #1 kept the most detailed and accurate records of production scrap due to pest and disease.

Market scrap

In 2012 Nursery #3 had an incident that involved a rust infestation on a plot of 1,000 *Agapanthus africanus 'Peter Pan'* in one of their greenhouses. It was scouted one week and found to be healthy and progressing well. The following week it was re-scouted and they discovered that the whole crop was infested with a species of rust. Once discovered, the plants were pruned and a chemical fungicide was applied. The crop was saved but was a month late relative to the prime market window when demand is highest. In the end, the percentage of market scrap, or unsold product, for the crop was higher than expected. The owner estimates that pests and diseases are responsible for about 40 percent of his annual production scrap and accounted for $40,000 in lost production in 2012 but he estimates that losses in gross revenue due to market scrap were between $60,000 to $65,000 in 2012, or about 7 percent of total revenue.

Future sales

The owner of Nursery #3 emphasized the risk of lost future sales due to pest and disease problems. Using weeds as an example, it has been his experience that once a nursery establishes a reputation of weed issues onsite or spreading weeds through their product the nursery will have a tough time competing. Garden center customers and landscape professionals will not risk bringing weeds to their retail location or passing them along to their clients.

Quarantine

Two of the nurseries in the study, Nursery #1 and Nursery #2, have recently experienced quarantine due to an infestation of *Phytopthora ramorum* (*P. ramorum*).

Nursery #1 experienced a crisis in 2011 with an infestation of their camellia crop. The positive test for *P. ramorum* led to four months of quarantine for a large portion of the nursery's inventory and was very costly. In addition to lost sales the nursery was required to trace where the propagative material for their camellia crop came from and where camellias they sold went. Ultimately the nursery owners decided, due the susceptibility of camellias to *P. ramorum*, to dump their entire remaining production and not produce camellias in the future. This decision was made, in large part, due to the risk of losing future out-of-state sales due to the potential for *P. ramorum* to return.

Nursery #4 has had quarantine issues related to the Light Brown Apple Moth (*Epiphyas postvittana*) (LBAM) since it was first detected on the nursery in 2010. When LBAM first arrived the nursery had no specific management program to control it. The owner stated they were forced to "get their act together" when inspectors from CDFA started finding LBAM on the product they shipped to customers. Regulations require that once LBAM is found in an area of the nursery the owners must treat a fixed area surrounding the point of detection. If LBAM is found in more than one location they are required to treat the entire nursery simultaneously. They must spray, get re-inspected and continue this process until they are declared LBAM clean by the state inspectors. This process can take up to a week, in which time no shipments of product are allowed. Since 2010 the nursery has experienced a few instances of being shut down by CDFA inspectors due to LBAM. Management for LBAM has become a year-long effort for Nursery #3 that includes daily targeted scouting and bi-weekly chemical spraying of the entire production area. In the words of the production manager "we spray so heavy because we can't afford to be shut down for a week due to LBAM."

Scouting Objectives and Tasks

Each of the four nurseries was asked what the specific objective was with regards to their scouting program. The response was similar across all four cases; early detection of pest and disease issues leading to isolation and eradication to minimize damage. Nursery owners and managers also viewed their scouting program as a means of reducing overall pest management costs by reducing chemical treatment costs (Table #3). Chemical treatment costs in 2012 ranged from $535 per acre for Nursery #1 to as much as $3,178 per acre for Nursery #4. The high cost per acre for chemical treatments in Nursery #4 can be related directly their problems with LBAM.

Table #3 Costs per Acre of Chemical Treatments and Scouting Across Four Cases for 2012

	Nursery #1	Nursery #2	Nursery #3	Nursery #4
		In actual dollar amounts		
Chemical	318	667	722	1,905
Labor	217	625	1,778	1,273
Total chemical cost	535	1,292	2,500	3,178

Although each nursery observed had similar objectives for their scouting program the content of each scouting program was unique. For the purpose of this study we distinguish between targeted scouting, defined as specific tasks related to pest and disease detection and general or passive scouting, which consists of looking for pest and disease issues while performing other production activities.

Scouting in Nursery #1:

Nursery #1, with the largest production area of the four, divides its space into six individual divisions of around 40 acres each. Each division will be target scouted by the plant health manager, the division manager and assistant division manager. The plant health manager will scout each of the six divisions separately and rotate around the nursery. It takes him two weeks to scout the entire nursery. The division managers and assistant managers will each target scout their separate divisions independently in addition to conducting other production tasks.

None of the target scouting is conducted in a fixed pattern, rather, the nursery scouts and monitors varieties within each block based on time of year and their susceptibility to pests and disease. The plant health manager and each of the division managers document their scouting efforts using a pest disease survey (Appendix B). Each scouting survey will list the incident of pest and disease by zone, the plant variety infested, the size of the plant, the percentage of the zone infested, the type of pest and the level of infestation. The level of infestation is determined by the person doing the scouting and is reported as either trace, light, medium or heavy infestation. The plant health manager will log data from each survey into a daily pest and disease report and determine treatment schedule based on the report. For heavy infestation chemical treatments will be applied the same day as the pest is detected, or as soon as possible. For light or medium infestation the zone will be scheduled for chemical spray treatment within a week after detection.

To compliment this "targeted" scouting method the nursery has a production calendar that is a body of knowledge developed over the past 40 years. The production calendar will inform the plant health manager and division managers at what time and under what conditions they need to scout for specific pests and disease. For example, in mid-March they know to start looking for signs of aphids in the nursery. Reading the signs and understanding the production calendar determines what issues they target when scouting.

Scouting in Nursery #2

Nursery #2 has one employee that conducts target scouting every Monday specifically for pest and disease. Another employee will perform scouting tasks twice a week while also checking for irrigation problems. Other employees are trained by the owner to passively look for pest and disease problems but do not conduct targeted scouting tasks. No records or log are kept of scouting results.

Scouting in Nursery #3

The owner of Nursery #3 and his production manager each spend about two hours total per week target scouting the 10-acre nursery. They will scout from a quarter to a half-acre block at a time, looking carefully at four different points on the plants inspected. Scouting is not done in a set or mapped pattern. The decision of which block to scout is determined by what plants are within each block. The owner will first scout blocks that contain "indicator" varieties, or those varieties that are early attractors of pests and disease. For example, Star Jasmine is an early attractor of mites and aphids. The owner uses this method for early detection of both insect pests and fungal disease.

The owner also utilizes yellow sticky traps that are provided by the county agricultural commissioner for the purpose of monitoring Glassy-Winged Sharp Shooter (GWSS). A county employee will come to the nursery and place the sticky traps around the nursery at one trap per acre intervals. Although the traps are placed specifically to monitor GWSS, the owner will use the traps as an early detection tool to scout total pest activity in the nursery.

Scouting in Nursery #4

Nursery #4's current scouting program is dominated by their need to prevent and eradicate the existence of the LBAM. The nursery has one employee whose job includes targeted scouting solely for LBAM. This employee spends 50 percent of her workday scouting for LBAM. For other pests and disease such as white flies, mites and aphids, one of the two owners or one of the two employees who specialize in chemical treatment applications will target scout the nursery. The owner confessed that in some ways LBAM has "been a blessing" as it has forced them to increase overall target scouting efforts. For example, since 2010 they have had earlier detection of white flies and aphids, which the owner attributes to the added scouting for LBAM. Walking past plants, brushing plants and handling plants to look for LBAM caused white flies and aphids to become apparent. They scout the greenhouses once every two weeks for mites, aphids and whiteflies. Scouting of outside production for other pest issues occurs according to the time of year, weather and varieties.

Although each of the four nurseries scouting programs was unique some similarities are apparent. None of the four nurseries had an employee who only performed scouting tasks. Each of the four did have at least one employee whose job included some targeted scouting in addition to other duties. Each of the four nurseries also expected all other production employees to passively scout for pests and disease while performing other production tasks. Nursery #1, Nursery #2 and Nursery #3 each based their scouting strategy around a production calendar, which informed them of which pests and disease to look for at specific times during the growing season. In addition, the production calendar also informed as to which plant varieties were most susceptible to infestation and, therefore could act as an indicator plant for targeted scouting. The scouting strategy for Nursery #4 is dominated by the need to control LBAM.

Resources Dedicated to Scouting

The only cost reported by the four nurseries for scouting was labor. Each of the four nurseries provided data on the number of people and hours per week dedicated to scouting (Table #4). Nursery #2 and Nursery #4, both of which have experienced a shutdown due to quarantine, reported the most intensive scouting effort per acre. Nursery #1 and Nursery #3 reported the same scouting intensity per acre.

Table #4 Targeted Scouting Effort per Area of Production

	Nursery #1	Nursery #2	Nursery #3	Nursery #4
Production acres	230	12	9	50

Number of employees who scout	15	2	2	4
Acres per scout	15.3	6	4.5	12.5
Total hours scouting (Per week)	50	8	2	32
Weekly time spent scouting per acre (In minutes)	13	40	13	38

The difference in scouting effort by Nursery #1 and Nursery #2 is interesting given their equal experience with a quarantine event due to *P. ramorum* infestation. The goal of both nurseries would be to decrease the risk of a similar quarantine reoccurring. Nursery #1, possibly due to their large size, made the decision to reduce future infestation risk by eliminating the production of camellias, a plant variety that is popular but highly susceptible to *P. ramorum*. In contrast, Nursery #2, which is relatively small in comparison, may not have the option to discontinue the production of a popular plant variety. As one owner explained some varieties, such as camellia, fall under the category of "must have" or products that a nursery must grow to satisfy their customers. Many customers will base entire orders around these popular "must have" varieties. Therefore the owner of Nursery #2 must rely on more intense scouting efforts as a means of reducing the risk of another quarantine.

A scouting program that achieves the objective of early pest detection and isolation can reduce overall pest management costs. Successful scouting can help target smaller chemical application areas, limiting the need for nursery-wide applications and reducing chemical application costs. In each of the four cases chemical treatment costs, which include the cost of chemicals and the labor required for application, were substantially higher than the costs of scouting (Table 5).

Table #5 Costs per Acre of Chemical Treatments and Scouting Across Four Cases for 2012

	Nursery #1	Nursery #2	Nursery #3	Nursery #4
		In actual dollar amounts		
Chemicals	318	667	722	1,905
Chemical treatment labor	217	625	1,778	1,273
Total chemical treatment costs	535	1,292	2,500	3,178
Scouting cost (all labor)	157	468	347	333

When comparing just labor costs, each of the nurseries spent significantly more on labor per acre for chemical treatment of pest and disease than on scouting. In the case of Nursery #4 and Nursery #3 chemical application labor costs were approximately three to four times the magnitude of costs for scouting labor. Although there are many factors that might influence this difference one plausible reason is due to the necessity of chemical treatment applicators to be licensed and, therefore, considered skilled labor that demand a higher wage rate. Scouting, although considered an important part of pest and disease management by each case participant, is not a licensed skill that demands a higher wage.

Investment in Scouting Labor

Each of the nursery owners and managers interviewed felt that increases in scouting would be beneficial to their operations as long as the scouting was effective. For Nursery #1 the owner stated “improved efforts in scouting would help to reduce our reliance on chemical treatments for managing pest and disease. The decision to increase scouting comes down to costs. Labor is very expensive and the accuracy of our scouting is hit and miss. A worker may scout a 5,000 plant block and miss the two plants that actually have aphids on them."

The owner of Nursery #3 would also like to increase their scouting efforts but believes that investing time and effort into training his employees to do more targeted scouting would not be cost effective. Most of the people he employs have little to no formal education and few stay with the nursery for very long. According to the owner it is difficult to find employees who are motivated to be good nursery growers and, therefore, effective scouts. He would like to hire additional trained growers who better understand the nursery business and could assist in targeted scouting efforts. He is willing to pay more for trained growers but they are hard to find and equally hard to retain.

The grower manager for Nursery #4 believes that some people are naturally gifted at spotting pest and disease issues on plants. He believes that having more people who were trained to scout for pests and disease would be a benefit to the nursery but only if the individuals have the talent and desire to do the job. The owner states that even if they train someone to scout, unless the individual has an eye for spotting pest and disease issues it will be a waste of time. The owner of Nursery #4 shares his manager's belief that if they had additional people who are capable of being good pest and disease scouts they could scout the nursery faster and keep ahead of pest-related issues better.

This reluctance to invest in training is reflected by the actions of each nursery (Table 6). Although each of the nurseries claimed they provide some form of training for scouting purposes through the year, the amount of training is minimal. Nursery #1 had the highest investment in training in 2012, providing eight hours for each employee that conducts targeted scouting at a total cost of just under $3,000. The remaining nurseries had practically no training costs in 2012 and minimal time dedicated to training. With regards to the minimal time spent training, one owner stated he would definitely like more training but time is a factor and taking time out of other production activities to train is difficult.

Table #6 Investment in Training for Scouting

	Nursery #1	Nursery #2	Nursery #3	Nursery #4
Do employees receive training?	Yes	Yes	Yes	Yes
How many hours of training annually ?	8	6	4	2
Who does training?	Nursery personnel and outside source	Nursery personnel and outside source	Outside source	Nursery personnel
Training costs for 2012	2,930	0	100	200

Conclusions

The information shared by the case study nurseries in this report demonstrates that the risks of economic loss from pests and disease are high for California nurseries. Nurseries can suffer lost revenue through production and/or market scrap caused by pest damage. In some years this loss can be as high as 40 percent of annual sales volume. Nurseries that establish a reputation of pests and disease infestation risk the loss of future sales and nurseries that ship product out-of-state face the risk of trade barriers due to the presence of pests and disease. Finally, the risk of quarantine and the shutdown of a nursery's entire production from infestation due to regulated pests can cause catastrophic economic loss.

The efficient mitigation of these risks is the primary objective of any pest management strategy. The nursery owners and managers in this study recognize that scouting is a fundamental practice in achieving this objective. As one owner stated "we would never think about not scouting". How a nursery scouts and the level of investment they put into their scouting program can determine its effectiveness to overall pest management. Examining the collective information shared by the four nurseries about their scouting programs reveals some points of interest about scouting in the California nursery industry.

1) Not all nurseries keep track of how much of their annual production and/or market scrap is due to pest and disease. Without a measure of the damage and loss that comes from pest and disease it is difficult to assess the effectiveness of scouting or the overall pest management strategy.
2) The objective of scouting programs is similar across nurseries. Early detection of pest related issues which lead to isolation and rapid treatment to reduce infestation risk to the rest of the nursery.
3) It is uncommon for a nursery to have employees who are full-time scouts. Targeted scouting is conducted as part of the duties of certain employees.
4) Nurseries try to include general labor in forms of non-targeted or passive scouting, which is conducted while performing other production tasks.
5) Targeted scouting in nurseries is centered on some form of implicit or explicit production calendar.
6) Scouting labor costs are far less than chemical treatment labor costs.
7) Nursery scouts, unlike chemical applicators, are not seen as skilled labor that deserves a higher level of compensation.
8) Nurseries identify the advantage of increased targeted scouting to reduce pest risk and lower chemical treatment costs. BUT
9) There is a lack of talented employees who have the ability and knowledge to be effective scouts. To be an effective scout an

employee must have a passion for the nursery profession. AND

10) Nurseries invest very little in training their employees to be effective scouts.

Appendix A: Project Description and Survey Sent to Case Participants

Project Title: Measuring the Costs and Benefits of Scouting in California Nurseries

Project Coordinators: The University of California Agricultural Issues Center (AIC) is responsible for the research and analysis of this project. AIC serves the state of California as a forum for the identification and analysis of important issues affecting the agricultural sector. Specifically, UC AIC studies the economic implications for agriculture and agribusiness in California of issues that are or can be state, national or global in nature. A sample of our work can be accessed from our website (www.aic.ucdavis.edu).

Fellow Collaborators: UC AIC is collaborating with the California Center for Urban Horticulture, The California Association of Nurseries and Garden Centers, and The California Department of Food and Agriculture.

Purpose of the Project: This project will provide evidence of the cost and revenue implications of a California nursery including a scouting program as part of their pest management strategy. This project will use a series of case studies to examine how California nurseries practice scouting, the costs associated with these specific scouting programs and the success these scouting programs may have toward increasing revenues through decreased crop loss, improved crop quality and reduced incidence of rejected product and quarantine.

Benefit to Case Study Participants: Participants in the case study will be provided an independent analysis of their current scouting program. This analysis will identify costs associated to the current scouting program and provide recommendations to improve the effectiveness of the current scouting program.

A more effective scouting program may make a nursery more competitive by:

- Reducing pesticide cost
- Reducing labor costs associated with pesticide application;
- Reducing revenue loss from scrappage due to pest and diseases.
- Reducing REI's associated with pesticide treatments.
- Increase plant quality.

Indirect benefits can be:

- Improved worker's safety
- Less environmental impact

Information Needed from Nursery Participants: Proper analysis will require collection of information regarding participants scouting program. All information provided for this study will be shared anonymously. Any information identifying participating nurseries name and location will be kept confidential.

The following information is needed for an accurate analysis:

Information about your nursery production and sales:

What was the total gross revenue of nursery sales in the last year? ($)		
How many units of each product size **WERE SOLD** in the last year?		
Liners		
1 gallon		
2 gallon		
5 gallon		
7 gallon		
15 gallon		
20 gallon		
25 gallon		
24 inch box		
36 inch box		
48 inch box		
Other Size (Please Specify):		
How many units of production **WERE SCRAPPED** in the last year?		
Liners		
1 gallon		
2 gallon		
5 gallon		
7 gallon		
15 gallon		
20 gallon		
25 gallon		
24 inch box		
36 inch box		
48 inch box		
Other Size (Please Specify):		
What share of scrapped production was due to pest and disease damage? (%)		
Did the nursery have quarantine product in the last year? (Yes/No)		
What were your **TOP 5** selling varieties?		
Plant Variety	Container Size	Number unit Sold
1.		
2.		
3.		
4.		
5.		

General information about your nursery:

How many different cultivars did the nursery produce in the past year?	
How many acres does the nursery occupy?	
How many acres were in production in the past year?	

Information about your nursery's labor costs:

How many full time employees does the nursery have?	
How many seasonal employees did the nursery hire in the last year?	
What was the total cost for labor (salaries and benefits) in the last year?	

Information about your nursery's overall pest management strategy:

Does your nursery base application of chemicals on a pre-determined schedule or are chemicals applied when pest and disease are detected?	
If a pre-determined schedule is used what chemicals are applied? (Please list all chemicals below.)	
If applications are based on detection:	
What determines when chemical treatment is needed?	
Is there a threshold for pests that triggers a chemical treatment? (Yes/No)	
What is your action plan?	
What were your total costs for chemicals used to treat pests and disease in the past year? ($)	
What were the costs (labor and equipment) to apply these chemicals?	
Labor Costs ($)	
Equipment Costs ($)	

Information about your nursery's scouting program:

What is your nursery's objective relative to its scouting program?		
Please describe the specific tasks associated with scouting in your nursery.	How Often is Task Performed? (Daily, weekly)	Percent of nursery task is performed each time

What are the nurseries total materials costs for scouting? ($) (Include costs of sampling and measuring tools and pest identification tools)	
How many people are employed whose primary job is scouting?	
How many hours do they scout per week?	
What is the average hourly wage rate for these employees?	
How many people are employed who's primary job **<u>IS NOT</u>** scouting but conduct some scouting tasks?	
How many hours do they scout per week?	
What is the average hourly wage rate for these employees?	
Do employees receive specific training with regards to scouting? (Yes/No)	
If Yes, How many hours of training do they receive?	
Is training conducted by nursery personnel or from an outside source?	
How often does re-training occur? (Annually, monthly, etc.)	
How much did the nursery spend on scouting training in the last year? ($)	

Appendix B: Contents of Nursery #1 Pest Disease Survey (On Going Pest and Disease Log)

Location:
Division:
By:
Date:

Infestation Codes
H: Heavy
M: Medium
L: Lite
T: Trace

By	Zone	Approximate coverage of pest (percent of zone)	Variety of plant	Part of plant pest is found	Size of plant	Pest	Level of infestation	Comments	Action	Follow up

August 22nd, 2013

To: Dave Fujino
Executive Director, CCUH

Fr: Michael P. Parrella
Professor and Chair, Department of Entomology and Nematology

Re: Research report for CANGC grant

Original Research Proposal

Research was initiated to add to the arsenal of strategies that growers use to deal with invasive pests. Biological control may be one of these options. While using natural enemies alone may be not be sufficient to control an invasive species (especially one that requires regulatory action), they may be used in combination with other management tactics to reduce pests to acceptable levels. Because some of the invasive species have a soil infesting life stage, the initial focus was to look at biological control in the soil or soil-less media that growers use. Invasive pests inhabiting this media for all or part of their life cycle include the *Diaprepes* root weevil, Red Palm Weevil, the European Brown Garden Snail and the Red Imported Fire Ant. While growers may or may not be contending with these pests (depending on where they are in state), almost all have problems with fungus gnats (*Braydesia* spp.) as soil/root pests, so we used these insects as surrogates for some of the invasive species. All soil borne pests are generally difficult to work with (including fungus gnats), but there are some distinct advantages when working with fungus gnats. We were able to develop a colony of these without that much difficulty and because they are found everywhere, we do not need USDA/CDFA permits to work with them and they can be reared in any greenhouse on campus without the need of a certified quarantine facility.

We chose to work with the entomopathogenic nematodes (EPNs) *Steinernema feltiae* and *S. carpocapsae* that are commercially available and have a very broad host range. *Steinernema feltiae* is a foraging parasite and actively seeks out its prey in the soil while *S. carpocapsae* is an ambush parasite and waits for its prey to come to it. In addition, we included an evaluation of the commercially available predatory mite *Stratiolaelaps scimitus* -- this mite has a host range that overlaps with the EPNs. A concern was the possibility that there would be a negative interaction (possibly intra-guild predation) between the predatory mite and the EPNs - i.e., would the predatory mites feed on the EPNs thus reducing overall efficacy against fungus gnats? Once we established this relationship between the predatory mites and the EPNs, we should be able to confidently make a recommendation as to whether they can be used together in a biological control program in addition to getting an idea of how well they worked alone. In addition, since soil and soil-media often vary from grower to grower and from landscape to landscape, we also proposed to see if soil type would influence the success of the selected biological control agents.

What Was Accomplished Under the Proposal

Working with fungus gnat larvae and these biological control agents proved to be much more difficult than we had originally anticipated. For the past year, we have been measuring interactions between EPNs and predatory mites for control of fungus gnats in petri dish bioassays. A known number of each biological component is placed in the dish with a soil-less mix, and recovered later to be counted. We expected to be able to use changes in population sizes in the petri dishes as an indicator of predation and fungus gnat control. The challenge was extracting all three of these biological components from the samples. In addition, we initially worked with three soil/soil-less mixes: UC mix, 50% sand/50% UC mix, and 50% Monrovia bark/50% UC mix. However, do to the complexity of recovering and counting the fungus gnats and the biological control agents from the petri plates, we reduced the trial to working only with sand because it is the easiest medium to extract nematodes from. Once effective methodologies were developed, we planned to work with other soil-less mixes again.

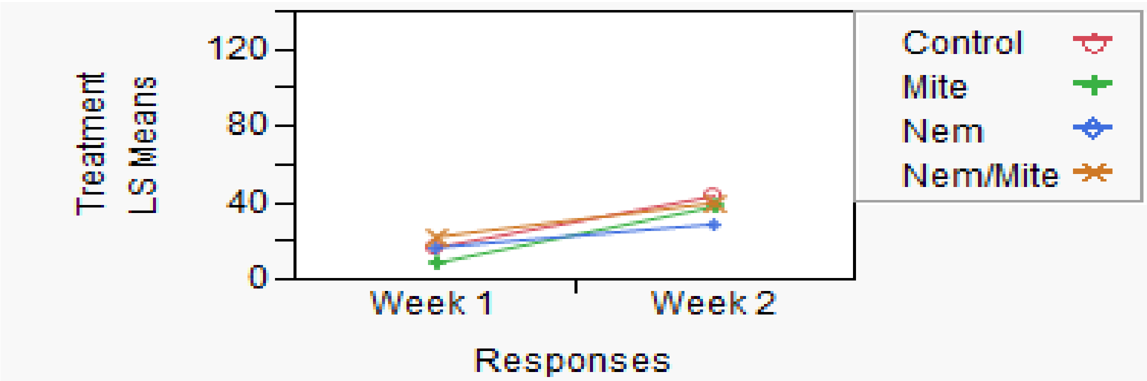
In order to recover each biological component separately, we used a series of sieves through which samples can be washed. Each of the biological components is a different size, with nematodes being the smallest and fungus gnat larvae being the largest (*S. feltiae*: 617–857 microns; *S. carpocapsae*: 500-600 microns; *H. miles:* 500 microns; fungus gnat larvae 5-9 mm). Samples are washed through a tiered sieve with three mesh sizes: a No. 80 screen to separate fungus gnat larvae from mites and nematodes; a No. 35 screen to separate mites from nematodes; a No. 500 screen to catch nematodes. Recovering *S. scimitus* proved to be the greatest challenge because it is highly mobile. Even though this was about as simple an experiment as we could construct and we could accurately count and add the biological agents to the petri dishes, we were unable to develop an effective method to extract and count them after a period of time to evaluate a treatment effect.

Therefore we moved to greenhouse trials designed to quantitatively evaluate the performance of *S. carpocapsae, S. feltiae* and *H. miles* against fungus gnats in different soil types. We simplified the experiment further by using only UC mix, and we dropped *S. carpocapsae* as a biological control agent. *Steinernema feltiae* is the better EPN to use against fungus gnats because of its searching strategy. A fungus gnat colony was maintained in small greenhouse flats in which bean plants were grown in UC mix. We assumed a uniform density of fungus gnats per unit area of soil in the flat. Soil samples (containing fungus gnat larvae) were placed in 4 inch pots. These pots were then placed in 6 x 12 inch cylindrical mesh cages. Pots were watered daily using an ebb and flow table. For the EPN treatment, one package of ENTONEM (Koppert Biological Systems) containing 50 million 3rd stage infective *S. feltiae* was mixed with 6 liters of water and 1ml of the solution was added to each pot on a weekly basis. This procedure follows the manufacturer's dosage recommendation. For the predatory mite treatment we added 10 ± 2 ml of ENTOMITE-M (Koppert Biological Systems) from a package containing 10,000 *S. scimitus* in a vermiculite carrier. This material was added (following label recommended rates) onto the soil surface of each pot at the beginning of the trial. Unlike the nematodes that were applied weekly, the predatory mites were not re-applied. Within each cage we placed a 23 cm^2 yellow sticky card; these were removed, counted for adult fungus gnats and replaced with new cards weekly for the duration of the experiment. There were five treatments in the experiment: the fungus gnat control; fungus gnats plus *S. feltiae*, fungus gnats plus *S. scimitus* and fungus gnats plus *S. feltiae* and *S. scimitus.* This experiment has only been running for a few weeks and it is too early to detect treatment differences (Figure 1). We plan to repeat this experiment and utilize biopesticides as well as the biological control agents for control of fungus gnat populations.

<u>What was not accomplished and lessons learned</u>

We were unable to complete the laboratory/petri dish bioassays due to our inability to recover the biological components of the system. However artificial this was, it would have given us a general understanding of how these natural enemies worked along and together to control fungus gnat populations and the potential influences of media type on this overall system. This forced us to move to a more general greenhouse bioassay where we let natural populations of fungus gnats develop as they will and added the biological control agents to individual pots. While this is more realistic from a grower perspective, we used adult catches on sticky cards as an indicator of successful suppression of fungus gnats. This is not as satisfying as quantifying fungus gnat larval mortality directly (as in the petri dish bioassays), but we were forced into a more general study. Unfortunately, we still had large variation in fungus gnat populations on a per pot basis, so the plan is to repeat this study guided by a precount of fungus gnat adults on a per pot basis and to use this to create blocks of pots with similar fungus gnat densities. This will allow better control of the variation across the experiment and we should be able to better detect differences in treatment means. In addition, this method will allow us to include biopesticides as treatments along with the biological control agents -- something that would be more difficult with the petri dish bioassays.

The overall advantage of this system is that it could be adapted to work with many of the invasive species with a soil dwelling stage that Californian nurserymen face. In addition, there is a commercially available product, NEMASLUG (produced by Becker Underwood) that contains the EPN *Phasmarhabditis hermaphrodita.* This EPN attacks many species of snail and slugs and is a potential biological control agent of the European Brown Garden Snail. Unfortunately, this is not available in the US at this time, but this EPN (or a related species), may become available in the future. When this does happen, we will have a bioassay system in place to evaluate this biological control agent.



Treatment

	Week 1	Week 2
Control	16.6	43.6
Mite	8.5	38
Nem	16.8	28.9
Nem/Mite	22.2	40

Figure 1. Effect of the predatory mite (*Stratiolaelaps scimitus*) alone, the entomopathogenic nematodes (*Steinernema feltiae*) alone and the combination of the two for control of fungus gnat larvae is small pot greenhouse trials.

Light Brown Apple Moth (LBAM) Detections in Nurseries* Beginning 2008 through 2012													
County	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alameda	120	3	13	5	5	10	14	25	16	5	11	6	7
Alpine	0												
Amador	0												
Butte	0												
Calaveras	0												
Colusa	0												
Contra Costa	281	3	23	19	32	40	43	40	34	22	24		1
Del Norte	0												
El Dorado	0												
Fresno	0												
Glenn	0												
Humboldt	0												
Imperial	0												
Inyo	0												
Kern	0												
Kings	0												
Lake	0												
Lassen	0												
Los Angeles	8	3		4				1					
Madera	0												
Marin	22	3	1	2	1	1	7		4	1		1	1
Mariposa	0												
Mendocino	0												
Merced	0												
Modoc	0												
Mono	2											2	
Monterey	3360	147	240	215	271	261	337	392	376	318	351	275	177
Napa	3			1		1				1			
Nevada	0												
Orange	5							2	1	1			1
Placer	0												
Plumas	0												
Riverside	0												
Sacramento	11			2	1		2	2	3		1		
San Benito	16			1	3	2		1	1		3	1	4
San Bernardino	0												
San Diego	0												
San Francisco	140	7	3	13	16	19	39	16	15	3	5	4	
San Joaquin	55		1	3	1	4	31	8	3	2	1		1
San Luis Obispo	8		1	2		1						2	2
San Mateo	490	27	37	28	26	49	54	35	49	44	50	56	35
Santa Barbara	47	1	4	7	3	3		9	8		1	3	8
Santa Clara	256	15	17	23	18	27	28	30	23	14	27	14	20
Santa Cruz	6828	467	533	514	674	650	553	668	596	516	744	520	393
Shasta	0												
Sierra	0												
Siskiyou	0												
Solano	4			1			1	1				1	
Sonoma	52	3	2	3	3	5	4	7	5	1	9	8	2
Stanislaus	0												
Sutter	0												
Tehama	0												
Trinity	0												
Tulare	0												
Tuolumne	0												
Ventura	0												
Yolo	2											2	
Yuba	0												
Total	11710	679	875	843	1054	1073	1113	1237	1134	928	1227	895	652

* Source: PDR database where Activity >8 and Situation =21, 22, or 23

Bagrada hilaris Detections in Nurseries* Beginning 2008 through 2012													
County	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alameda	0												
Alpine	0												
Amador	0												
Butte	0												
Calaveras	0												
Colusa	0												
Contra Costa	0												
Del Norte	0												
El Dorado	0												
Fresno	0												
Glenn	0												
Humboldt	0												
Imperial	0												
Inyo	0												
Kern	0												
Kings	0												
Lake	0												
Lassen	0												
Los Angeles	0												
Madera	0												
Marin	0												
Mariposa	0												
Mendocino	0												
Merced	0												
Modoc	0												
Mono	0												
Monterey	0												
Napa	0												
Nevada	0												
Orange	0												
Placer	0												
Plumas	0												
Riverside	1									1			
Sacramento	0												
San Benito	0												
San Bernardino	0												
San Diego	1										1		
San Francisco	0												
San Joaquin	0												
San Luis Obispo	0												
San Mateo	0												
Santa Barbara	0												
Santa Clara	0												
Santa Cruz	0												
Shasta	0												
Sierra	0												
Siskiyou	0												
Solano	0												
Sonoma	0												
Stanislaus	0												
Sutter	0												
Tehama	0												
Trinity	0												
Tulare	0												
Tuolumne	0												
Ventura	0												
Yolo	0												
Yuba	0												
Total	2	0	0	0	0	0	0	0	0	1	1	0	0

* Source: PDR database where Activity >8 and Situation =21, 22, or 23

Glassy-winged Sharpshooter (GWSS) Detections in Nurseries* Beginning 2008 through 2012													
County	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alameda	4			1					2		1		
Alpine	0												
Amador	0												
Butte	0												
Calaveras	0												
Colusa	0												
Contra Costa	1		1										
Del Norte	0												
El Dorado	0												
Fresno	0												
Glenn	0												
Humboldt	0												
Imperial	0												
Inyo	0												
Kern	1								1				
Kings	0												
Lake	0												
Lassen	0												
Los Angeles	11							10	1				
Madera	6							4			2		
Marin	1								1				
Mariposa	0												
Mendocino	0												
Merced	0												
Modoc	0												
Mono	0												
Monterey	0												
Napa	0												
Nevada	0												
Orange	0												
Placer	0												
Plumas	0												
Riverside	7	1		2			2			2			
Sacramento	2							1			1		
San Benito	0												
San Bernardino	2			2									
San Diego	0												
San Francisco	0												
San Joaquin	5						1	3		1			
San Luis Obispo	3	1						1	1				
San Mateo	0												
Santa Barbara	3							1			1	1	
Santa Clara	0												
Santa Cruz	0												
Shasta	1												1
Sierra	0												
Siskiyou	0												
Solano	0												
Sonoma	0												
Stanislaus	1							1					
Sutter	0												
Tehama	0												
Trinity	0												
Tulare	0												
Tuolumne	0												
Ventura	8					1			4	2		1	
Yolo	0												
Yuba	0												
Total	56	2	1	5	0	1	3	21	10	5	5	2	1

* Source: PDR database where Activity >8 and Situation =21, 22, or 23

Asian Citrus Psyllid (ACP) Detections in Nurseries* Beginning 2008 through 2012													
County	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alameda	0												
Alpine	0												
Amador	0												
Butte	0												
Calaveras	0												
Colusa	0												
Contra Costa	0												
Del Norte	0												
El Dorado	0												
Fresno	0												
Glenn	0												
Humboldt	0												
Imperial	0												
Inyo	0												
Kern	0												
Kings	0												
Lake	0												
Lassen	0												
Los Angeles	150	1		1	2	3	12	15	7	26	36	20	27
Madera	0												
Marin	0												
Mariposa	0												
Mendocino	0												
Merced	0												
Modoc	0												
Mono	0												
Monterey	0												
Napa	0												
Nevada	0												
Orange	31								1	5	16	2	7
Placer	0												
Plumas	0												
Riverside	109								18	15	34	29	13
Sacramento	0												
San Benito	0												
San Bernardino	71			1				1	3	23	32	8	3
San Diego	1												1
San Francisco	0												
San Joaquin	0												
San Luis Obispo	0												
San Mateo	0												
Santa Barbara	0												
Santa Clara	0												
Santa Cruz	0												
Shasta	0												
Sierra	0												
Siskiyou	0												
Solano	0												
Sonoma	0												
Stanislaus	0												
Sutter	0												
Tehama	0												
Trinity	0												
Tulare	0												
Tuolumne	0												
Ventura	0												
Yolo	0												
Yuba	0												
Total	362	1	0	2	2	3	12	16	29	69	118	59	51

* Source: PDR database where Activity >8 and Situation =21, 22, or 23

Diaprepes abbreviatus Detections in Nurseries* Beginning 2008 through 2012													
County	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alameda	0												
Alpine	0												
Amador	0												
Butte	0												
Calaveras	0												
Colusa	0												
Contra Costa	0												
Del Norte	0												
El Dorado	0												
Fresno	0												
Glenn	0												
Humboldt	0												
Imperial	0												
Inyo	0												
Kern	0												
Kings	0												
Lake	0												
Lassen	0												
Los Angeles	0												
Madera	0												
Marin	0												
Mariposa	0												
Mendocino	0												
Merced	0												
Modoc	0												
Mono	0												
Monterey	0												
Napa	0												
Nevada	0												
Orange	0												
Placer	0												
Plumas	0												
Riverside	0												
Sacramento	0												
San Benito	0												
San Bernardino	0												
San Diego	1									1			
San Francisco	0												
San Joaquin	0												
San Luis Obispo	0												
San Mateo	0												
Santa Barbara	0												
Santa Clara	0												
Santa Cruz	0												
Shasta	0												
Sierra	0												
Siskiyou	0												
Solano	0												
Sonoma	0												
Stanislaus	0												
Sutter	0												
Tehama	0												
Trinity	0												
Tulare	0												
Tuolumne	0												
Ventura	0												
Yolo	0												
Yuba	0												
Total	1	0	0	0	0	0	0	0	0	1	0	0	0

* Source: PDR database where Activity >8 and Situation =21, 22, or 23

Red Imported Fire Ant (RIFA) Detections in Nurseries* Beginning 2008 through 2012													
County	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alameda	0												
Alpine	0												
Amador	0												
Butte	0												
Calaveras	0												
Colusa	0												
Contra Costa	0												
Del Norte	0												
El Dorado	0												
Fresno	0												
Glenn	0												
Humboldt	0												
Imperial	0												
Inyo	0												
Kern	3											2	1
Kings	0												
Lake	0												
Lassen	0												
Los Angeles	2				2								
Madera	0												
Marin	0												
Mariposa	0												
Mendocino	0												
Merced	0												
Modoc	0												
Mono	0												
Monterey	0												
Napa	0												
Nevada	0												
Orange	10			1	2		2	1		2		1	1
Placer	0												
Plumas	0												
Riverside	61	1	1	1	2	14	27	2	1	1	4	3	4
Sacramento	0												
San Benito	0												
San Bernardino	1					1							
San Diego	0												
San Francisco	0												
San Joaquin	0												
San Luis Obispo	0												
San Mateo	0												
Santa Barbara	0												
Santa Clara	0												
Santa Cruz	0												
Shasta	0												
Sierra	0												
Siskiyou	0												
Solano	0												
Sonoma	0												
Stanislaus	1									1			
Sutter	0												
Tehama	0												
Trinity	0												
Tulare	0												
Tuolumne	0												
Ventura	0												
Yolo	0												
Yuba	0												
Total	78	1	1	2	6	15	29	3	1	4	4	6	6

* Source: PDR database where Activity >8 and Situation =21, 22, or 23

Phytophthora ramorum Detections in Nurseries* Beginning 2008 through 2012													
County	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alameda	1				1								
Alpine	0												
Amador	0												
Butte	0												
Calaveras	0												
Colusa	0												
Contra Costa	6		2	4									
Del Norte	0												
El Dorado	0												
Fresno	0												
Glenn	0												
Humboldt	7						2		5				
Imperial	0												
Inyo	0												
Kern	0												
Kings	0												
Lake	0												
Lassen	0												
Los Angeles	7	2	1	1		1	2						
Madera	0												
Marin	0												
Mariposa	0												
Mendocino	7					4	3						
Merced	0												
Modoc	0												
Mono	0												
Monterey	0												
Napa	0												
Nevada	0												
Orange	11			3	8								
Placer	1										1		
Plumas	0												
Riverside	0												
Sacramento	29			9	2	12						3	3
San Benito	0												
San Bernardino	0												
San Diego	1		1										
San Francisco	0												
San Joaquin	19			3	3	9	4						
San Luis Obispo	0												
San Mateo	0												
Santa Barbara	15			12	3								
Santa Clara	14			6	1	6						1	
Santa Cruz	3				3								
Shasta	0												
Sierra	0												
Siskiyou	0												
Solano	0												
Sonoma	1				1								
Stanislaus	9				8	1							
Sutter	0												
Tehama	0												
Trinity	0												
Tulare	0												
Tuolumne	0												
Ventura	0												
Yolo	0												
Yuba	0												
Total	131	2	4	38	30	33	11	0	5	0	1	4	3

* Source: PDR database where Activity >8 and Situation =21, 22, or 23

Pest Monitoring in Ornamental Plant Production (in English and Spanish)
July 5, 2011 San Marcos
attendance 27

Scouting and Spray Evaluation Workshop
August 23, 2011 Watsonville
attendance 40

Erosion and Pesticide Runoff Management in Nurseries
September 13, 2011 Ventura
Attendance 68

California Nursery Conference
October 6, 2011 Etiwanda (Rancho Cucamonga)
attendance 89

Effective Use of Pesticides in Ornamental Plant Production
(English and Spanish)
October 18, 2011 San Marcos
attendance 26

Biological Control in Ornamental Plant Production Symposium
January 18, 2012 San Marcos CA (includes presentations)
attendance 69

Insect ID, Scouting, Spray Evaluation, and Resistance Management
May 24, 2012 Monrovia Nursery, Woodlake CA (includes presentations)
attendance 69

Effective Use of Pesticides to Produce Ornamental Plants While Protecting Water Quality
(1/2 day English, 1/2 day Spanish)
June 5, 2012 Ventura
attendance 40 English + 15 Spanish = 55 total

Nursery and Greenhouse Runoff Treatment Workshop
August 21, 2012 UC Davis
attendance 55
Included industry trade show

Farm Water Quality Planning and Evaluation of Management Practices
September 5, 2012 Carpinteria
attendance 50

Erosion and Pesticide Runoff Management in Nurseries
September 27, 2012 Watsonville
attendance 31

Nursery/Floriculture Disease Management Symposium
October 25, 2012 Watsonville
attendance 96
Included industry trade show

Best Management Practices Programs for CA Nurseries: Review and Outlook (San Marcos)
January 9, 2013 San Marcos
attendance 45

Best Management Practices Programs for CA Nurseries: Review and Outlook (Ventura)
March 20, 2013 Ventura
attendance 57

Nursery/Floriculture Disease Management Symposium
May 8, 2013 San Marcos
attendance 61
Included industry trade show

Best Management Practices Programs for CA Nurseries: Review and Outlook (Salinas)
May 14, 2013 Salinas
attendance 42

COUNTY **in which pest / pathogen has been Reported (since 2007 or later)**

Torticid moth		Stink Bugs		Leafhoppers	Psyllids	Weevils		Ants	Phytophthora species	Snails
LBAM	EGVM	Brown Marmorated	Bagrada bug	GWSS	ACP	Diaprepes	Red Palm Weevil	Red Imported	P. ramorum	EBGS
										ALL counties
Alameda				Alameda					Alameda	Alameda
										Alpine
										Amador
										Butte
										Calaveras
										Colusa
Contra Costa				Contra Costa					Contra Costa	Contra Costa
										Del Norte
										El Dorado
										Fresno
										Glenn
									Humboldt	Humboldt
			Imperial		Imperial					Imperial
										Inyo
				Kern				Kern		Kern
										Kings
										Lake
										Lassen
Los Angeles			Los Angeles	Los Angeles	Los Angeles	Los Angeles		Los Angeles	Los Angeles	Los Angeles
				Madera						Madera
Marin				Marin					Marin	Marin
										Mariposa
									Mendocino	Mendocino
										Merced
										Modoc
										Mono
Monterey									Monterey	Monterey
Napa	Napa	Napa							Napa	Napa
										Nevada
Orange			Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange
									Placer	Placer
										Plumas
			Riverside	Riverside	Riverside			Riverside		Riverside
Sacramento				Sacramento					Sacramento	Sacramento
San Benito										San Benito
			San Bernardino	San Bernardino	San Bernardino					San Bernardino
			San Diego	San Diego	San Diego	San Diego			San Diego	San Diego
San Francisco									San Francisco	San Francisco
San Joaquin				San Joaquin					San Joaquin	San Joaquin
San Luis Obispo				San Luis Obispo	San Luis Obispo					San Luis Obispo
									San Mateo	San Mateo
Santa Barbara			Santa Barbara	Santa Barbara	Santa Barbara				Santa Barbara	Santa Barbara
Santa Clara									Santa Clara	Santa Clara
Santa Cruz									Santa Cruz	Santa Cruz
				Shasta						Shasta
										Sierra
										Siskiyou
Solano	Solano								Solano	Solano
Sonoma	Sonoma								Sonoma	Sonoma
				Stanislaus				Stanislaus	Stanislaus	Stanislaus
										Sutter
										Tehama
										Trinity
					Tulare					Tulare
										Tuolumne
Ventura			Ventura	Ventura	Ventura					Ventura
Yolo										Yolo
										Yuba

Appendix A

Events held:

- **Heartland Festival**: May 28, 2011
    - Stevinson, California
    - Double T Acres
    - 281 attendees
    - *Four workshops:*
        - *Incorporating Hedgerows and Financing for Resource Conservation*
        - *Pump Efficiency and Flow Meters*
        - *Your Stake in the Integrated Regional Water Management Plan*
        - *Farmer Roundtable: Sharing Water Management Concerns and Best Practices.*
- **Pajaro Valley Growers Water Forum**: November 29, 2011
    - Corralitos, California
    - Corralitos Grange
    - 39 attendees
    - *Pajaro Valley Community Water Dialogues (PVCWD): Watsonville California, Multiple events held, and regular emails. EFA organized the farmers from our community around local water stewardship efforts.*
- **CAFF Dry Farmed Vineyard Workshop**: August 22, 2012
    - Paso Robles, California
    - Tablas Creek Winery
    - 30 attendees
    - See Appendix E
- **EFA Video Case Studies Launch Event**: September 27, 2012
    - Santa Cruz, California
    - Patagonia Outlet
    - 70 attendees
    - See Appendix G
- **Pajaro Valley Community Water Dialogue Meeting**: October 10, 2012
    - Watsonville Civic Center
    - Watsonville, CA
    - 37 attendees
- **CAFF Dry Farmed Vineyard Workshop**: December 6, 2012
    - Watsonville, California
    - Mica Cellars Winery
    - 8 attendees
    - See Appendix F
- **California Climate and Agriculture Network's Summit (CalCAN)**: February 20 & 21, 2013
    - Davis, CA
    - UC Davis Conference Center
    - 240 attendees
    - *Farming for the Future: California Climate & Agriculture Summit*

- **California Small Farms Conference**: March 10-12, 2013
    - Fresno, CA
    - Radisson Hotel and Conference Center
    - 500 attendees
    - *Booth and videos on loop as well as announcement during water management presentation.*
- **Multi Cultural Exchange for Sustainable Agriculture (MESA)**: March 27, 2013
    - Hidden Villa
    - Los Altos, CA
    - 58 attendees
    - *Spring Orientation Event for 2013 MESA Stewards: international farmers and food justice activists from Peru, Ecuador, Ghana, Thailand, Sri Lanka, Mexico, France and Georgia.*
- **Collaborative Regional Alliance for Farmer Training & Education (CRAFT)**: April 11, 2013
    - Love Apple Farms
    - Santa Cruz, CA
    - 15 attendees
    - *Training event and mixer for Santa Cruz farming apprentices.*
- **Pajaro Valley Community Water Dialogue Meeting**: May 2, 2013
    - Watsonville Civic Center
    - Watsonville, CA
    - 42 attendees

EVENT AUDIENCE REACHED: 1,320

Annual EcoFarm Conference:

- **2011 Conference: Total Attendees: 1272**
    - CA Water Policy and Agriculture (42)
    - Dry Farming for High Quality Crops (90)
    - Aquaculture (45)
    - Voices of the Klamath Basin (17)

- **2012 Conference: Total Attendees: 1754**
    - Pond Design and Management (45*)
    - Advanced Irrigation Monitoring (50*)
    - CAWSI coordinated:
        - Water Biometrics (38*)

- **2013 Conference: Total Attendees: 1658**
    - EFA coordinated:
        - New Ag Order (22)
        - Pajaro Valley Community Water Dialogues (12)
        - Dealing With Problem Water (20)
        - EFA Video Case Studies (32)

        - EFA Exhibitor Booth (in tent where all attendees visited)
    - CAWSI coordinated:
        - From Storage to Retention: Working Landscapes for Water Storage (55)

* indicates that we do not have the data, but are including our best estimate from what we do know.

<u>AUDIENCE REACHED IN SPECIFIC WORKSHOPS, FORUMS AND EVENTS: 1320</u>

<u>AUDIENCE REACHED THROUGH ALL OF ECOFARM: 4,684</u>

<u>TOTAL AUDIENCE REACHED THROUGH PRESENTATIONS AND ECOFARM: 6,004</u>

Appendix B

Highlights of survey feedback include:

***"Please expand on which aspect of the 'Water Stewardship curriculum' site was most useful to you
and why."***

- "The video case studies brought this topic to life and demonstrated the viability of the water stewardship techniques/strategies highlighted on the web site. Equally important was the Curriculum Companion Guide because it provided details/easy reference about each case study."
- "The videos were well made, informative, and combined with an easy to read details of the process of water conservation, which made it easy to understand and visualize as a real thing you too can do!"
- "I don't have a lot of knowledge on this subject - I like the blog and companion guide the most, since they are good for people like me who want to learn more."
- "Video case studies are well produced, with a combination of beauty and personal stories and bullet points of practical step by step information."
- "The videos were most useful because they caught my attention and gave me a good amount of information in a short amount of time. Also, the blog kept me abreast of what Water Stewardship has going on in the local community, which is useful."
- "These are good resources as they offer full video and audio to explore in my own way and let me make judgments with full context of a presentation, and many of these are high quality presentations."
- "Audio is great because I can listen while I work."
- "The videos were most useful because they caught my attention and gave me a good amount of information in a short amount of time. Also, the blog kept me abreast of what Water Stewardship has going on in the local community, which is useful."
- "I really like the blog, its more of a personal connection than the other sites, although all useful, I enjoy the blog most."
- "Most of the farmers I know are super busy so their time is valuable and gathering info needs to be both efficient and compelling in that the value needs to be obvious up front. I loved the case studies because they were practical and informative, concise and visual. I learned a lot in small bites of time."

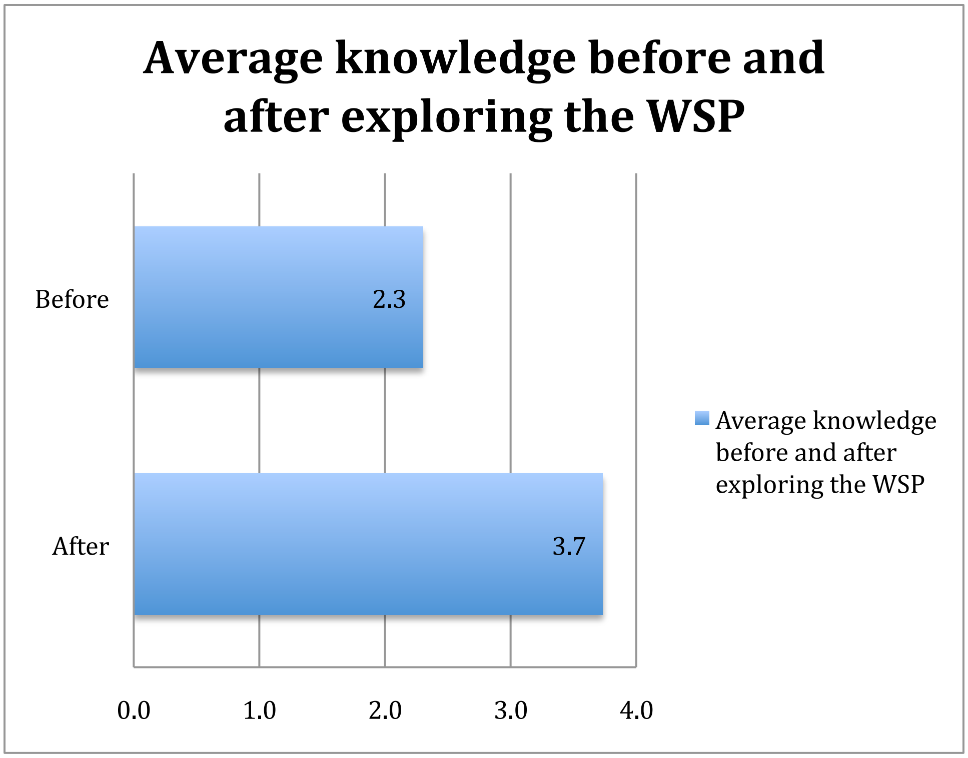
EFA is encouraged that participants have considered improvements in the following areas, all of which point to project expansion in new arenas! This shows us that our work is relevant and could be expanded into the future.

What could we add to the Water Stewardship Project site or materials to make them more useful?

- “More detailed case studies from various regions of CA such as desert, seaside, and high altitude.”
- “More downloadable talks.”
- “More reading materials/handouts.”
- “Emphasize the most accessible tools and processes for everyone, regardless of income or grant eligibility.”
- “Maybe more information about how to access the resources for funding to implement these types of systems. How accessible is this funding really?”
- “Not sure if this is a new site, but it's new to me. How can this be promoted more? Very good information.”
- “I would like to see more about how this water conservation project will impact urban farmers.”
- “This is an awesome site. The video case studies are very informative. I would love to see this sort of content for all aspects of small farming-bedding up strawberries, flame weeding, cover crops incorporation etc etc etc.”
- “More video case studies to show different tactics for each category of water saving practices.”
- “It looks great! This is very seriously needed.”

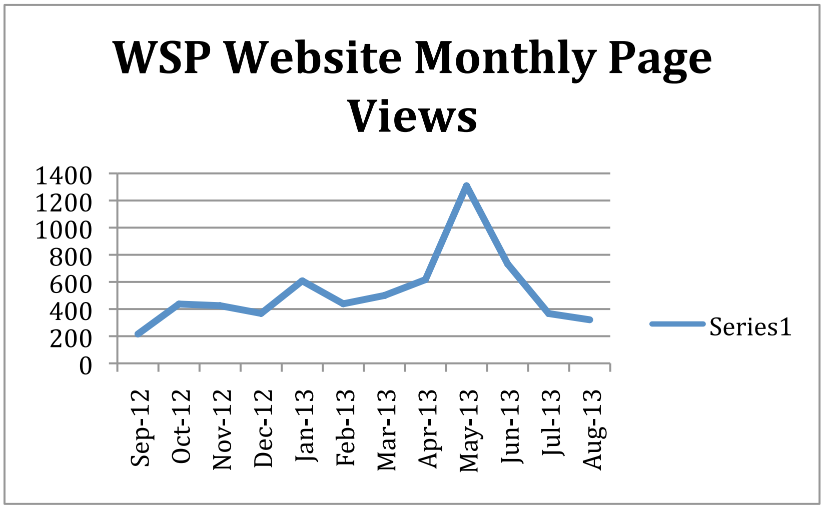
Appendix C

WSP = Water Stewardship Project



Scale: 1 = Not well-informed, 5 = Well-informed
Number of respondents = 82

Appendix D



The Water Stewardship Project (WSP) website has the following facets:

- Six Case Studies of farmers describing best management practices on farm ponds, dry farming, precision irrigation, rainwater catchment & water recycling, keyline design, and water reuse and methane digestion.
    - Highly accessible and appealing videos, featuring one farm per practice
    - Detailed Descriptions of each farm's system
    - Image Galleries for each farm
- The "Recharge" Blog
    - Monthly feature from NRCS
    - News, event updates, and other timely resources
    - Other guest contributors
- Curriculum Companion Guide with detailed descriptions of each BMP and flow arrows for ease of understanding in a graphic.
- Ten Audio Files from EcoFarm 2011, 2012, and 2013 water workshop tracks. Specifically:

2013 EcoFarm Conference Workshops
1. Working Landscapes for Water Storage
2. Approaches to Dealing with Problem Water for Organic Farmers
3. Pajaro Valley Community Water Dialogues: A Model for Collaboration
4. The New Ag Order

2012 EcoFarm Conference Workshops
5. Ecological Pond Design and Management
6. Advanced Irrigation Monitoring

2011 EcoFarm Conference Workshops
7. CA Water Policy and Agriculture: What You Need to Know
8. Dry Farming for High Quality Crops
9. Aquaculture: Farming in Fertile Waters
10. Voices of the Klamath Basin: Tale of a Battle Over Water

- A highly visible link to a partner project: The Ag Water Stewardship Resource Center
- Funding and Technical Assistance Page that describes the related value of NRCS, RCD, and UCCE.
- Detailed Surveys requesting feedback
    - One for Farmers/Ranchers but specifying area to learn who is a specialty crop grower, another for everyone else.

the

WATER STEWARDSHIP PROJECT

A Companion Guide to
EFA's Water Stewardship Project Curriculum

www.efawaterstewardship.org

a program of the Ecological Farming Association
www.eco-farm.org

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We are proud to have partnered with many organizations and individuals to produce the Water Stewardship Project. We offer special thanks to the California Department of Food and Agriculture, California Association of Resource Conservation Districts, California Natural Resources Conservation Service, University of California Cooperative Extension, Ag Innovations Network, the Community Alliance for Family Farmers, and the Pajaro Valley Community Water Dialogues. We are grateful for the work of Adam Hain, the project videographer, and farmers Steve and Linda Butler, Dee Harley, Frank Estrada, Doniga and Erik Markegard, Joe Curry, and Albert Straus who are featured in the case studies. We also thank the EcoFarm Conference water workshop participants who provided expertise in the audio resources.

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1. INTRODUCTION

"Agricultural water stewardship—the careful and responsible management and use of available water resources—can help insulate farmers against future uncertainty in water supply, bolster food security, enhance environmental quality, and contribute to overall appropriate water management in California."

Ensuring a Secure Future for California Agriculture, June 2008

Water stewardship is key to any sustainable agriculture operation. As water becomes increasingly more expensive and inaccessible, water stewardship provides cost savings, supply security, and opportunities for farms to thrive!

The EFA Water Stewardship Project gives specialty crop farmers a hub for learning and exchanging information about water conservation. This companion guide is a print version of the curriculum found on our website (www.efawaterstewardship.org). The information in this guide is also on the website. Be sure to visit the website to access the multimedia components of this curriculum, including streaming audio and video. The Water Stewardship Project will help you effectively plan and manage your precious water resources through practical on-farm systems.

The online curriculum features video case studies; these highlight on-farm practices that can be valuable to anyone seeking to better design their water management plans. It features audio files from EcoFarm Conference workshop recordings on topics ranging from using landscapes for water storage to dry farming to advanced irrigation monitoring. The resources are another important facet of the curriculum, and they provide information about funding, assistance, and other valuable tools for farmers. The online curriculum is a great place for farmers and ranchers to learn about on-farm water stewardship practices that benefit both their business' bottom line and the long-term sustainability of their agricultural practices. Dig deeper into these curriculum components at www.efawatersewardship.org.

We hope you use this guide to find the resources to implement water conservation on your farm.

—Ecological Farming Association, 2013

The Ecological Farming Association's (EFA) mission is to nurture healthy and just farms, food systems, communities, and the environment by bringing people together for education, alliance building and advocacy. EFA offers events, resources, and services that provide farmers with information on all aspects of running an ecological farm business. Since our inception in 1981, EFA has worked to facilitate farmer to farmer education.

2. ABOUT

Water will shape the future of agriculture.
(In fact, it already has.)

The cost of water and the energy needed to deliver it are rising, and this impacts farmers across the West. Farmers across California are working on ways to use water more wisely and more efficiently. The water conservation practices featured in the Water Stewardship Project Curriculum—and this companion guide to that curriculum—hold incredible potential for providing farmers with technical support to manage and use water.

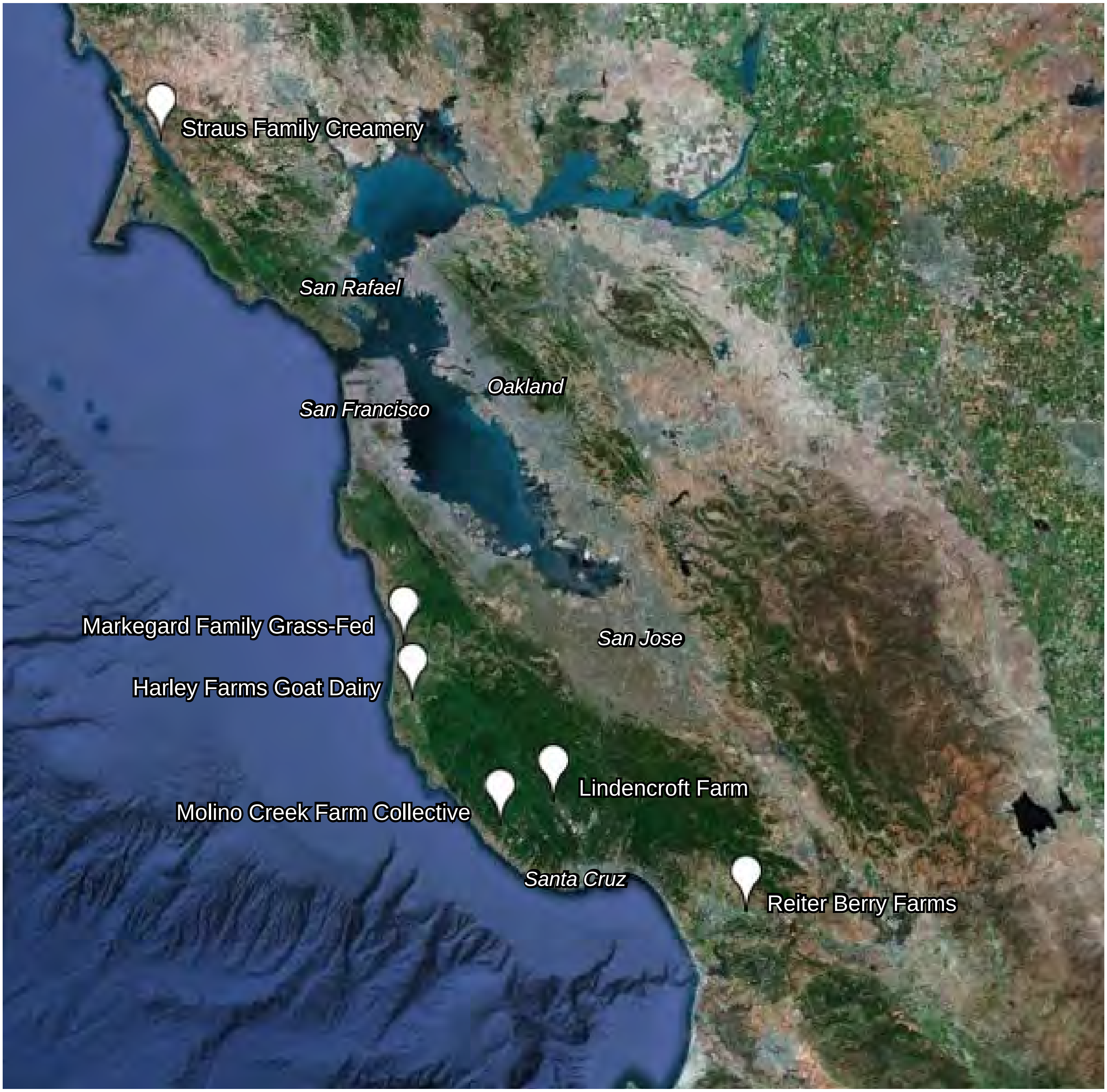
Water stewardship is not one-size-fits-all! Farmers are innovators who know their land, and many farmers have created place-based solutions that work for their unique conditions. This guide to water stewardship practices features models from a variety of agricultural systems. From low-tech to high-tech solutions, farmers can benefit from each other's ingenuity, adapt innovations to their own systems, and learn from each other.

Through the Water Stewardship Project, the Ecological Farming Association (EFA) is helping to educate farmers about implementing on-farm water stewardship practices with workshop sessions at the annual EcoFarm Conference and by bringing the food and farming community together for education, alliance building, and advocacy around our precious water resources. Conservation organizations like the National Resource Conservation Service (NRCS), Resource Conservation Districts (RCDs), the University of California Cooperative Extension (UCCE), and Ag Innovations California Roundtable on Water and the Food Supply are leading water stewardship projects that link farmers with each other, landowners, and the community. The RCD and NRCS and UCCE provide technical support and financial resources to design and adopt water stewardship techniques. The California Roundtable for Water and the Food Supply provides an online Agricultural Water Resources Center which may be very useful to farmers and others who are looking to learn more about water stewardship. Links to all of these valuable resources are aggregated by EFA and listed in this guide and online at www.efawaterstewardship.org.

The Water Stewardship Project is funded in part by the California Department of Food and Agriculture.

3. GUIDE TO WATER STEWARDSHIP PRACTICES

Each farm encounters its own water conservation challenges. These six case studies from Northern California are just some of the solutions that farmers, businesses, and others have offered from their own experiences. There is tremendous value in farmers learning from one another.



Practice 1: Farm Ponds

Ponds can be filled by rainfall and can be beneficial to irrigation water supply security on the farm. Ponds are commonly sited at a natural low point in the landscape to also collect runoff water. Ponds can be lined or un-lined.

Case Study: Lindencroft Farm, Ben Lomond, California

Lindencroft Farm captures rainwater in farm ponds and uses these man-made reservoirs to ensure that they have a secure supply of irrigation water for their specialty crops, especially during the end of the dry season when their well output decreases.

At Lindencroft Farm, Linda and Steven Butler use drip irrigation on the two acres that they farm, pulling primarily from a well that, according to Steven, "has maybe enough capacity for the farm and nothing to spare." To ensure that there is always ample water, they put in a 250,000 gallon plastic-lined pond. This pond usually fills up with the first rain of the season and provides them with about "one year's worth of irrigation insurance." The Butlers also have a second pond that handles the run off from the first. The ponds receive water from their

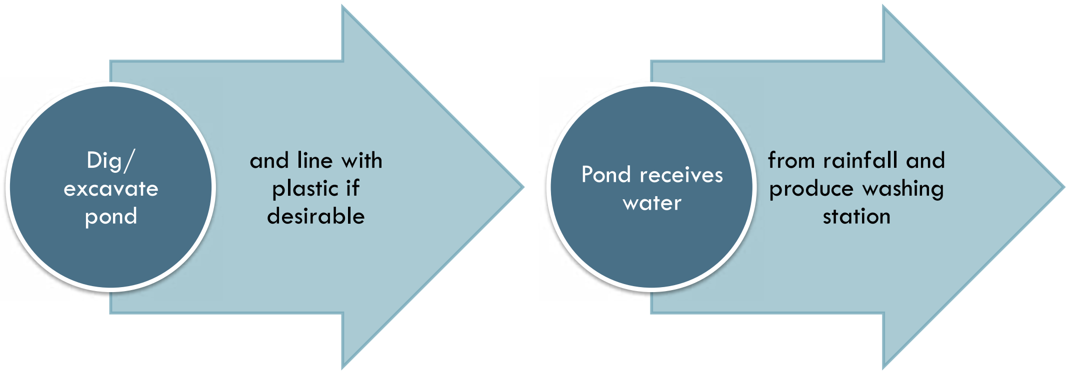


Figure 1a. Lindencroft Farm farm pond process.

produce wash station, but are filled primarily from rainwater and by rain run-off from the buildings on their property. The plastic liners for the ponds are about $6,000 each, but the rental of the excavator was the biggest expense—about $10,000, and Steven adds, "if you can avoid that cost, you can save a lot of money".

A half-horsepower submersible pump is set-up to send the water up a hill to several 5,000 gallon holding tanks. Steven can control the flow of water from the pump house. The plumbing for this system is "very straightforward," utilizing components that just about every farmer would be familiar with, such as PVC piping.

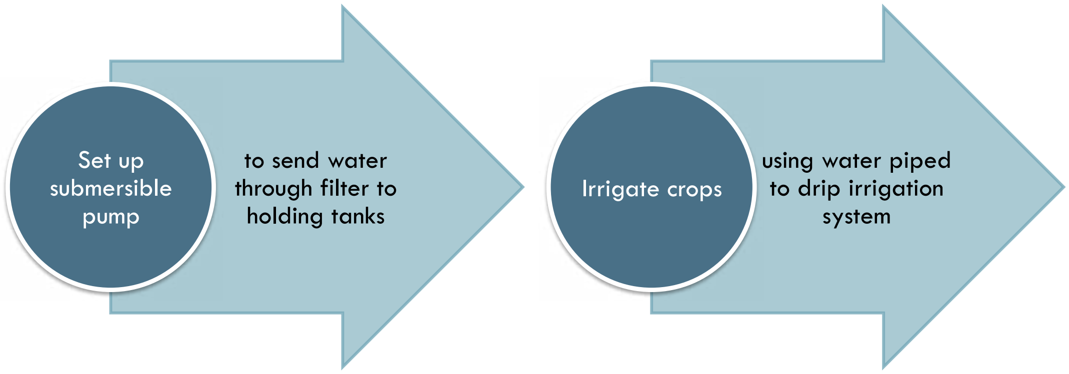


Figure 1b. Lindencroft Farm farm pond process.

Steven says, “the one thing I would do differently is put in an automatic, or semi-automatic backwashing filter.” The ponds themselves need virtually zero maintenance, but the filters can get clogged easily. Without the automatic type, it is manual labor that does this easily avoidable job.

Ecological sustainability and good systems planning is evident on Lindencroft Farm by their photovoltaic panels, farm ponds and efficient irrigation systems. Steven reflects that Ben Lomond is a good place to be a farmer and only wishes that he had gotten into agriculture sooner!

Recommended Materials

2012 EcoFarm Conference Audio: Ecological Pond Design and Management

CAWSI’s Agricultural Water Stewardship Center: http://agwaterstewards.org/index.php/practices/farm_ponds_for_irrigation/

Lindencroft Farm: http://www.lindencroft.com/

Practice 2: Dry Farming

Dry farming refers to crop cultivation where the residual moisture in the soil is used instead of irrigation. This is usually done in a region that receives twenty inches or more of annual rainfall. Dry farming works to conserve soil moisture during long dry periods primarily through a system of tillage, surface protection, and the use of drought-resistant varieties. Dry farming is more than the absence of irrigation—the soil, type of crop, regional rainfall, and types of tools must be considered.

Case Study: Molino Creek Farm Collective, Davenport, California

Joe Curry, farmer and founding member of Molino Creek Farm Collective, uses a water efficient method of raising crops—dry farming—which does not utilize irrigation at all, but instead manages the field's soil moisture prior to planting. The dry farming method saves on water and produces a smaller, more nutritious and flavor-rich tomato to be sold at market.

Molino Creek Farm Collective has been dry farming tomatoes for over thirty years. Joe Curry and the Farm Collective began dry farming because they "didn't have much water." No irrigation is used once the seedlings are in the field, which makes dry farming a great method for farmers with little access to water.

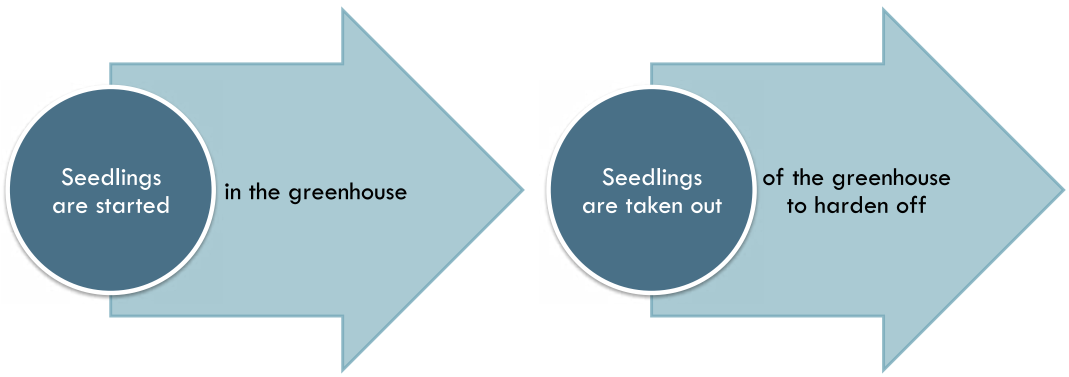


Figure 2a. Molino Creek Farm Collective dry farming process.

"Dry farming starts with managing the soil moisture," says Joe. Seedlings are grown in the greenhouse as usual, while the soil in the field is being developed to sustain tomato starts. The seedlings are taken out of the greenhouse to harden off and are soon transplanted to the field. The soil is developed so that "what fell as rain [will] stay where it is until a tomato root gets to it". The plants in field do not get their moisture from above, but rather from below—their roots must burrow down to grab the water stored in the soil six to twelve inches below the surface.

Joe tells us that “dry farming doesn’t come without its price”: the tomatoes are under a bit of stress from having to work for their water, so the resulting product is smaller in size than an irrigated tomato. They are also, however, more nutrient-rich and more flavorful than normal tomatoes, some would argue.

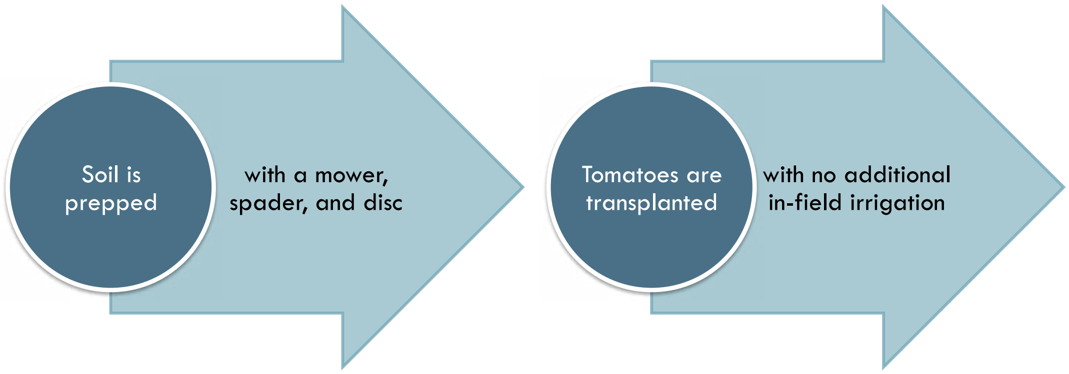


Figure 2b. Molino Creek Farm Collective dry farming process.

Dry farming has benefited the members of Molino Creek Collective by giving them a niche market before many other people were involved in dry farming tomatoes. Joe Curry describes one highlight of his career working the fields as “being able to sell food directly to the people who are going to eat it” as “an honor and a privilege.”

Recommended Materials

2011 EcoFarm Conference Audio: Dry Farming for High Quality Crops

CAWSI’s Agricultural Water Stewardship Center: http://agwaterstewards.org/index.php/practices/dry_farming/

Molino Creek Farm Collective: http://www.molinocreek.com/molino_site/tomatoes.html

Practice 3: Precision Irrigation

Soil tensiometers can read the soil moisture content at the root zone and can tell a grower how much irrigation is needed for that crop on that day. By monitoring the soil moisture, farmers can more precisely irrigate their crops.

Case Study: Reiter Berry Farms, Watsonville, California

Farm Manager Frank Estrada employs precision irrigation practices which Reiter Berry Farms has helped to pioneer with the Hortau company. This system is monitored through the Wireless Irrigation Network (WIN), a pilot project of the Pajaro Valley Community Water Dialogue.

Reiter Berry Farms has been certified organic by CCOF for fifteen years. They grow all types of berries but focus on strawberries, which take up 370 acres on eleven farms sold directly to Driscoll's Berries. Reiter has worked with Hortau technology, a tension-based irrigation monitoring system, to pioneer this method for monitoring their water use. Over the past three years, through this cutting-edge technology, they have cut water usage by an average of thirty percent.

The system works with in-field probes that read water tension in soil. "Soil tension measures how hard a plant has to work to pull the water molecule away from the soil particle," says Jeremy Otto, the manufacturer's representative for Hortau's West Coast operations.

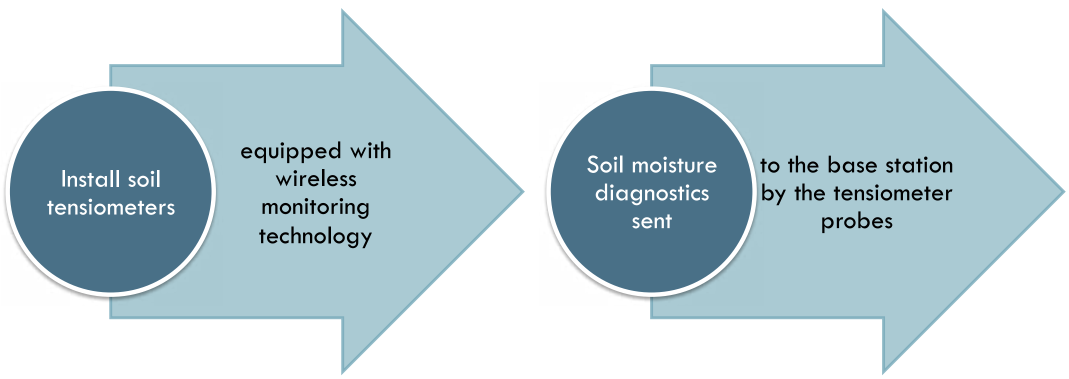


Figure 3a. Reiter Berry Farm precision irrigation process.

The wireless field probes then send tension diagnostics to the base station through cell phone networks, and the farmer uses a wireless device to monitor irrigation needs. This allows the farmer to access the information remotely in real time, and to use these precise measurements for their irrigation schedules.

To implement the system, fields are mapped to decide probe and base station locations. Then the probes and base station are installed, including the probes which are buried at whatever depth the farmer wants to monitor. Reiter's Frank Estrada says "once everything is online it's as easy as having your laptop or cell phone, logging onto the network and checking your probes." Reiter has nine fields with nine probes.

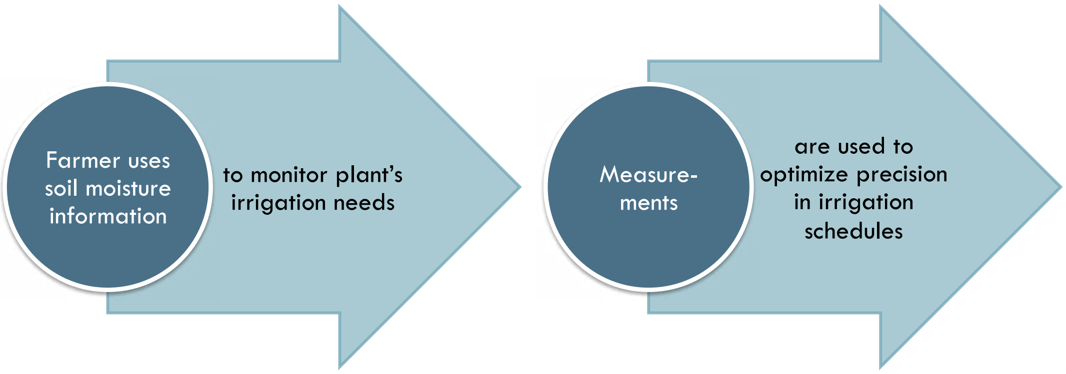


Figure 3b. Reiter Berry Farm precision irrigation process.

The Wireless Irrigation Network (WIN) is a pilot project of Pajaro Valley Community Water Dialogue that allows everyone to spend less on the install of these systems by sharing the cost. Probes are generally $800 each plus $7,100 for a base station and $197 per month for service, but in the Pajaro Valley, it is $150/month to join the WIN project. WIN offers a network of base stations providing broad coverage. When farmers buy into the WIN network, they avoid the initial base station cost. The Pajaro Valley aquifer has been in overdraft since about 1950 according to Kelley Bell of Driscoll's Berries. Bringing precision to the equation of farming in this region has started to create a ripple of positive change to the aquifer management issues in the region.

Recommended Materials

2013 EcoFarm Conference Audio: Pajaro Valley Community Water Dialogues: A Model for Collaboration

2012 EcoFarm Conference Audio: Advanced Irrigation Monitoring

Driscoll's Sustainability: http://www.driscolls.com/about/sustainability

Hortau: http://www.hortau.com/

Pajaro Valley Community Water Dialogues: http://www.pajarowatershed.org/Content/10111/CommunityWaterDialogue.html

Practice 4: Rainwater Catchment & Water Recycling

Rainwater catchment is the act of collecting water before it reaches an aquifer. Rainwater can be collected off of a rooftop or in a natural drainage area. The water can be held in a tank or cistern to be used for any number of uses the farmer may require.

Water recycling can be implemented in different ways: you can recycle municipal water, agricultural wastewater, or gray water. The California Water Recycling Criteria allow the use of recycled wastewater for irrigation of all types of food crops. The greatest hurdle to the use of recycled water is distance from the water source, so having on-site agricultural wastewater recycling may be very preferable.

Case Study: Harley Farms Goat Dairy, Pescadero, California

Owner Dee Harley captures and recycles rainwater as well as water from the dairy and creamery. These efforts save Harley Farms Goat Dairy 40,000 gallons of water per year and allow for the development of specialty crop production for their on-farm dinners and other events.

Harley Farms Goat Dairy serves as a great model for on-farm rainwater catchment and water recycling practices for a variety of agricultural operations. Owner Dee Harley calls water "liquid gold" and has a deep commitment to the sustainability of the farm. This is clear through her careful attention to water use and reuse. The dairy, creamery, and gardens are on site, and so are the two hundred alpine goats from whom the cheese is made.

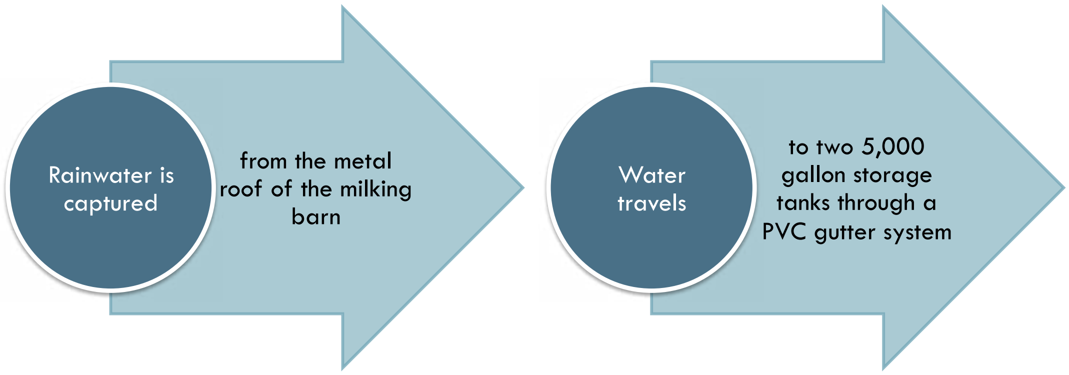


Figure 4a. Harley Farms Goat Dairy rainwater catchment process.

"To run a dairy operation, it takes quite a lot of water," says Dee. They've installed large water storage tanks to capture rainwater coming off of the metal roof of the milking barn. That captured rainwater travels directly to two 5,000-gallon storage tanks through a PVC gutter system. From there, the water is piped to thirteen different troughs for the goats to drink. The addition of the rainwater catchment system has enabled Dee to add a garden. That garden has become a place to grow specialty crops, including edible flowers, herbs, and vegetables for the farm dinners, which increases the ecological sustainability and profitability of the farm.

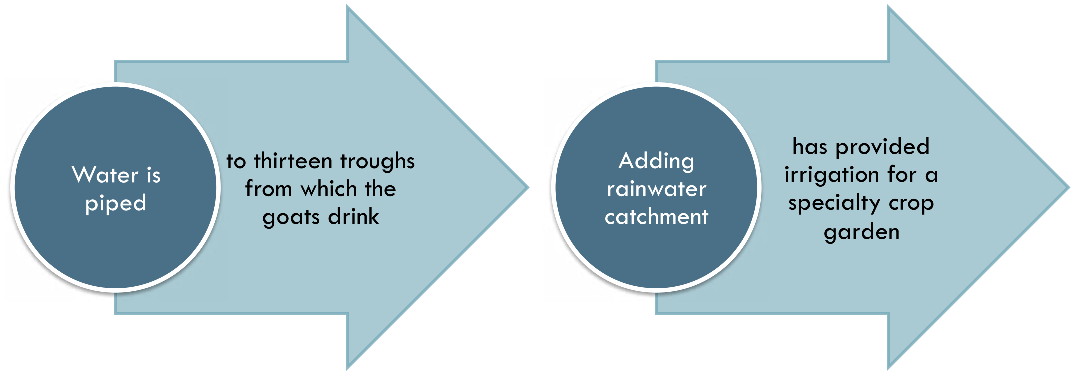


Figure 4b. Harley Farms Goat Dairy rainwater catchment process.

Harley Farms recycles its water by capturing all of the water that has already been used to clean the milking parlor, pasteurizer, and creamery and then spreading it out over the pastures as a form of irrigation. Besides an annual cleaning of the roof and drainpipes for the rainwater barrels—and some maintenance of the filtration system—the whole rainwater catchment and water recycling system takes "very little maintenance, really," according to Dee.

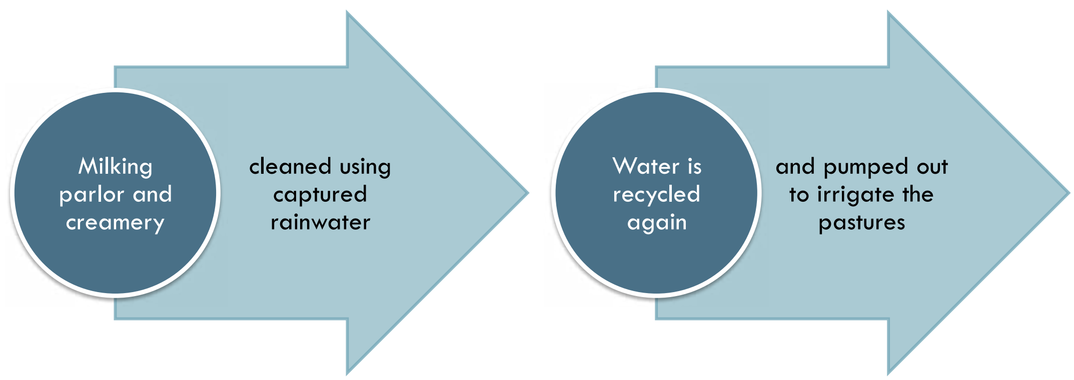


Figure 4c. Harley Farms Goat Dairy water recycling process.

Dee was able to fund these complimentary water stewardship projects through the EQIP cost-share program in partnership with the NRCS, and also through her own financing. She sees that it has been "an important partnership" because "there are always new and interesting grants and available funding for people." Her goal was to avoid drawing any water from the creek for her farm operations. These types of systems are helping farmers innovate and more intentionally use our precious water resources. Dee sees this as evidence of "thinking to the future."

Recommended Materials

CAWSI's Agricultural Water Stewardship Center: http://agwaterstewards.org/index.php/practices/reuse_of_agricultural_wastewater/

American Rainwater Catchment Systems Association: http://www.arcsa.org/index.asp

Harley Farms Goat Dairy: http://www.harleyfarms.com/index.php

Practice 5: Keyline Design

Keyline Design is a permaculture practice where topographic features are linked to the flow of water over and through a landscape. The technique was developed by P.A. Yeomans and the practice requires the use of a Yeomans plow (also known as a Keyline plow). This practice allows water to more effectively infiltrate the landscape and to be channeled into keypoint ponds.

Case Study: Markegard Family Grass-Fed, San Gregorio, California

Erik and Doniga Markegard have a 1,000 acre home ranch as well as six ranches leased for livestock. They produce grass-fed beef, grass-fed lamb, pastured pork, and pasture raised laying hens. They are excited to share how they came to promote Keyline Design strategies on their farm.

Markegard Family Grass-Fed serves as a great model for the Keyline Design to increase the sustainability of a farm. Keyline Design is a permaculture practice which slows down the movement of water over and through the land to increase absorption and percolation into the soil and water table. Doniga explains that "Keyline Design is a whole systems approach to water and land management."

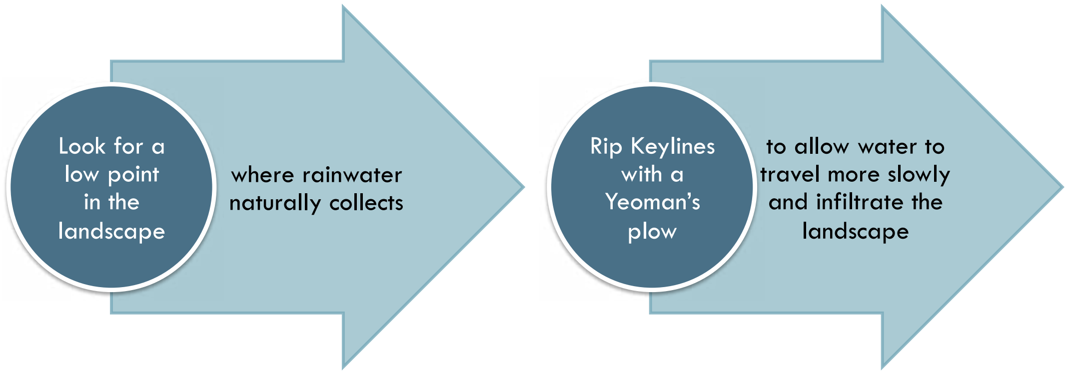


Figure 5a. Markegard Family Grass-Fed Keyline design process.

The Markegards have chosen to use this system because when Erik first came to the property, he noticed there was "a lot of surface water" on the property and "thought it would make a lot of sense to use gravity to bring water" to a central collection point. This approach lent itself perfectly to Keyline Design, because in permaculture design terms, Erik had discovered a Keypoint: a low point where rainwater naturally collects.

The water travels from the Keypoint through a Keyline channel, which is a man-made line ripped into the land by a tractor with a special Keyline/Yoeman's plow. The Keyline allows water to go deeper into the soil and move where it is directed. Doniga notes that the water "runs very slow" through the Keyline. They have used bulldozers, excavators, and "even a pick and a shovel" to implement this design technique.

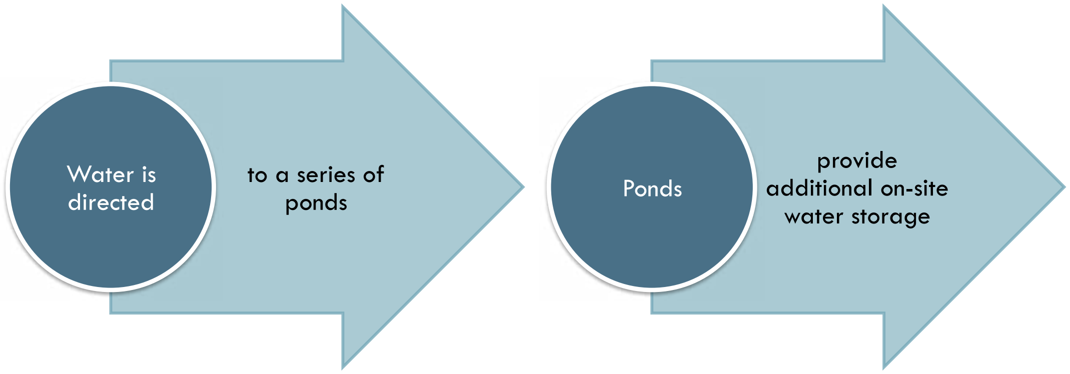


Figure 5b. Markegard Family Grass-Fed Keyline design process.

Markegard Family Grass-Fed uses this passive irrigation technique because it builds soil, increases forage production, saves electricity, and reduces runoff. Erik notes that they “use the Keyline Design instead of irrigating.” This is just one way that they are closing the loop and increasing the ecological sustainability of their ranch.

Recommended Materials

2013 EcoFarm Conference Audio: Working Landscapes for Water Storage

CAWSI’s Agricultural Water Stewardship Center: http://agwaterstewards.org/index.php/practices/keyline_design/

Markegard Family Grass-Fed: http://markegardfamily.com/watershedstewardship

Practice 6: Water Reuse & Methane Digestion

A tarp-covered pond can be used to capture methane gas as it escapes from manure, organic matter, and other sources. Dairy wastewater can be reused through custom water reclamation systems as well as a methane digestion system where energy is captured.

Case Study: Straus Family Creamery, Tomales Bay, California

Straus Family Creamery President Albert Straus has tailored his farm's energy production system. Methane digestion uses recycled water and methane captured from cow manure in this system. The methane produced from the breakdown of manure is turned into enough energy to run their whole dairy, power Albert's car, and put power back onto the grid. Now that is some powerful poop!

Straus Family Creamery serves as a great example for low-impact energy production and water reuse. Straus' President Albert Straus says they are "always trying to see how we can improve—from energy production, to minimizing our water usage." This idea is exemplified by their methane digester, which utilizes cow manure from their herds to create all of the energy that their operation needs.

The creamery reuses "about ninety-four percent" of the 3,000 to 3,500 gallons of water used per day to process the milk. Water is first used to clean equipment, then to flush the barns, and finally sent out to irrigate the fields. This is the beginning of the "closed loop system" of the energy produced by the methane digester. It begins with the reuse of water and results in energy.

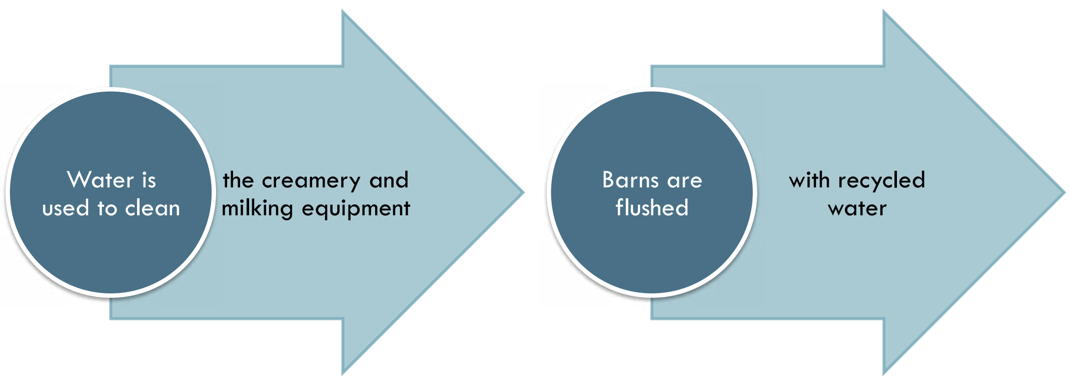


Figure 6a. Straus Family Creamery water reuse process

Once the barns have been flushed, the liquid waste is sent to the methane digester, which is a "covered lagoon"—a large pond covered by a large floating tarp. The liquid waste goes through anaerobic digestion and releases methane gas that rises up and is caught by the tarp.

The methane is then "piped into the generator, and used as fuel in the generator." It produces electricity and heats water. The methane digester produces enough energy to run the farm, power Albert's electric car and put energy back on to the grid!

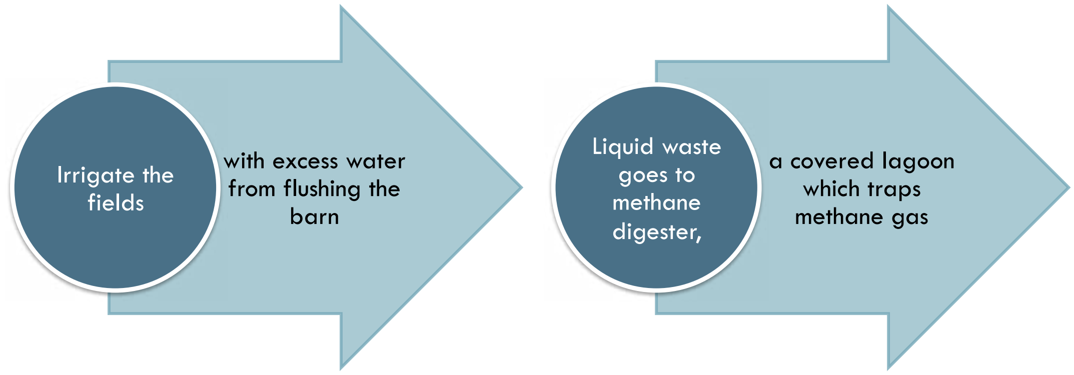


Figure 6b. Straus Family Creamery methane digestion process

This system was expensive to implement, but "government and non-profits can help offset the initial cost and get these systems in place." Straus found that his contribution to the system's installation was paid off in about "four to five years."

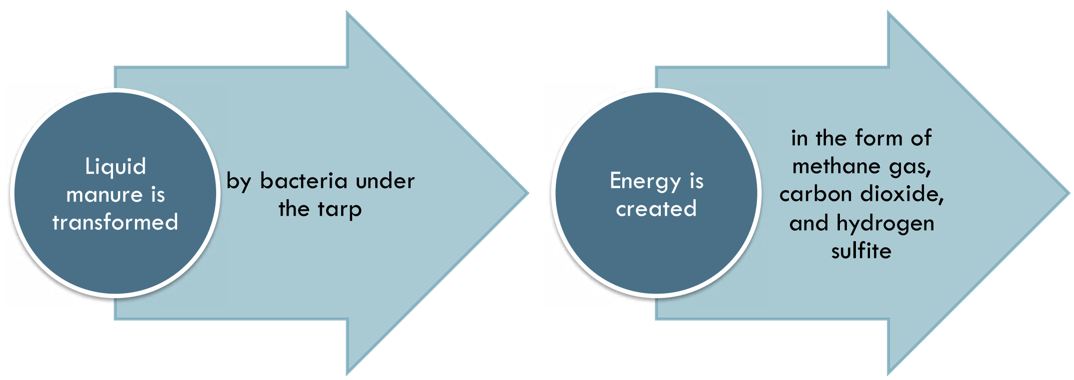


Figure 6c. Straus Family Creamery methane digestion process

There are many benefits to the methane digester system, possibly the most important of which is that it keeps methane gas—"a greenhouse gas that twenty-three times more detrimental than carbon monoxide"—out of the atmosphere. It also keeps odors down and saves a lot of money on energy bills.

As a company, Straus Family Creamery's mission has been to "sustain family farms." As long as the focus is kept on small family farms and animal welfare, Albert believes that they can.

Recommended Materials:

"How to make a methane digester," Mother Earth News: http://www.motherearthnews.com/renewable-Energy/methane-gas-production-zmaz73mazraw.aspx#axzz2PupP22e8

Straus Family Creamery: http://strausfamilycreamery.com/values-in-action

4. FUNDING & TECHNICAL ASSISTANCE

Does this curriculum get you dreaming about a project for your farm? Funding is available for water stewardship and conservation projects and there are resources that provide technical assistance and support to qualify for funding. Here are some places that can help you.

Natural Resource Conservation Service (NRCS)

The NRCS works with landowners by providing conservation planning and technical assistance in water, soil, energy, etc. to foster healthy ecosystems. They also provide funding through programs such as the Agricultural Water Enhancement Program (AWEP), Environmental Quality Incentives Program (EQIP), and other Farm Bill-funded programs.

- http://www.ca.nrcs.usda.gov/

  The NRCS has state offices across the country: if you are not in California you can connect to your state's resources through the national site: http://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/

California Resource Conservation District (RCD)

The CA RCD has 100 regional offices. Connect with your local office for funding and project opportunities.

- http://www.carcd.org/home0.aspx

  Use this page to locate RCD Offices by county: http://www.carcd.org/rcd_directory0.aspx

University of California Co-op Extension—UC Agriculture and Natural Resources

More services for your project are available through 200 locally based Cooperative Extension advisors and specialists.

- http://ucanr.edu/

  Use this page to locate offices in your county: http://ucanr.edu/County_Offices/
  Here is the directory of all ANR staff: http://ucanr.edu/sites/anrstaff/Staff_Directory/

5. APPENDICES

A. ECOFARM CONFERENCE WATER WORKSHOP AUDIO

For thirty-three years, EFA has provided the space for the food and farming community to come together around celebration and education. These EcoFarm Conference workshop audio files feature expert farmers, policy makers, planners, government employees, etc. The Water Stewardship Project Curriculum website includes the following EcoFarm Conference workshop audio files that cover aspects of implementation and on-farm water conservation practices. Listen to it all for free at **http://agwater.wordpress.com/audio/**.

2013 EcoFarm Conference Workshops

1. Working Landscapes for Water Storage
2. Approaches to Dealing with Problem Water for Organic Farmers
3. Pajaro Valley Community Water Dialogues: A Model for Collaboration
4. The New Ag Order

2012 EcoFarm Conference Workshops

5. Ecological Pond Design and Management
6. Advanced Irrigation Monitoring

2011 EcoFarm Conference Workshops

7. CA Water Policy and Agriculture: What You Need to Know
8. Dry Farming for High Quality Crops
9. Aquaculture: Farming in Fertile Waters
10. Voices of the Klamath Basin: Tale of a Battle Over Water

B. RESOURCES

*** Visit the Agricultural Water Stewardship Resource Center**

for further information about the practices featured in EFA's Water Stewardship Project

www.agwaterstewards.org

I. Ag Water Stewardship Resources

Natural Resource Conservation Service (NRCS)

The NRCS works with landowners by providing conservation planning and technical assistance in water, soil, energy, etc. to foster healthy ecosystems. They also provide funding through programs such as the Agricultural Water Enhancement Program (AWEP), Environmental Quality Incentives Program (EQIP), and other Farm Bill-funded programs.

- http://www.ca.nrcs.usda.gov/

The NRCS has state offices across the country: if you are not in California you can connect to your state's resources through the national site: http://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/

California Resource Conservation District (RCD)

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Here is the directory of all ANR staff: http://ucanr.edu/sites/anrstaff/Staff_Directory/

Ag Innovations Network—California Roundtable on Water and Food Supply

This site is a hub for news and reports in California Agricultural water use. Ag Innovation's work also identifies action and membership opportunities.

- http://aginnovations.org/roundtables/crwfs/

Occidental Arts and Ecology Center —The WATER Institute

The WATER Institute (Watershed Advocacy, Training, Education, & Research) is committed to raising hydrological literacy. The site has recommended readings, inspirational words, and is a partner in EFA's water work.

- http://www.oaecwater.org/

USDA Alternative Farming Systems Information Center—Water Conservation

This USDA site promotes "wise development, control, protection, management and use of water resources." The information center has a number of resources, which will be of practical use to farmers.

- http://afsic.nal.usda.gov/soil-and-water-management/water-conservation

Driscoll's Water Conservation and Quality

Driscoll's Berries are featured in the Precision Irrigation case study video. They are among the largest growers in the Pajaro Valley, whose aquifer has been in overdraft since the 1950's. Thus, Driscoll's takes water conservation seriously.

- http://www.driscolls.com/about/sustainability/water-conservation-quality

HORTAU Irrigation

Hortau's wireless irrigation network was featured in the Reiter Berry Farms Precision Irrigation case study video, and is an example of a water tension metering system technology that can help farmers save water.

- http://www.hortau.com/en/home/

University of California—Water Resources Collections and Archives

This website is a library of contemporary and historic materials on all aspects of water resources. This is likely not a practical resource for your on-farm projects, but its archival resources may be useful for learning about local projects and histories.

- http://library.ucr.edu/wrca/about

The Organisation for Economic Co-operation and Development (OECD)

Sustainable agriculture and water quality statistics and meta-economic and policy analyses are available through this site. Their data on broad trends and publications such as: "Water Quality and Agriculture: Meeting the Policy Challenge—Key Messages and Executive Summary" may be valuable for grant writing and beginning to make a case for worldwide water quality control.

- http://www.oecd.org/environment/wateruseinagriculture.htm

California's Water: A Crisis We Can't Ignore

The Association of California Water Agencies (ACWA), a coalition of 450 public water agencies, has launched a statewide effort to educate Californians about critical challenges now confronting the state's water supply and delivery system.

- http://www.calwatercrisis.org/

California Water Plan

The CA Water Plan is updated every five years and it presents the status and trends of California's water-dependent natural resources; water supplies; and agricultural, urban, and environmental water demands for a range of plausible future scenarios. The 2009 Update and the 2013 Update are both worth taking the time to browse.

- http://www.waterplan.water.ca.gov/

USDA Annual Phosphorus Loss Estimator

This is a tool developed by USDA scientists that can help you model phosphorus loss in runoff and determine ways to reduce these losses.

- http://www.ars.usda.gov/Services/docs.htm?docid=21763

II. Valuable Water Reports

From Storage to Retention, CA Roundtable on Water and Food Supply

- http://aginnovations.org/images/uploads/CRWFS_Storage_to_Retention.pdf

Agricultural Water Stewardship, CA Roundtable on Water and Food Supply

- http://aginnovations.org/images/uploads/CRWFS_Water_Stewardship_Recs_electronic.pdf

Principles of On-Farm Water Management, University of Florida IAFS Extension

- http://edis.ifas.ufl.edu/pdffiles/AE/AE09900.pdf

Draft Report on Quantifying the Public Benefits of Water Storage Projects, CA Water Commission

- https://cwc.ca.gov/Pages/2012/01_January/011812agenda.aspx

California Water Stewards: Innovative On-Farm Water Management Practices, Ag Innovations Network

- http://aginnovations.org/agwaterstewards.org/uploads/docs/CaliforniaWaterStewards.pdf

learn more at www.efawaterstewardship.org

The Water Stewardship Project is a program of the Ecological Farming Association

www.eco-farm.org

WATER STEWARDSHIP
on the farm

THURSDAY, SEPTEMBER 27
DOORS AT 7 PM, EVENT 7:30 PM

ECO FARM

WATER STEWARDSHIP VIDEO PREMIERE
AND ICE CREAM SOCIAL

As dramatic changes in population, drought and flooding impact water quality and availability, farmers – who use 70% of the world's fresh water – are becoming more concerned about conservation. Join us for the premiere of the Ecological Farming Association's *Water Stewardship Case Studies* video series, which profiles best practices on six organic farms in California. The evening will also spotlight Patagonia's own conservation efforts with *Our Common Waters* campaign.

After the show enjoy the Straus Ice Cream Social and taste the fruits of their labor.

Photo: Adam Hain

PATAGONIA OUTLET SANTA CRUZ 415 RIVER ST., #C 831-423-1776

RESOURCES FOR ON-FARM WATER STEWARDSHIP

Practices that improve water distribution efficiency, conservation, and supply security are vitally important to addressing our economic and ecological sustainability today and in the future.

Agricultural water stewardship is the use of water in a way that optimizes agricultural production while also addressing co-benefits for the environment and human health. Specialty crop growers have a great opportunity to lead the way in water stewardship as agriculture becomes increasingly water constrained in California.

The Ecological Farming Association's **WATER STEWARDSHIP PROJECT** provides education and outreach materials about implementing and adapting on-farm water conservation measures to a variety of agricultural systems. Currently, the Water Stewardship Project includes six video case studies featuring practices implemented by farmers in Northern California.

Turn the page to see the list of practices covered by the video case studies!

For water stewardship resources and to view the videos, visit: www.efawaterstewardship.org

This project is funded in part by a water stewardship grant from the California Department of Food & Agriculture.

Water stewardship, one farm at a time

Watch the following videos on our website, www.efawaterstewardship.org, and learn about cost of implementation, immediate and long-term benefits, and technical tips from the farmers.

Rainwater Catchment & Water Recycling

Harley Farms Goat Dairy, Pescadero, CA

Owner Dee Harley discusses the farm's water stewardship initiatives that capture and recycle rainwater as well as water from the dairy and creamery. These efforts save Harley Farms Goat Dairy 40,000 gallons of water per year and allow for the development of specialty crop production for on-farm dinners.

Water Reuse & Methane Digestion

Straus Family Creamery, Tomales Bay, CA

President Albert Straus demonstrates the farm's energy production system of methane digestion, which utilizes recycled water and methane captured from cow manure. The methane produced from the breakdown of manure is turned into enough energy to run their whole dairy, power Albert's car, and put power back onto the grid. Now that is some powerful poop!

Dry Farming

Molino Creek Farm Collective, Davenport, CA

Joe Curry, farmer and founding member of the collective, discusses the farm's water efficient method of raising crops which does not utilize irrigation at all, but instead manages the field's soil moisture prior to planting. Molino Creek's dry-farming method saves on water and produces a smaller, more nutrient flavor-rich tomato to be sold at market.

Keyline Design

Markegard Family Grass-Fed, San Gregorio, CA

Erik and Doniga Markegard have a 1000 acre home ranch as well as 6 ranches leased for livestock. They produce Grass-Fed beef, Grass-Fed lamb, pastured pork, and pasture raised laying hens. They share the techniques and benefits of Keyline Design strategies on their farm.

Farm Ponds

Lindencroft Farm, Ben Lomond, CA

Linda and Steven Butler showcase the farm's water stewardship projects which capture rainwater in farm ponds and use these man made reservoirs to ensure that they have a secure supply of irrigation water for their specialty crops, especially during the end of the dry season when their well output decreases.

Precision Irrigation

Reiter Berry Farms, Watsonville, CA

Farm Manager Frank Estrada demonstrates the farm's precision irrigation practices which they have pioneered with the Hortau company. This system is monitored through the Wireless Irrigation Network, a pilot project of the Pajaro Valley Community Water Dialogue.

View all of the video case studies and learn more at www.efawaterstewardship.org.

EFA thanks the farmers who, by sharing their farms and their techniques, made this project possible.

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Appendix A

Samples of Program Components

1) Screenshot of California Grown website in Canada:

2) Radio News Release on News Canada to announce the start of the California cherry season:

Script 1
Length: TBD
Spokesperson: Chris Zanobini

Reporter Script
"Cherries are a great local summer treat, but with such a short growing season, they are off the shelves before we even realize they're in season. The Good news is Canadians can turn south of the border to California to access more of this delicious delicacy just before local products become available. Chris Zanobini from the California Cherry Marketing and Research Board offers easy tips on how to enjoy fresh cherries."

Spokesperson Script
"Freezing fresh cherries and enjoying them slightly frozen as treats at kids' sporting events is a great way to keep them energized during the game. For the more mature taste buds, pit cherries and serve them in a lettuce salad with smoked turkey or pancetta. Fresh Bing cherries from California are also perfect in a summer fruit salad with melons, tree fruits and pineapples. Keep cherries as cold as possible, ideally at 0°C and 90-95% humidity, and enjoy the freshness up to 10 days."

Reporter Script
Cherries are a great source of Vitamin C and high in iron, potassium, dietary fiber and antioxidants. California cherries are now in season and available at your local grocery store until the end of June.

For more information on California cherries and recipe ideas, visit www.calcherry.com.

3) Targeted retailer, Thrifty Foods, participating in *California Grown* promotional funding program, running a California Asparagus flyer ad Easter week, with logo as required.

Attachment A: List of Education Materials, Resources, & Press Releases

Educational Materials:

- Education handout for winegrape growers (4 page attachment): http://www.sustainablewinegrowing.org/docs/DNDC_Handout.pdf

- SWP Metric Calculator & DNDC User Guide (10 page attachment)

- Online education video, “Reducting Greenhouse Gases with Vineyard Practices”: https://vimeo.com/70430113

Links to the two web sites developed for the DNDC work:

- WebGIS tool for querying DNDC model results and assessing mitigation options: http://winegrapes.appliedgeosolutions.com/

- DNDC meta model site that was linked with CSWA SWP metrics tool: http://dndc.appliedgeosolutons.com/metamodel/test/

Press Release:

- DNDC Press Release (2 page attachment): http://www.sustainablewinegrowing.org/articletype/4/Press_Releases.html#94

Benefiting the environment, the community and high quality grapes and wine

CALIFORNIA
SUSTAINABLE WINEGROWING
ALLIANCE

CSWA would like to thank the U.S. Department of Agriculture and the California Department of Food and Agriculture for the Specialty Crop Block Grant that helped make this project possible, in addition to the many project partners who also contributed their time and expertise.

Project Partners:

American Carbon Registry

Applied GeoSolutions

California Association of Winegrape Growers

Environmental Defense Fund

SureHarvest

University of California, Davis

USDA Agricultural Research Service

Wine Institute

DNDC Greenhouse Gas Modeling for California Vineyards

What Is DNDC?

DNDC (DeNitrification-DeComposition) is a computer model that simulates carbon and nitrogen cycling among soil, air, and crops. Because it is a process-based model, DNDC simulates the interactions among local climate, local soils, and on-site management practices to simulate crop growth and yield, and the emissions and consumption of gases within the soil environment. Gases include ammonia (NH_3) and the greenhouse gases (GHGs) carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4). Calculations by most GHG models do not account for vineyard-specific interactions, and instead rely on constant emission factors or simple empirical relationships. Thus, process-based GHG models are presumed to provide more realistic simulations because they simulate the mechanisms that drive emissions.

Why is DNDC Needed for the California Wine Industry?

For more than a decade, the California wine industry has promoted sustainable practices through the California Sustainable Winegrowing Program (SWP; www.sustainablewinegrowing.org) and regional activities. Most efforts to date have involved growers and vintners assessing their use of management practices that have been determined to be more sustainable by peers and experts. In spring 2012, the California Sustainable Winegrowing Alliance (CSWA) expanded the SWP to include performance metrics for energy, water, and nitrogen use, and GHG emissions. Calculating and linking metrics with practices helps practitioners “measure to manage,” to reduce input costs and risks (environmental and production), and potentially benefit from market and regulatory incentives.

Although the wine industry has identified GHG metrics as important, minimal research has been conducted to quantify soil-related GHG

California Vineyard Climate Change Projects

Vineyard Management Practices and Carbon Footprints Grower Handout

A short summary of the key management practices that influence carbon sequestration and GHG emissions in the vineyard.

www.sustainablewinegrowing.org/docs/GHGhandout.pdf

California Vineyard Greenhouse Gas Emissions: Assessment of the Available Literature and Determination of Research Needs

A summary report of a literature review used to determine what was known about California vineyard GHG production and sequestration potential. The report also provides a strategic plan to prioritize research to advance understanding of the influence of vineyard management practices on GHG emissions.

www.sustainablewinegrowing.org/docs/GHGreport.pdf

DNDC simulates the interactions among local climate, local soils, and on-site management practices to simulate crop growth and yield, and the emissions and consumption of gases within the soil environment.

emissions and carbon sequestration in California vineyards. Because of this, and prior to application of DNDC modeling, calculations of GHG metrics for California vineyards used unrefined emission factors for soil processes or only considered emissions from energy use. Nevertheless, to increase grower awareness and begin influencing on-the-ground actions, key practices expected to mitigate soil-related GHG emissions and enhance carbon sequestration were highlighted in a grower handout. DNDC enables the California wine industry to more accurately and completely quantify vineyard GHG emissions and carbon sequestration.

How Has DNDC Been Modified for California Vineyards and Linked to the SWP Online System?

Modification of the DNDC model involved calibrating it to account for the growth, development, and fate of above- and below-ground plant tissues (vine and cover crop) based on interactions among climate, soils, and management practices. After calibration, the model was validated by comparing field-collected data to modeled results for soil temperature and moisture, vine growth, and GHG emissions.

The full California vineyard DNDC model is a powerful tool for quantifying the effects of management practices on GHG emissions. Its application, however, requires extensive knowledge and data inputs. To increase the usability by growers while retaining sufficient accuracy for educational purposes, a simplified version has been linked to the SWP online system. This version limits the data inputs for practices to those having the greatest impacts on soil-related emissions and carbon sequestration (row spacing, type of tillage, use and type of cover crop, amount of compost, and amount of nitrogen applied as fertilizer). Results help growers understand relationships between key practices and emissions, and how to improve. The full DNDC model also has the potential to be used to simulate results for other practices or circumstances requiring the highest level of accuracy (e.g., for saleable carbon offsets).

How Does DNDC Function Within the SWP Online Framework?

The Metrics Calculator within the SWP online system is used to provide inputs to the simplified DNDC model that subsequently returns estimates of N_2O emissions, change in soil carbon content (CO_2 emissions minus carbon sequestered), and the total of soil-related GHG emissions for the year simulated. Inputs needed are selected within the Metrics Calculator (location, tillage practices, cover cropping, row spacing, fertilizer and compost amounts, etc.) and run through the simplified model. The model integrates the selected management practices with historical climate information via the nearest CIMIS station and soils data via the NRCS Soil Survey for its calculations. DNDC results are then combined with Metrics Calculator results for GHG emissions from fuel use and purchased electricity to provide cumulative GHG metrics (CO_2 equivalents per acre and per ton of yield).

SWP participants can access the Metrics Calculator User Guide from the SWP online system homepage for more details about how to use the Calculator and its DNDC application.

What Are Potential Future Uses of the DNDC Model for Winegrapes?

The DNDC model offers one of the most promising, cost-effective and accurate ways to estimate GHG emissions in agricultural ecosystems, which is why its use has increased over the past two decades. The model has been calibrated for over 40 crops, including corn, rice, wheat, grapes, tomato, pasture, and almonds in locations from India to Belgium to Costa Rica to the United States. Application of the model is supporting the development of offset protocols for cap-and-trade markets and voluntary supply chain initiatives.

California's cap-and-trade system provides some agricultural producers with the opportunity to generate additional revenue for practices that are not yet widely adopted and that reduce overall GHG emissions through a voluntary carbon market. Winegrape growers may be able to participate in this market by aggregating carbon offsets. Since the DNDC model has been calibrated and validated for California winegrapes, an important step in the development of carbon offset protocols for winegrapes has been achieved.

California Vineyard Climate Change Projects

Sustainable Winegrowing Performance Metrics Calculator

A user-friendly online tool for California growers and vintners to measure and track their use of energy, water, nitrogen and GHG emissions. Knowing and understanding the relationship between management practices and measured outcomes is important for benchmarking and managing performance to optimize business operations, decrease costs, and conserve natural resources.

https://metrics.sustainablewinegrowing.org/

Use the New DNDC Online Tool to Calculate Your Vineyard GHG Emissions

DNDC Tool Inputs:

- Vineyard location
- Row spacing
- Tillage practices
- Use and type of cover crop
- Amount of compost
- Amount of nitrogen applied as fertilizer

https://metrics.sustainablewinegrowing.org/

DNDC stands for DeNitrification and DeComposition, two processes dominating losses of N and C from soil and GHG emissions into the atmosphere.

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San Francisco, CA 94105
415.512.0151
www.wineinstitute.org
communications@wineinstitute.org

Additionally, retailers, food producers, and agricultural trade groups are developing and implementing GHG measurement and reduction initiatives for the food and beverage supply chain. Initiatives include The Sustainability Consortium and the Stewardship Index for Specialty Crops. A key goal is to encourage growers, processors, and other businesses within the supply chain to measure the impacts of their practices on GHG emissions and natural resources.

Use of the SWP online Metrics Calculator and its integration with the DNDC model can help California winegrape growers participate in supply chain initiatives and – in the future – potentially benefit from cap-and-trade markets by calculating and tracking GHG emissions.

About the California Sustainable Winegrowing Alliance

The California Sustainable Winegrowing Alliance (CSWA) is a San Francisco-based 501(c)3 non-profit organization created in 2003 by Wine Institute and the California Association of Winegrape Growers to promote the adoption of sustainable winegrowing practices and enlist industry commitment through the implementation of the Sustainable Winegrowing Program (SWP). In addition to this DNDC handout, CSWA has a number of additional resources available on its website. To view CSWA educational videos, including videos on Performance Metrics and DNDC, visit http://www.sustainablewinegrowing.org/CSWA-video.php. For more information and a calendar of upcoming CSWA workshops, visit www.sustainablewinegrowing.org/workshopcalendar.php.

CSWA promotes sustainability through continuous improvement with the implementation of best practices, but also recognizes that not all practices are relevant or appropriate for every operation. CSWA strives to provide information and resources to help growers and vintners make the most sustainable decisions for their individual operations.

SWP Performance Metrics Calculator & DNDC Tool User Guide

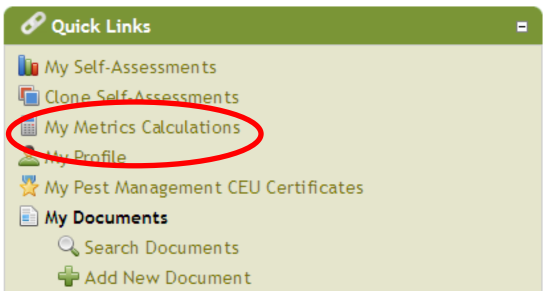
These instructions will help you use the SWP Metrics Calculator to track performance metrics for vineyards and/or wineries. Metrics can be calculated for use of energy (vineyards and wineries), water (vineyards and wineries), and nitrogen (vineyards), and for emissions of greenhouse gases (GHGs). Tracking metrics and practices used over years can help determine which practices have the most impact on specific metrics for your operation.

Getting Started

Log into the SWP application as you would when doing a self-assessment of vineyard/winery practices.

Once logged in, you will see the Quick Links section on the Home page.

- Click “My Metric Calculations.”



Your organization’s structure and individual vineyards and/or wineries are displayed.

- Click on the vineyard/winery that you want to calculate metrics for.
- Select the Assessment Year that you will be working on.
- Click on the Metrics tab to go to the Metrics Summary page.

The Metrics Summary page shows results of any calculations already done. This page is also the "gateway" to the Metrics Center which houses the Metrics Calculator.

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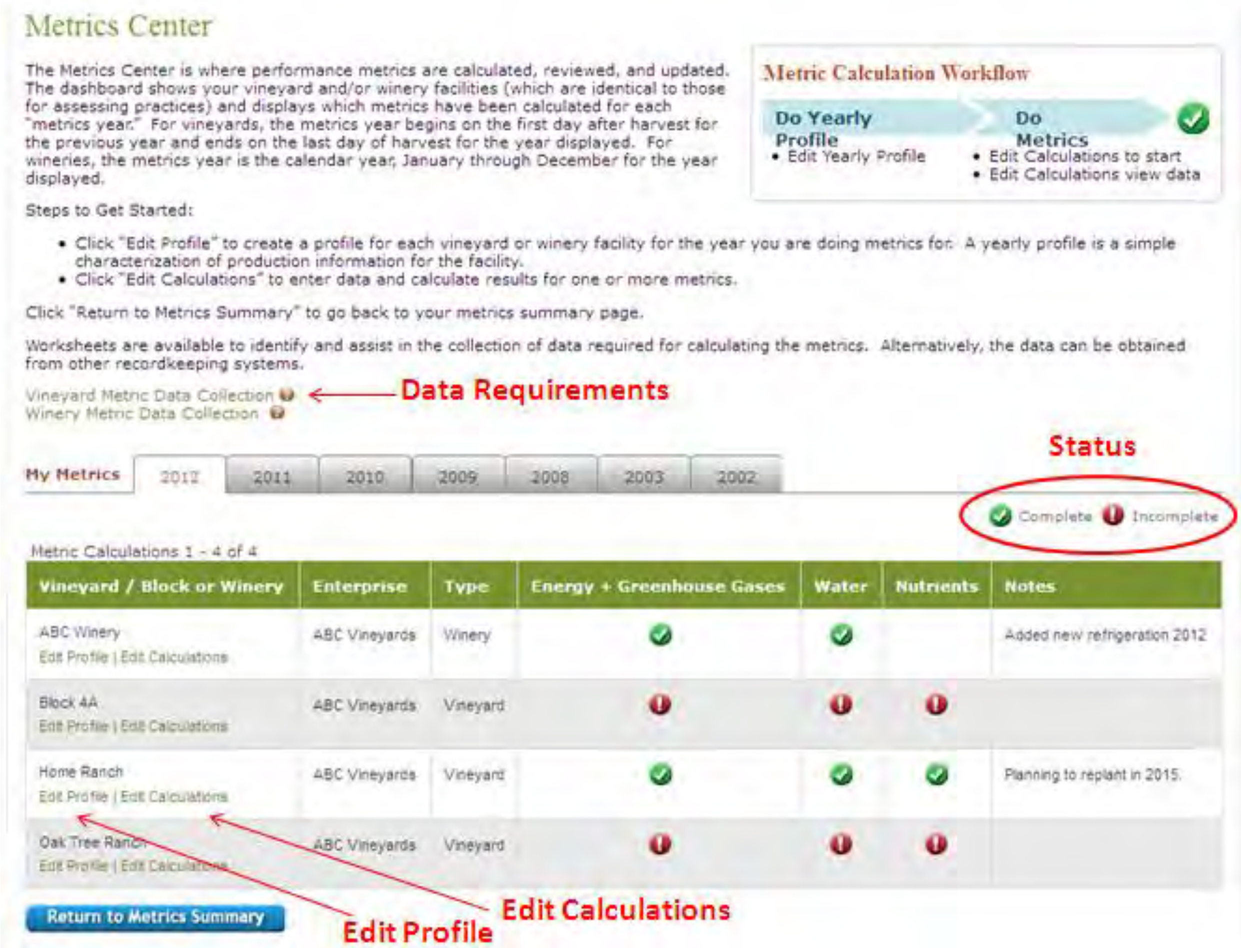
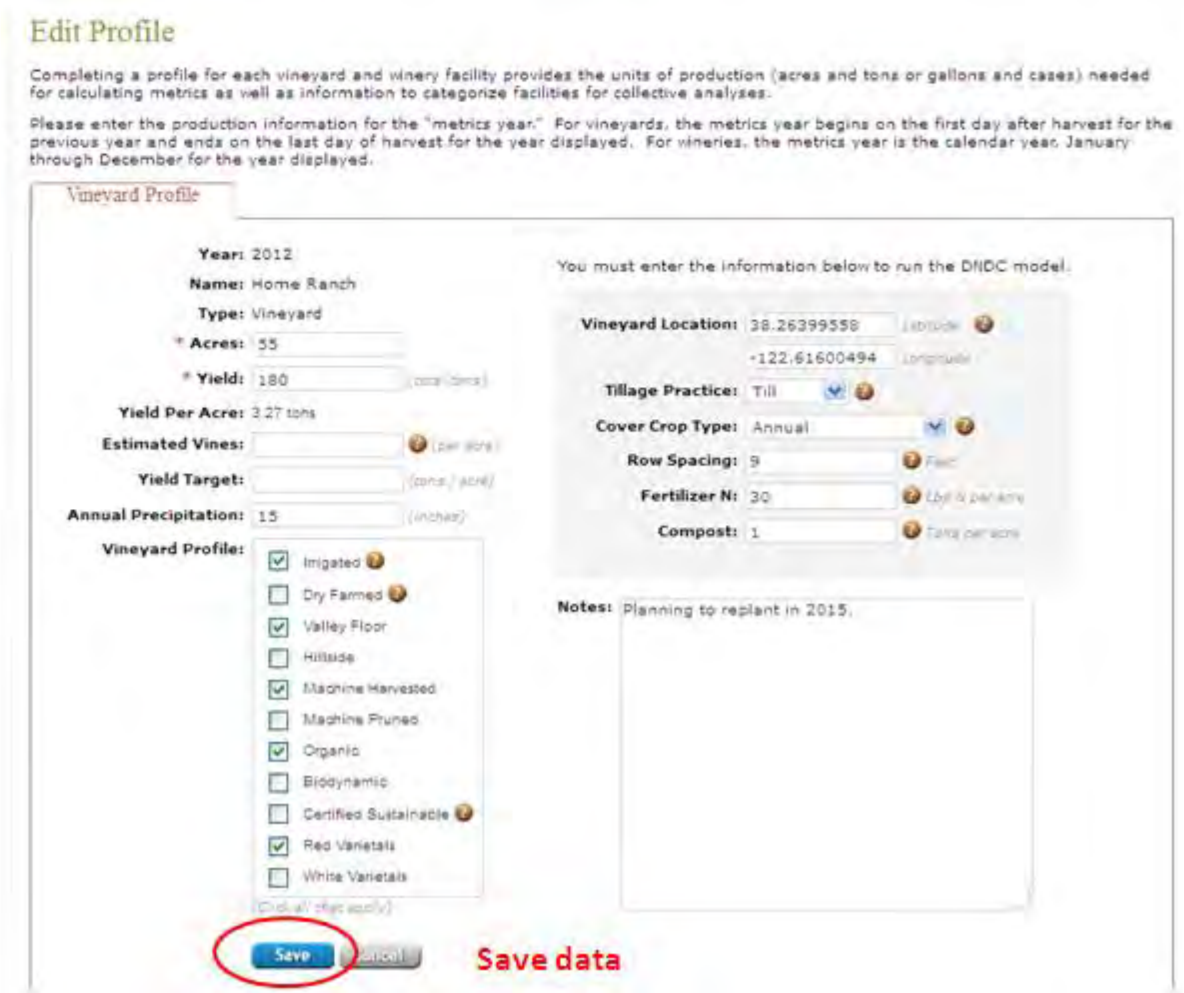
Using the Metrics Calculator

Click "Go to Metrics Center" to view the summary page showing the status (complete or incomplete) of metrics calculations for each vineyard/winery by year.



These are the steps for using the calculator:

- Click on Edit Profile for the vineyard/winery you are working on.



- Enter all relevant information on the Profile page.
- Click the Save button.

You will now be back on the Metrics Center page.

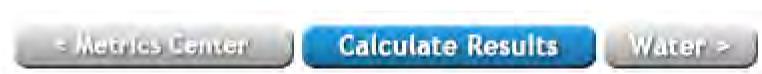
- Click on Edit Calculations to go to the Metrics Calculator.

The screen shot above shows the information associated with the Energy & Greenhouse Gases tab in the calculator. Tabs for other resource areas are displayed to the right. Each tab leads to a separate page where you follow instructions and enter required data to calculate metrics for that resource area.

- Once all required data is entered, click "Calculate Results" to calculate the metrics. The results are shown at the bottom of the page.
- Click the "Take Action" button associated with each set of results to access helpful information about key SWP practices and other resources impacting the metrics.

- Click the "Back" button to return to the calculator page for that resource area.

- Once metrics are calculated for a resource area, you can proceed by clicking the button in the middle of the page for the next resource area .



- Once completing the metrics of interest, you can print the results by clicking the "Print" button at the bottom of the left panel.

- To return to the Metrics Center, click the Metrics Center button in the middle of the page.

Once back at the Metrics Center, you will see any changes in the status of the metrics for each resource area – green checkmark means complete, red circle means not complete.

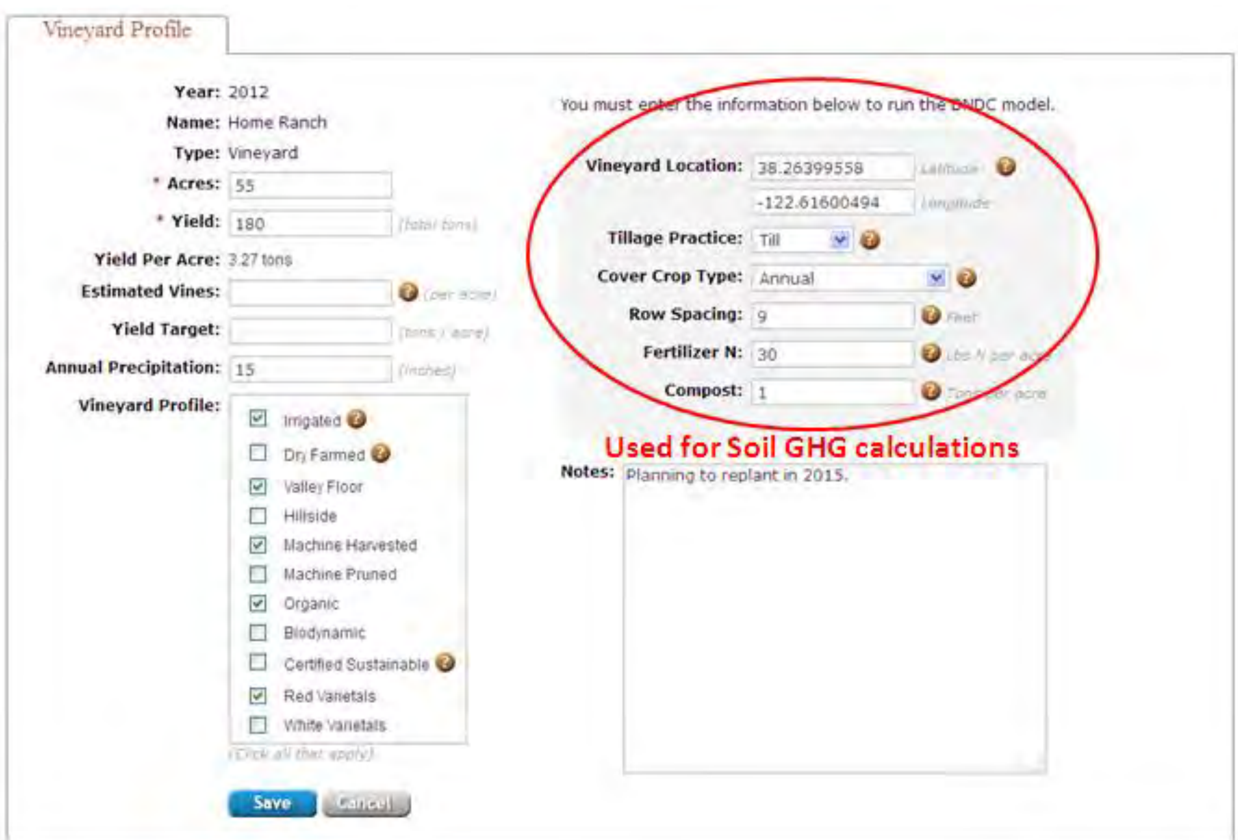
- To return to the Metrics Summary page in the self-assessment section of the online application, click the "Return to Metrics Summary" button.

Instructions for SWP Metrics Calculator & DNDC GHG Emissions Calculations

The SWP Metrics Calculator has been integrated with the DNDC soil GHG model to calculate soil GHG emissions from vineyards.

The following instructions will help growers add required data to and run the model.

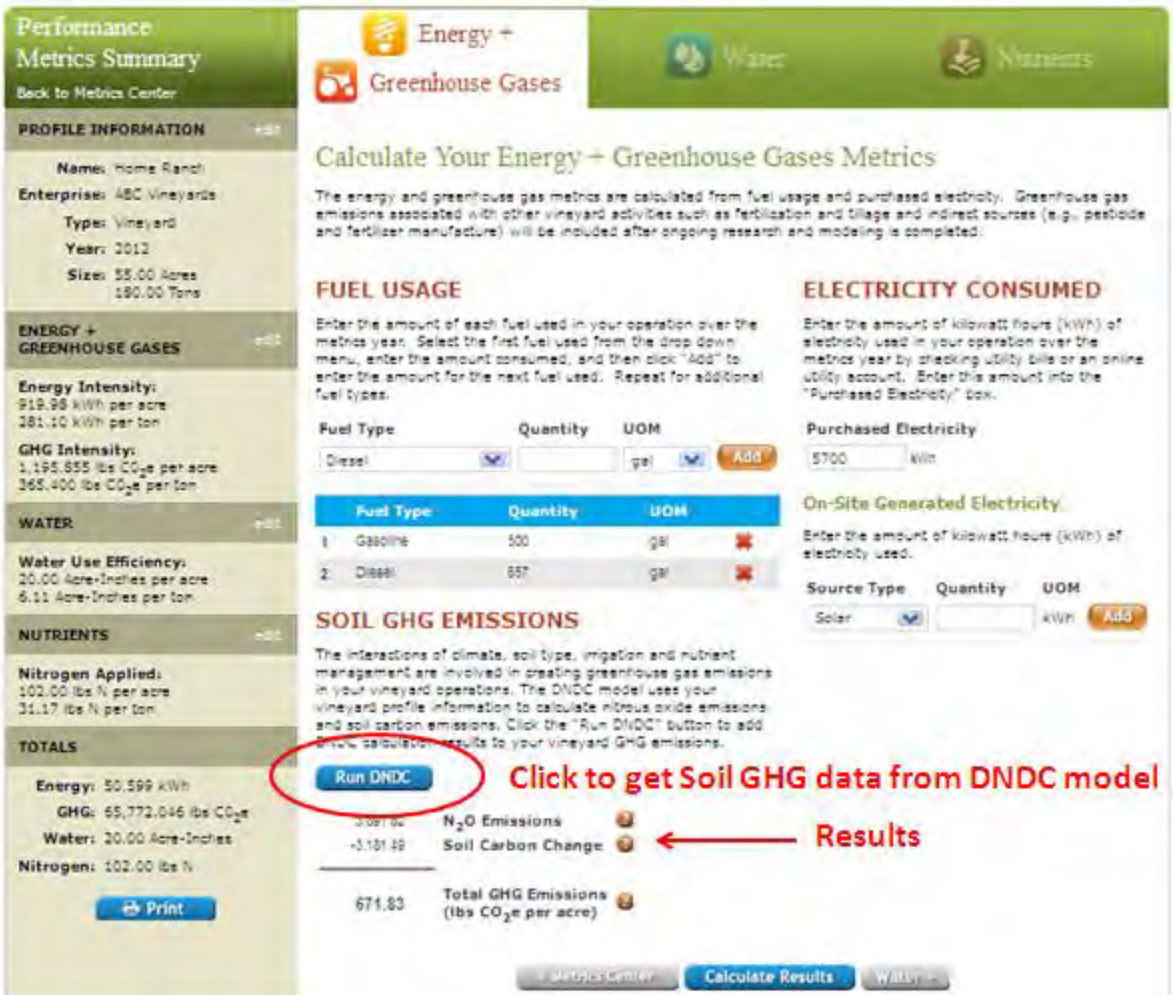
- From the Metrics Center, the grower selects "Edit Profile" and fills in the relevant Vineyard Profile information (including that circled below).



  - Vineyard Location is the Latitude & Longitude for a point in the vineyard (see instructions below for accessing a Web-based tool to find this information)
  - Tillage Practice
    - No-till or till (includes every other row)

- Cover Crop Type
    - Annual, perennial, or native
- Row Spacing
    - *Note: if your row spacing was more than 11 feet, enter 11*
- Fertilizer N
    - *Note: If you applied more than 30 lbs N per acre from commercial fertilizers, enter 30.*
- Compost
    - *Note: If you did not apply compost, enter 0 (zero)*

- Grower proceeds to metrics calculations
- On the Energy and Greenhouse Gases page, grower clicks the “Run DNDC” button in the Soil GHG Emissions section.



- DNDC results will be displayed in the Soil GHG Emissions section of the page.
    - ***Note:*** In some cases, an error message may pop up describing a problem in the profile information that was entered. Return to the Profile page and make the correction(s), then return to the Energy and Greenhouse Gases page to try the “Run DNDC” button again.

- After the amounts for fuel usage and electricity consumed have been entered and DNDC has been run, grower will click “Calculate Results” button.
- The GHG emissions results per category and in total will be displayed in the GHG section.

Greenhouse Gas Take Action

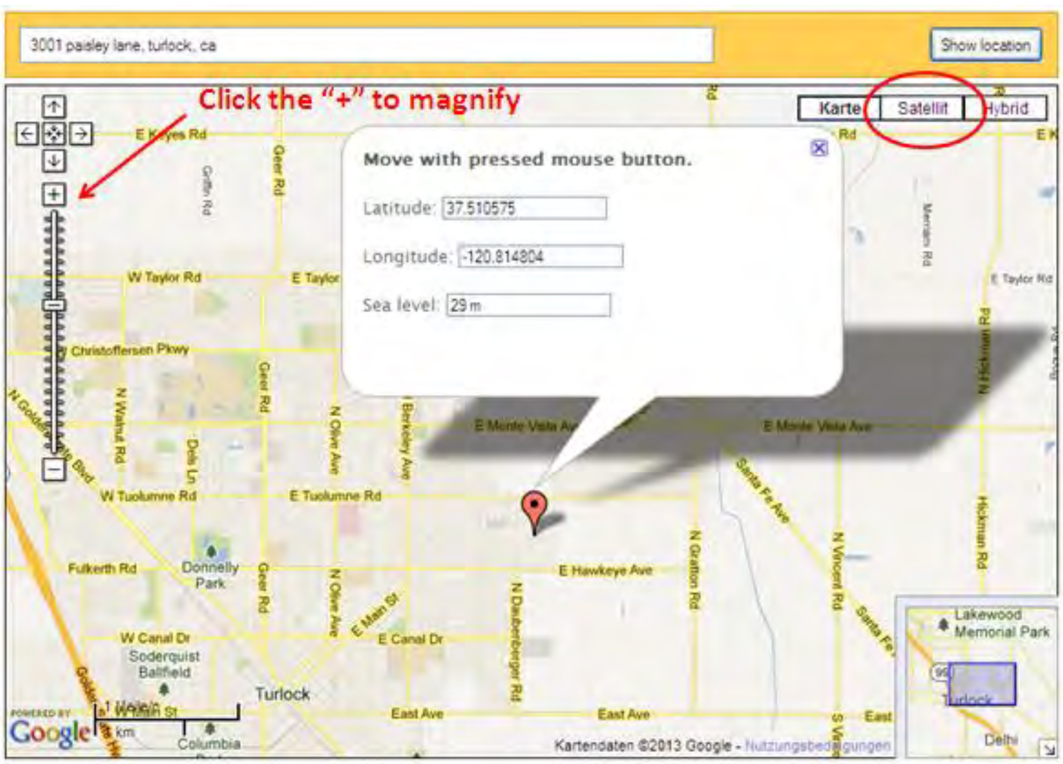
Fuel	Electricity	Soil	Total $C0_2e$	GHG Intensity
14,861.080 lbs	4,145.110 lbs	-4,785.039 lbs $C0_2e$ per acre	14,221.150 lbs	258.566 lbs $C0_2e$ per acre 79.006 lbs $C0_2e$ per ton

- Grower can now continue to calculate metrics for other resource areas.

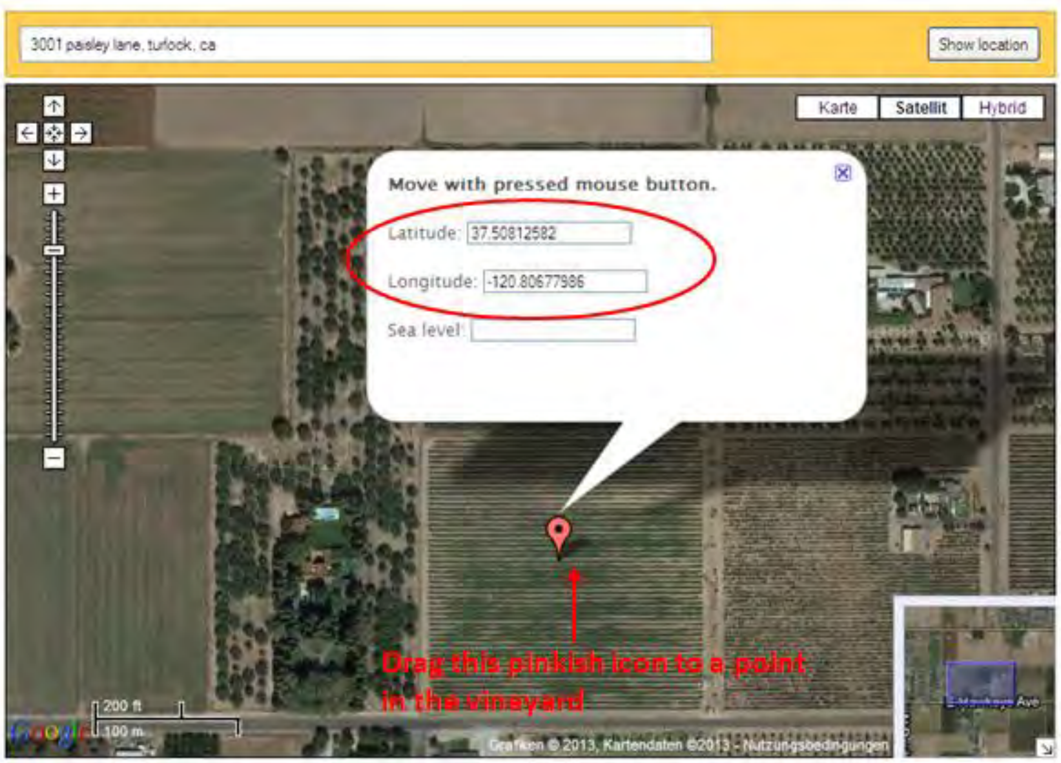
Finding a Latitude & Longitude for Your Vineyard

The DNDC model requires a latitude and longitude for a point in your vineyard. You may already have these coordinates from a vineyard consultant or other source. If not, the following instructions will help you obtain the information.

- Go to the web site www.mapcoordinates.net/en
- Type in an address near your vineyard in the orange bar in the middle of the page and then click the “Show location” button.



- Click the “Satellit” button in the upper right of the map. An aerial image of the area near your vineyard will be displayed. Click the “+” sign to magnify the image so you can find your vineyard.
- Use the mouse to drag the pinkish icon with the black dot to a point in the vineyard.



- Record the displayed Latitude and Longitude coordinates (or copy and paste) for entry into the Vineyard Profile page in the Metrics Calculator.

Contact: Allison Jordan, 415/356-7535
ajordan@wineinstitute.org or
Gladys Horiuchi, 415/356-7525
communications@wineinstitute.org

July 19, 2013

CSWA Introduces Online Tool to Measure Vineyard Greenhouse Gas Emissions

SAN FRANCISCO – The California Sustainable Winegrowing Alliance (CSWA) has introduced an online tool for calculating greenhouse gas emissions and carbon sequestration in California vineyards. The tool, named the DeNitrification and DeComposition (DNDC) model for winegrapes, was developed to help winegrowers "measure to manage" to reduce input costs and emissions. The tool is part of CSWA's online Sustainable Winegrowing Self-Assessment and Performance Metrics system, the latter of which measures, manages and tracks energy, water and nitrogen use, and greenhouse gas emissions. The tool was developed with partial funding from a three-year California Department of Food and Agriculture Specialty Crop Block Grant.

"More than 1,400 researchers and stakeholders worldwide use the DNDC Model on over 40 agricultural crops to assess the effects of various management practices on greenhouse gas emissions," said Allison Jordan, CSWA executive director. "By incorporating the DNDC model into our program, growers can see more clearly how vineyard practices combine to reduce nitrogen applications, save money and minimize soil-related greenhouse gas emissions. Avoiding excess nitrogen benefits growers' bottom-line, contributes to wine quality and delivers better environmental outcomes."

Jordan explained that the online Performance Metrics system offers a simplified, user-friendly version of the DNDC tool that enables winegrowers to customize the variables that are the most significant drivers of soil-related greenhouse gas emissions in vineyards. These variables include practices such as row spacing, type of tillage, use and type of cover crop, amount of compost and amount of nitrogen applied as fertilizer. Results help growers understand relationships between key practices and emissions, and how to improve. For more DNDC tool information, click here.

CSWA worked with Applied GeoSolutions, UC Davis, SureHarvest, the USDA Agricultural Research Service and other project partners over several years to calibrate and validate the DNDC model for winegrapes, assess the influence of vineyard management practices on greenhouse gas emissions and create a user-friendly tool for use by California winegrowers. To begin using the DNDC tool within the Performance Metrics site, visit https://metrics.sustainablewinegrowing.org where California participants can log in with their CSWA Username and Password or request a new Username.

About the California Sustainable Winegrowing Alliance

The California Sustainable Winegrowing Alliance is a 501(c)(3) nonprofit organization incorporated in 2003 by Wine Institute and the California Association of Winegrape Growers. CSWA's mission is to ensure that the California wine community is recognized globally as the leader in sustainable winegrowing in the marketplace and public policy arena through the development and promotion of sustainable practices, tools for education and outreach, partnerships with key stakeholders and prioritizing research. In the last decade, 1,800 vineyard and winery organizations, representing more than 70 percent of California's winegrape acreage and case production, have participated in CSWA's Sustainable Winegrowing Program. See: www.sustainablewinegrowing.org.

# # #

Attachment B – Outreach & Education Event List and Sample Flyers & Agendas

December 14, 2012 – Broad Stakeholder Meeting, Davis, CA
January 24, 2013 – Stakeholder Meeting, San Francisco, CA
June 6, 2013 – DNDC Preview, Webinar
June 11, 2013 – DNDC Workshop, Oakville, CA
June 12, 2013 – DNDC Workshop, Lodi, CA
June 19, 2013 – DNDC Winegrape Grower Workshop, Webinar

Vineyards and Greenhouse Gases Workshop
Agenda

June 6, 2013
10:00am-11:30 PST
CSWA Board and Joint Committee Preview Webinar

- Welcome, Intro, and Overview of SWP and Climate Change Initiatives
    - Allison Jordan, CSWA

- Metrics Background and Online Tools for Greenhouse Gas Calculations:
    - Background on DNDC, regional results, features and rationale for DNDC educational model
        - Bill Salas, Applied Geosolutions
    - Overview and online system demo including interaction w/DNDC "educational" model
        - Joe Browde, SureHarvest

- Future Application of Greenhouse Gas Modeling for Saleable Carbon Offsets
    - Robert Parkhurst, Environmental Defense Fund


CALIFORNIA
SUSTAINABLE WINEGROWING
ALLIANCE

Vineyards & Greenhouse Gases Workshop

Co-Sponsored By: California Sustainable Winegrowing Alliance (CSWA), Lodi Winegrape Commission, Napa Valley Grapegrowers, Wine Institute, & California Association of Winegrape Growers

June 11, 2013	June 12, 2013	June 19, 2013
NAPA	**LODI**	**WEBINAR**
8:30am - 1:00pm	8:30am - 12:00pm	10:00am - 11:30am
UCD Oakville Vineyard	Wine & Roses Hotel	

The Oakville workshop includes a tour of the research vineyard. For both the Oakville & Lodi workshops, registration begins at 8am & coffee/lunch will be provided.

TOPICS TO BE COVERED INCLUDE

- Overview of Sustainable Winegrowing & Climate Change Initiatives
- Hands-On use of online tools for Greenhouse Gas Calculations & Tracking
- Vineyard Practices Impacting GHG Emissions & Sequestration
- Learn how online tools can help you track your Water use, Energy use, and Applied Nitrogen

WHO SHOULD ATTEND

Vineyard managers & employees; Anyone interested in learning more about climate change mitigation in the vineyard

COST

This is a FREE workshop for CA growers


RSVP LINK

https://wineinstitute.wufoo.com/forms/vineyards-and-greenhouse-gases-workshops/

QUESTIONS?

Contact Kate Venugopal at kvenugopal@wineinstitute.org or 415.356.7548.

CSWA would like to thank the California Department of Food & Agriculture, and the many collaborators who made this research and workshop possible.

CALIFORNIA
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ALLIANCE

Vineyards & Greenhouse Gases Workshop

Tuesday, June 11, 2013
Napa, UC Davis Oakville Station Conference Room
8:30am-12:00pm *(Lunch included)*

Wednesday, June 12, 2013
Lodi, Wine & Roses
8:30am-12:00pm *(Lunch included)*

AGENDA:

Welcome and Overview of the Sustainable Winegrowing Program (SWP) and Climate Change Initiatives
- *Lisa Francioni Hai, California Sustainable Winegrowing Alliance*

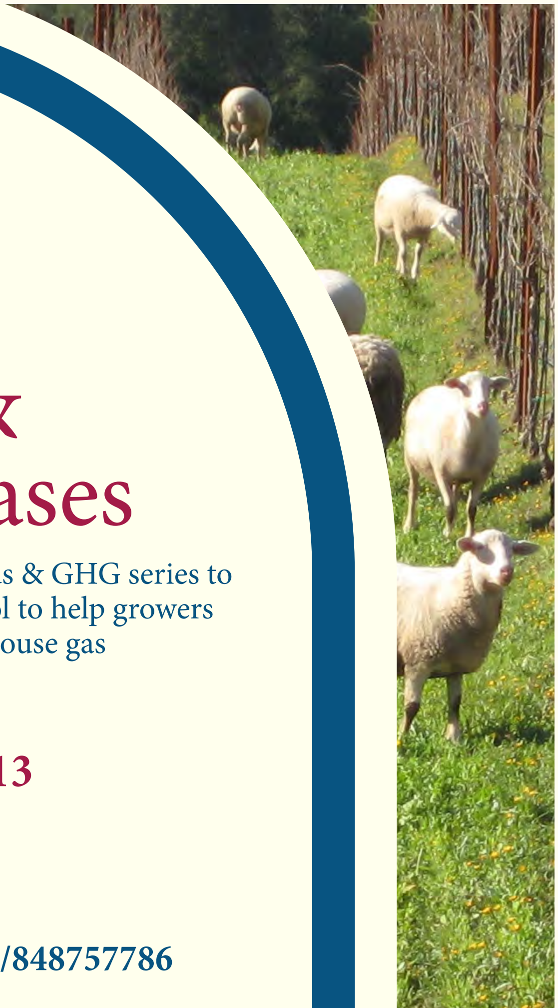
Performance Metrics and Online Tools for Greenhouse Gas Calculations
- Background on the DeNitrification DeComposition (DNDC) Tool
  - *Bill Salas, Applied GeoSolutions*
- Overview of the SWP's Performance Metrics and Demonstration of the Online Tool
  - *Andrew Arnold, SureHarvest*

Hands-On Use of Online Tools for Greenhouse Gas Calculations and Tracking

Vineyard Practices Impacting Greenhouse Gas Emissions and Sequestration
- Napa – Presentation and Vineyard Tour
  - *Dave Smart, UC Davis*
- Lodi – Group Discussion
  - *Joe Browde, SureHarvest and Bill Salas, Applied GeoSoultions*

Future Application of Greenhouse Gas Modeling for Saleable Carbon Offsets
- *Belinda Morris, American Carbon Registry*

Lunch

CALIFORNIA
SUSTAINABLE WINEGROWING
ALLIANCE

WEBINAR
Vineyards & Greenhouse Gases

Take advantage of the last workshop in the Vineyards & GHG series to hear from experts who developed a new online tool to help growers calculate carbon sequestration and greenhouse gas emissions in vineyard soils.

Wednesday, June 19, 2013
10:00am - 11:30am
(Pacific Standard Time)

Registration Web Link:
https://www2.gotomeeting.com/register/848757786

Co-Sponsored By: California Sustainable Winegrowing Alliance (CSWA), Wine Institute, & California Association of Wingegrape Growers


topics to be covered include

Overview of Sustainable Winegrowing & Climate Change Initiatives

Demonstration of new online tools for Greenhouse Gas Calculations & Tracking

Learn how online tools can help you track your Water use, Energy use, & Applied Nitrogen

who should attend

Vineyard managers & employees; Anyone interested in learning more about climate change mitigation in the vineyard

cost

This is a FREE webinar for CA growers

rsvp link

https://wineinstitute.wufoo.com/forms/vinyards-and-greenhouse-gases-workshops/

questions?

Contact Kate Venugopal at kvenugopal@wineinstitute.org or 415.356.7548.

CSWA would like to thank the California Department of Food & Agriculture, and the many collaborators who made this research and workshop possible.

Appendix: Table and Figures

Table 1: Experimental Design of the Vacuum Cooling Study

	Abaxial	Adaxial
6log CFU	Wet/Dry	Wet/Dry
3log CFU	Wet/Dry	Wet/Dry

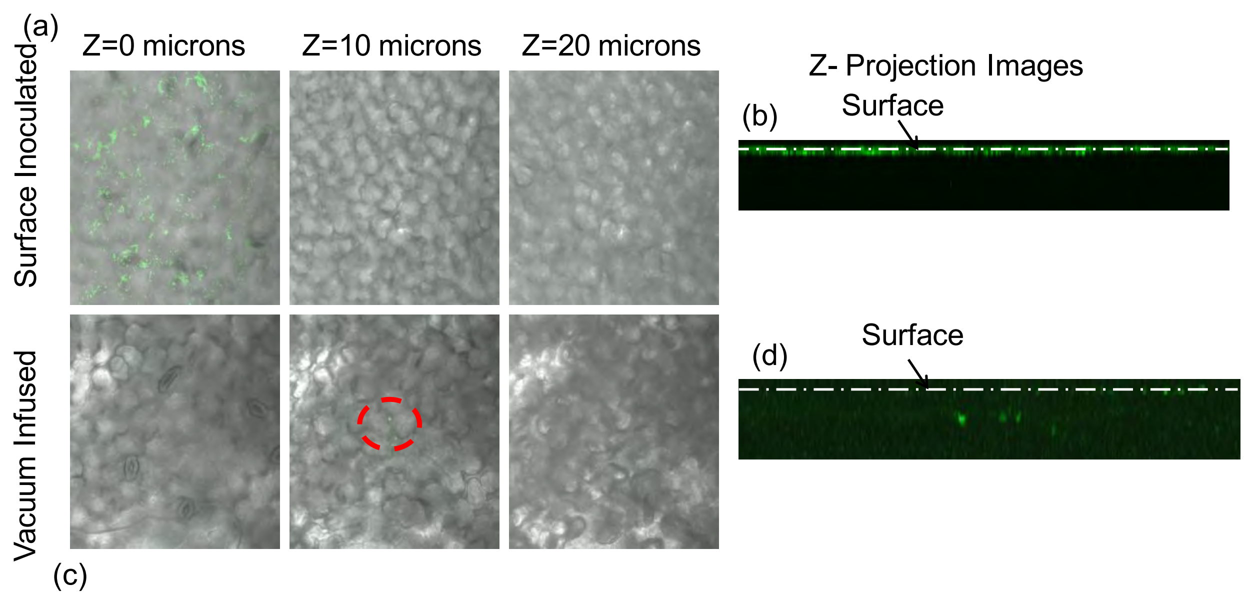
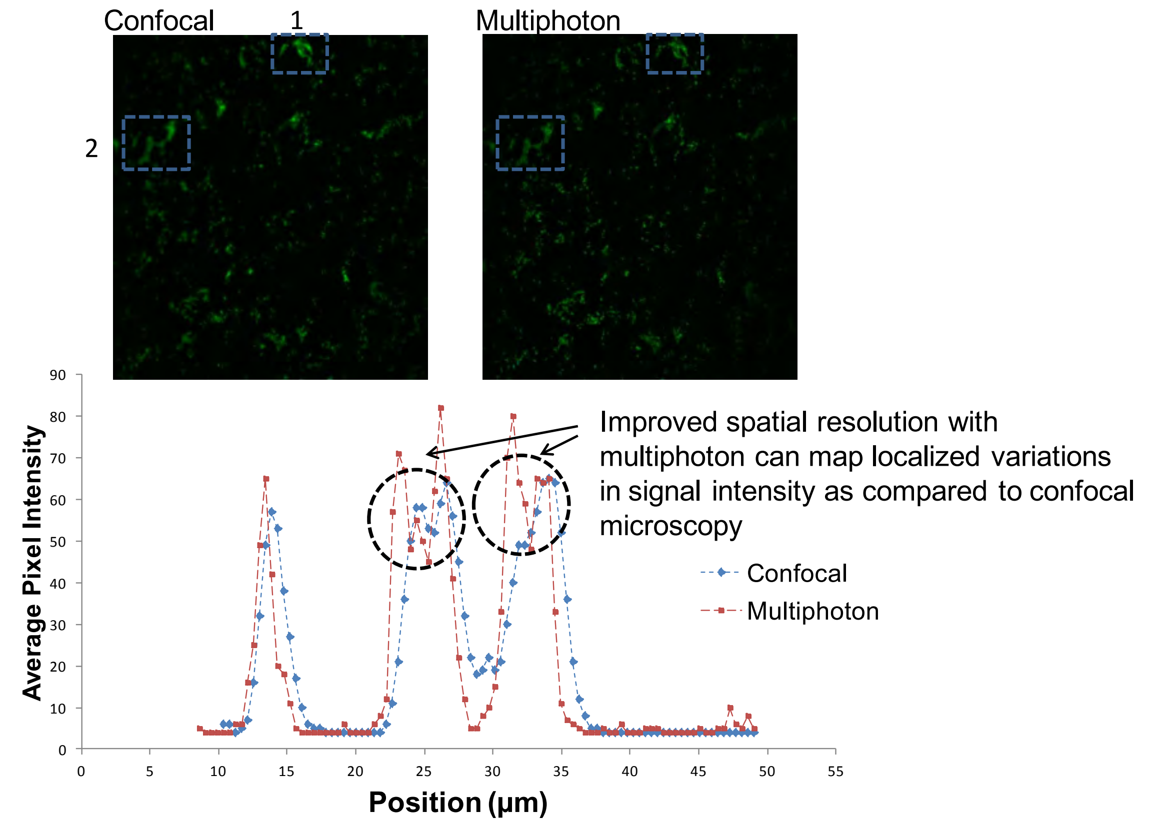
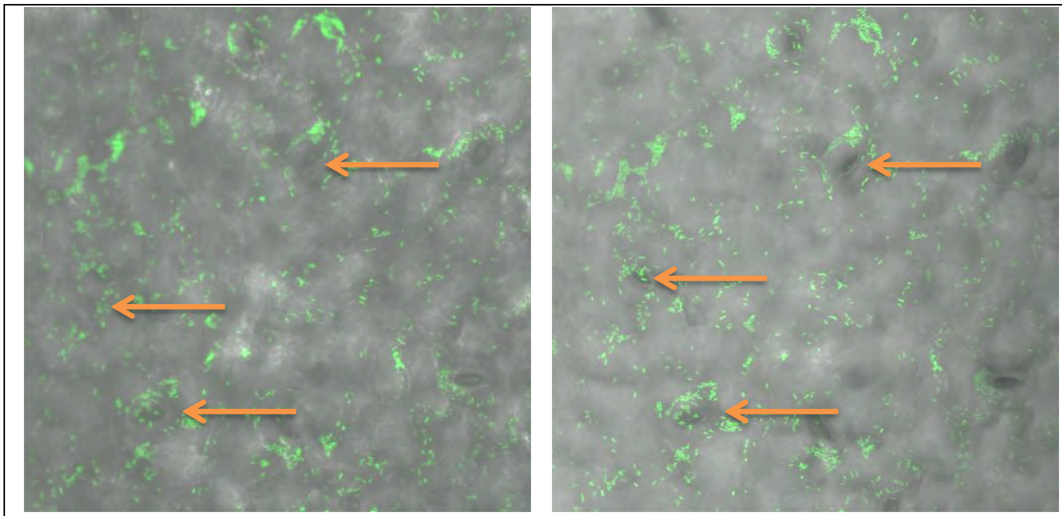


Figure 1: Imaging of surface inoculated and infiltrated microbes in intact lettuce leaves using multiphoton imaging.



Figures 2(a-b): Comparison of confocal and multiphoton fluorescence imaging data. Improved spatial resolution of multiphoton is highlighted in the representative line scan



Figures 2 (c-d): Comparison of confocal and multiphoton imaging data. The image on the left is a confocal image of an *E. coli O157:H7* surface contaminated lettuce leaf. The right image is a multiphoton image of the same sample.

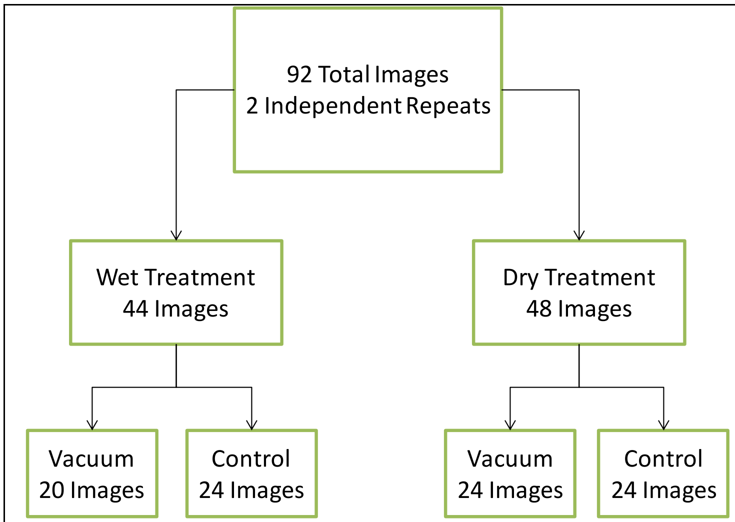


Figure 3. Design of imaging experiments to characterize potential infiltration during vacuum cooling

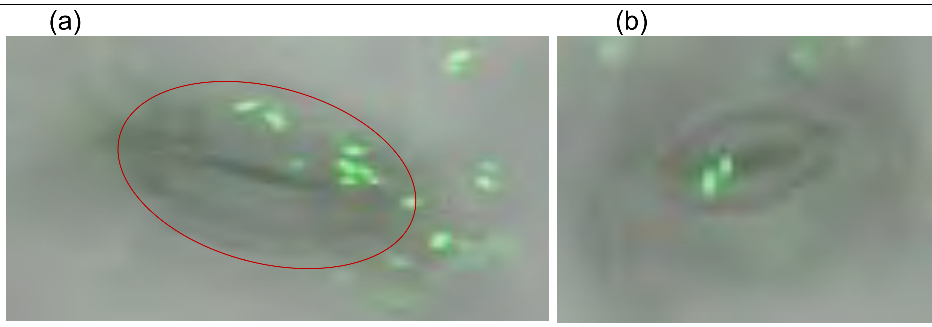


Figure 4: Approach to quantify association of microbes with stomata and to measure internalization of microbes in stomata cavity

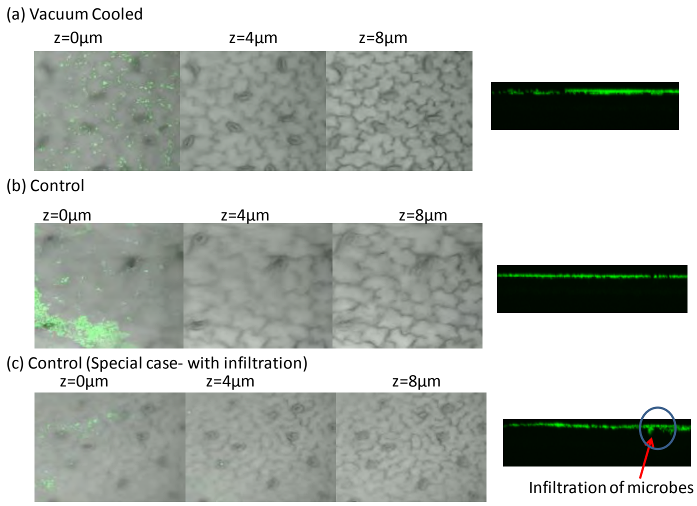


Figure 5(A) Imaging micrograph illustrating no significant increase in internalization after vacuum cooling of lettuce leaves inoculated on abaxial side and maintained under wet conditions (excess moisture on surface)

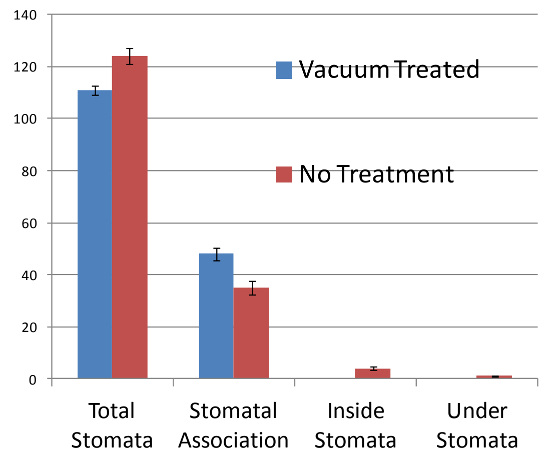


Figure 5(B) Quantification of changes in localization of microbes with vacuum cooling of lettuce leaves inoculated on abaxial surface.

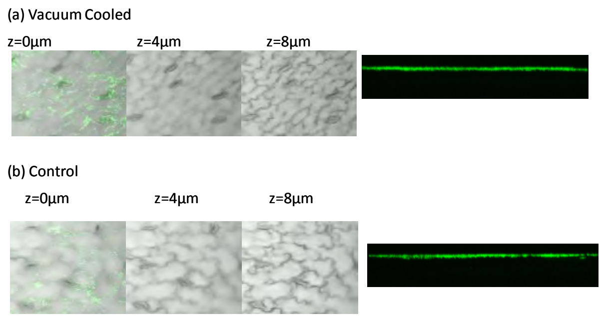


Figure 6(A) Imaging micrograph illustrating no significant increase in internalization after vacuum cooling of lettuce leaves inoculated on abaxial side and dried after inoculation

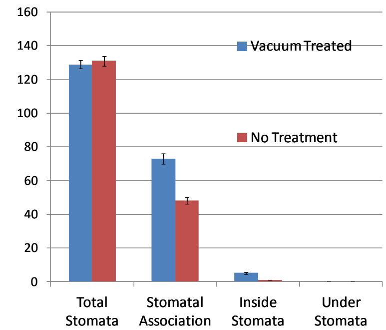


Figure 6(B) Quantification of changes in localization of microbes with vacuum cooling of lettuce leaves inoculated on abaxial surface.

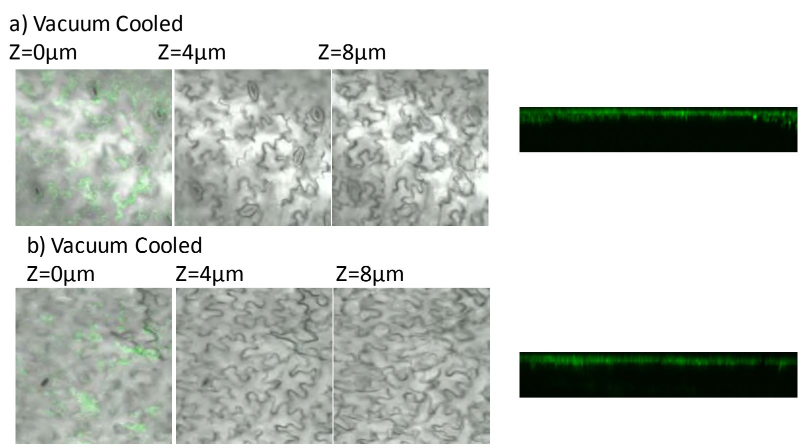


Figure 7(A) Imaging micrograph illustrating no significant increase in internalization after vacuum cooling of lettuce leaves inoculated on adaxial side under high moisture conditions

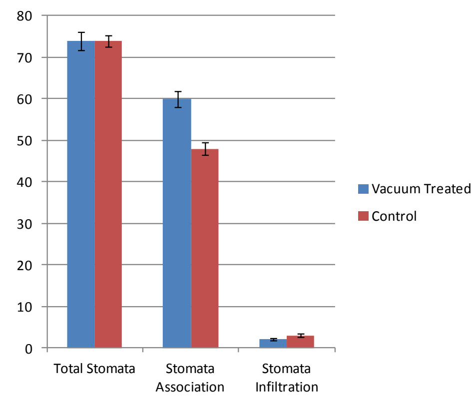


Figure 7(B) Quantification of changes in localization of microbes with vacuum cooling of lettuce leaves inoculated on adaxial surface under high moisture conditions.

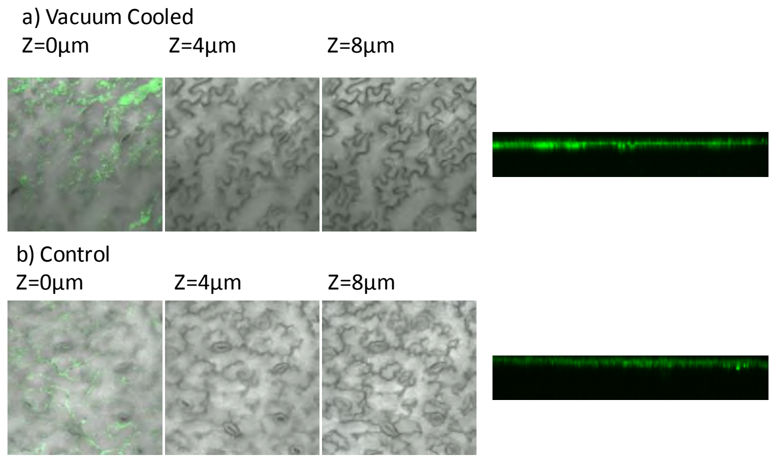


Figure 8(A) Imaging micrograph illustrating no significant increase in internalization after vacuum cooling of lettuce leaves inoculated on adaxial side under low moisture conditions

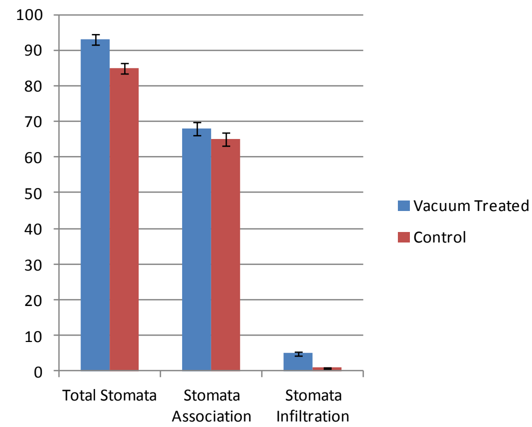


Figure 8(B) Quantification of changes in localization of microbes with vacuum cooling of lettuce leaves inoculated on adaxial surface under low moisture conditions

Project 61 Attachments

CPS 2012 Produce Research Symposium survey

Survey Details | Overall Results | Individual Results

Results View: Partial & Completed Update View

72 Responses | Filter these respondents Export results to: - Select a file type - Export

Share results: No
Results URL: Available when results sharing is enabled.

Click a value under 'Number of Responses' to view those respondents and save them to a list.
(For rating and ranking questions, click on Show Details first. Not available for open-ended text and questions that collect personal information.)

1 **Was sufficient time given for each research presentation?**

1 = Sufficient , **2** = Neutral , **3** = Insufficient

	1	2	3	Number of Responses	Rating Score*
				72	1.5

*The Rating Score is the weighted average calculated by dividing the sum of all weighted ratings by the number of total responses.

Show Details

2 **How would you rate the format of Sessions I, II, III (panel discussion after each research presentation):**

1 = Excellent , **2** = Good , **3** = Fair , **4** = Poor , **5** = N/A

	1	2	3	4	5	Number of Responses	Rating Score*
						72	1.8

*The Rating Score is the weighted average calculated by dividing the sum of all weighted ratings by the number of total responses.

Show Details

3 **How would you rate the format of Session IV? (panel discussion after all research projects were presented)**

1 = Excellent , **2** = Good , **3** = Fair , **4** = Poor , **5** = N/A

	1	2	3	4	5	Number of Responses	Rating Score*
						72	2.2

*The Rating Score is the weighted average calculated by dividing the sum of all weighted ratings by the number of total responses.

Show Details

4 **How would you rate the relevance of each research project to the industry? (Session I - Good Agricultural Practices - Buffer Zones and Animal Vectors)**

1 = Very Important , **2** = Somewhat Important , **3** = Neutral , **4** = Somewhat Unimportant , **5** = Very Unimportant , **6** = N/A

Answer	1	2	3	4	5	6	Number of Responses	Rating Score*
E. coli O157:H7 in bioaerosols from cattle production areas: evaluation of proximity and airborne transport on leafy green crop contamination							70	1.4
Developing buffer zone distances between sheep grazing operations and vegetable crops to maximize food safety							70	1.6
Evaluation of amphibians and reptiles as potential reservoirs of foodborne pathogens and risk reduction to protect fresh produce and the environment							69	1.8
Wildlife survey for E. coli O157:H7 and Salmonella spp. in the central coast counties of California							70	1.7

*The Rating Score is the weighted average calculated by dividing the sum of all weighted ratings by the number of total responses.

Show Details

5

How would you rate the relevance of each research project to the industry? (Session II - Good Agricultural Practices - Irrigation Water)

1 = Very Important , **2** = Somewhat Important , **3** = Neutral , **4** = Somewhat Unimportant , **5** = Very Unimportant , **6** = N/A

Answer	1	2	3	4	5	6	Number of Responses	Rating Score*
Epidemiologic analysis and risk management practices for reducing E. coli in irrigation source water supplies and distribution systems							71	1.4
Science-based evaluation of regional risks for Salmonella contamination of irrigation water at mixed produce farms in the Suwannee River watershed							67	1.6
Risk assessment of Salmonella preharvest internalization in relation to irrigation water quality standards for melons and other cucurbits							71	1.5
Mitigation of irrigation water using zero-valent iron treatment							71	1.7

*The Rating Score is the weighted average calculated by dividing the sum of all weighted ratings by the number of total responses.

Show Details

6

How would you rate the relevance of each research project to the industry? (Session III - Good Agricultural Practices - Inputs, Cultivation and Harvest)

1 = Very Important , **2** = Somewhat Important , **3** = Neutral , **4** = Somewhat Unimportant , **5** = Very Unimportant , **6** = N/A

Answer	1	2	3	4	5	6	Number of Responses	Rating Score*
Benefits and challenges of using industry data: experiences with Washington state tree fruit and Leafy Green Marketing Agreement							70	2.0

Developing and validating practical strategies to improve microbial safety in composting process control and handling practices		71	1.7
Assessing postharvest risks for Salmonella in pistachios		70	2.1
Pathogen transfer risks associated with specific tomato harvest and packing operations		70	1.7

*The Rating Score is the weighted average calculated by dividing the sum of all weighted ratings by the number of total responses.

Show Details

7

How would you rate the relevance of each research project to the industry? (Session IV - Wash Water and Process Control)

1 = Very Important , **2** = Somewhat Important , **3** = Neutral , **4** = Somewhat Unimportant , **5** = Very Unimportant , **6** = N/A

Answer	1 2 3 4 5 6	Number of Responses	Rating Score*
Rapid testing of flume water organic load to better assess the efficacy of free chlorine against E. coli O157:H7 during commercial lettuce processing		71	1.7
Enhancing the efficacy of fresh produce washing operations through establishing monitoring methods and water disinfection technologies based on a combination of filtration and UV		71	1.9
Evaluation and optimization of postharvest intervention strategies for the reduction of bacterial contamination on tomatoes		71	1.8
Improving produce safety by stabilizing chlorine in washing solutions with high organic loads		70	1.8

*The Rating Score is the weighted average calculated by dividing the sum of all weighted ratings by the number of total responses.

Show Details

8

How would you rate the opening session, "Food Safety Rationale?"

1 = Excellent , **2** = Good , **3** = Fair , **4** = Poor , **5** = N/A

	1 2 3 4 5	Number of Responses	Rating Score*
		71	2.0

*The Rating Score is the weighted average calculated by dividing the sum of all weighted ratings by the number of total responses.

Show Details

9

How would you rate the closing session, "Food Industry / Government Discussion?"

1 = Excellent , **2** = Good , **3** = Fair , **4** = Poor , **5** = N/A

	1 2 3 4 5	Number of Responses	Rating Score*
		71	2.3

*The Rating Score is the weighted average calculated by dividing the sum of all weighted ratings by the number of total responses.

Show Details

10 Share your thoughts about the poster session - information shared, size and format, session location, etc.

	Number of Responses
View Text Answers	42

11 What specific take-aways did you get from the Symposium?

	Number of Responses
View Text Answers	47

12 How could we improve your overall experience with logistics, registration, lunch, breaks, etc.?

	Number of Responses
View Text Answers	49

13 How likely are you to recommend this event to a colleague?

Answer	0% 100%	Number of Responses	Response Ratio
Very likely		47	65.2%
Somewhat likely		19	26.3%
Neutral		2	2.7%
Somewhat unlikely		2	2.7%
Very unlikely		0	0.0%
No Responses		2	2.7%
	Totals	**72**	**100%**

14 How did you learn about the Symposium?

Answer	0% 100%	Number of Responses	Response Ratio
In the media (newspaper, magazine, blog)		2	2.7%
CPS Website		9	12.5%
Through a colleague		26	36.1%
Through an association		7	9.7%
E-mail		22	30.5%
Mailing		0	0.0%
Other (View all)		6	8.3%
No Responses		0	0.0%
	Totals	**72**	**100%**

15 What additional comments would you like to share with the CPS?

	Number of Responses
View Text Answers	36

16 **May we use your comments for future promotional materials?**

Answer	0% 100%	Number of Responses	Response Ratio
Yes		49	68.0%
No		19	26.3%
No Responses		4	5.5%
	Totals	**72**	**100%**

17 **Please enter the information indicated below (Optional).**

Answer	Number of Responses
First Name	33
Last Name	33
Job Title	30
Company Name	30
Email Address	32

View answers

CPS 2012 Produce Research Symposium survey

Survey Details | **Overall Results** | Individual Results

Back

Text answer(s) for:

11 **What specific take-aways did you get from the Symposium?**

50 per page Update

47 Responses

Answer	Respondent
Our understanding of wash water contamination and control is murkier than I realized.	[redacted]
I had a prior underestimation of the poor quality that wash water could achieve - and hence the need for continuous quality measuring systems.	[redacted]
Still more work to be done. I wish the presenters can be specific in how the finding would apply in the industry.	[redacted]
The importance of payhing attention to the potential for cross contamination.	[redacted]
New data to influence food safety recommendations	[redacted]
Research has been coming forward that is very relevant. Specific questions we had are being answered so we can now develop strategies for applicable interventions - or relax.	[redacted]
Less take-aways than last year.	[redacted]
The funding that CPS is providing for research about our industry is really paying off with results that we can apply immediately with regards to our risk assessments and GAPs.	[redacted]
CPS should fund research on reducing foodborne pathogens in cattle, especially in feedlot situations - that is the elephant in the room. Put out a call for research on a) alternatives to large feedlots, b) affects of policies that could require testing cattle before they are sold, and c) on different ways to subsidize cattle vaccinations.	[redacted]
The iron filtration information was very interesting.	[redacted]
The importance of collaboration between regulators, research and industry in adoption of research output	Anonymous
1. The process of composting is not understood by the majority. Isolated studies like the one presented shows that this will continue to be a major problem for the fresh produce industry. 2. Similar thoughts on water, particularly that which is used for processing. The lack of consensus from the panel was not very encouraging.	[redacted]
validated relevance/non-relevance of food safety concerns with some GAPs	[redacted]
many items confirmed existing thoughts providing better scientific foundation	[redacted]
That the CPS research is valuable to the industry by providing the science behind the standards, and that we need to continue funding practical real life projects.	[redacted]
Food Safety is key. Treat procesing/packing and irrigation water for our safety.	[redacted]
We have a lot to learn!	[redacted]
Environmental contamination may be more significant than any particular vector. Insect movement of pathogens is unpredictable.	[redacted]
Collaboration, coordination of research and information sharing is crucial.The Symposium emphasized the benefits of working together as regulators, academia, industry and consumers to keep fresh produce safe. There's no better marketing strategy than to raise confidence and understanding of the efforts being made by all to address food safety risks	Anonymous
There is a great deal of creditable research that requires more than 8 minutes to better understand.	[redacted]

I absolutely loved Tim York's interview with Dana and I also thought the format with the industry panels was very good.	[redacted]
More research needed in specific areas such as processors.	[redacted]
Much of the food safety practices that were in place ten years ago are being confirmed, or questioned, based peer reviewed research. There is much more to be done, but a CPS is off to a very good start.	[redacted]
That industry is improving, and that certain accepted facts, i.e., statements in CalFert reports are taken as "gospel" when they are in dispute, but no one tracks them after release.	[redacted]
Lots of variables affect microbial levels, and it's not clear that laboratory studies are directly relevant to field experience. The wash water issue seems particularly confounding.	[redacted]
being able to back up certain GAP's with science is an invaluable tool. This was great to see, and a vast improvement from our conjecture based GAP's currently being used	[redacted]
There is still much we do not know. And the scientists don't behave all the answers. There is a big difference between how very large growers deal with risk compared with small growers.	[redacted]
A symposium of this nature provides a provocative environment for discussion,the potential for informational exchange and allows for development of progressive contacts if desired.	[redacted]
Produce research is not universal. Our researchers found microbial reduction in wash water, while the presenter only found that cross contamination is eliminated by the introduction of chlorine or PAA. It proves to me that every commodity has to do some preliminary work to find what is applicable to them.	[redacted]
That we do not have perfect solutions to produce disinfection, so it is still best not to contaminate it in the first place. People's food is personal.	[redacted]
The main problem is the flume water for washing.	[redacted]
The science of food safety risks has advanced in the past few years such that some conclusions can be made about relative risks and good practices to prevent outbreaks. This despite the extremely nuanced nature of the issue. I was also impressed with the level of participation at the symposium.	[redacted]
that the food safety world is still very much in a state of flux and that we really don't know much more than we did a few years ago other than that most of what we assumed is incorrect. good to know, just disappointing that we are not making faster strides.	[redacted]
Produce companies need to pay attention to the issues that are important to their business, and the issues that are of particular interest to the regulatory agencies.	[redacted]
I came away with some unanswered questions about water systems. That particular session was interesting because it seemed there were opposing camps on stage as to the point of wash systems. The information about animal activity, intrusion, incidences was very informative. I missed a section in the middle but enjoyed seeing this round of reasearch	[redacted]
The one big take away is that a lot more work needs to be done to align on best wash water and process control solutions.	[redacted]
The networking opportunity was fantastic. The subjects covered in both the posters and the presentations were great take-away information.	[redacted]
Too much material for one day-or just too much. Getting behind schedule hurts presenters, panelists and audience.	[redacted]
Testing for coliform in water is not a good indicator for the presence or absence of E.coli O157:H7.	[redacted]
Much more research is needed in control of quality of water in processing.	[redacted]
Wildlife can't be dismissed as a source of pathogens. Research done in states outside of major production areas doesn't have the same relevance as that conducted on the "50 yard line".	[redacted]
The CPS is getting more focused on what is important and that the science/academic community is finally spending time on real world issues.	[redacted]
Industry, government and academia working together to enhance microbiological safety of fresh produce. Identified key areas where knowledge gaps exist and how previous research is being put directly into applications.	[redacted]
Farmers are definately becoming responsible for all microorganisms found and being brought onto their land regardless of whether or not the presence of pathogens are from their actions. People expect all crops to be ready-to-eat in the field.	[redacted]
Produce research is boldly moving forward, and is better geared towards answering pertinent questions for risk assessment.	[redacted]
A lot of good work is in progress	[redacted]
I'm still thinking about this. Industry folks want information that can be used right away.	[redacted]

50 per page Update

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CPS 2012 Produce Research Symposium survey

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Text answer(s) for:

10 **Share your thoughts about the poster session -□ information shared, size and format, session location, etc.**

42 Responses 50 per page Update

Answer	Respondent
Posters really help fill in information that may not be shared (due to time, etc.) in the presentations. A must have	[redacted]
Good. There was more than enough detailed information. The limiting factor was my time, which your organization has no control over.	[redacted]
Great! Really enjoyed talking to the presenters that ml mcaught.	[redacted]
More information on the Fly risk to the industry	[redacted]
Good cutting edge inmformation with practical application. Bob Noha Zenith Agribusiness	[redacted]
There was no time to actually view them.	[redacted]
Set up perfectly	[redacted]
Good.	[redacted]
The poster session was good. However, the area was a little crowded particularly since the snack area was nearby. I would allow more room for poster section.	[redacted]
There should have been somebody to answer questioons at the poster site	Anonymous
Posters were great, but there is just too many people milling about to have enough time.	[redacted]
Bacause some of the sessions went over time and because there was limited time for lunch, it was difficult during the breaks to get access and time to read the posters. Much of the break time is used to discuss with peers the researchers findings and panel discussion. The area was physically over-croweded as well.	[redacted]
Very good infromation. I would like to have copies of many of the posters for training.	[redacted]
Right on the mark, symposium was relevant and timely	[redacted]
Poster session was very informative and well done	[redacted]
Need more time to review them.	[redacted]
Did not have enough time to read.. But the brochure included the main information.	[redacted]
There was no real poster session. The closing reception should have been in the poster area or allot time for the poster session. I would have liked more time to look at the posters.	[redacted]
I didn't get a chance to review any of the posters. Just not enough time this year with the truncated lunch session and short breaks. "Food safety activists" should not be associated with CPS. By the nature of our involvement with CPS we are all food safety activists. Dana's mother has her own agenda using her daughter's illness.	[redacted]
Excellent venue; however a separate room/area for posters - away from the refreshments would have provided better accessibility to each poster. Interesting research exposed. Having authors/presenters at each poster would have provided opportunity for discussions.	Anonymous
Outstanding! The posters are really valuable because we can take as much time as we wish to read them.	[redacted]
Good way to impart additional information "on the spot" after listening to brief summaries from presenters. Also, it is nice to see the data sets.	[redacted]
Excellent	[redacted]
Seemed to be an afterthought. I barely had the time to review them. They were nicely succinct though.	[redacted]

Someone should spell check the poster content before printing them. It reflects poorly on the researcher's names that are associated with them.	[redacted]
I did not get to cover all the posters. During breaks I was held up in other discussions. I'm disappointed that I did miss quite a few posters.	[redacted]
Need more space for people to walk by each other - the spacing was just too tight to move comfortably,	[redacted]
No formal poster session with the the scientists - the posters were simply there.	[redacted]
Looked great. I did not spend time there however as I was most interested in making people connections vs taking in data.	[redacted]
i liked the idea of limiting the researchers to the 8-10 minute recap. too bad many couldn't follow the rules. I was disappointed to learn that the researchers presentations were all edited the day before by CPS.	[redacted]
There is NOT enough time to review the poster sessions! It would be great if there was an opportunity to view the posters the night before the symposium event. Last year having the posters at the closing reception was great.	[redacted]
It was difficult to get through all of the posters in the time of the symposium. Would it be possible to get copies posted to the CPS website for review?	[redacted]
Very good.	[redacted]
Nice to see work and results on research projects that were not able to present at the symposium. It was difficult to read some of the posters as the sun was in your eyes while viewing. Set up and accessibility was good, but space was limited and therefore difficult to move around between people to see the next poster.	[redacted]
Could they be provided electronically or on paper as a take away?	[redacted]
I had very little time to look at posters. There should be a poster session in the schedule. The poster location was awkward in the morning - I needed sunglasses and a program to shade the posters because of the glare.	[redacted]
Presentastions were good, but maybe too many to really spend time on.	[redacted]
Very good format and easy to read. Nice location of posters so could be read at any time	[redacted]
Didn't seem to have enough time to review all of them. One poster was missing regarding washing your hands prior to eating...see #12 below...	[redacted]
No real problems.	[redacted]
Unfortuately, there was no specific poster session so there was not much time to read them during breaks. It would have been good to have the final reception in the poster area for people to have that additional time to read. I generally like posters.	[redacted]
Posters could be displayed better	Anonymous

50 per page Update

CPS 2012 Produce Research Symposium survey

Text answer(s) for:

12 **How could we improve your overall experience with logistics, registration, lunch, breaks, etc.?**

49 Responses 50 per page Update

Answer	Respondent
From my perspective, it is quite smooth. Early on, the on line registration seemed to have a glitch where I was not able to register (maybe).	[redacted]
While the lunch was delicious and interesting in its variety, the serving format was too slow. You need a diffent queuing system - maybe distribute the food across more serving tables, so the line could move faster and people would have more time to eat.	[redacted]
All was good - but I would prefer to go to mthe silo.	[redacted]
None	[redacted]
This probably should be a day and a half with an evening session being offered for several hours for poster viewing and small group discussion. Maybe sponsored by technology innovators?	[redacted]
Time management was lacking for presentations and discussions. Lunch was a bottleneck; multiple lines would have helped. Food itself was good and registration was easy. Facility was beautiful.	[redacted]
Good logistics and excellent food	[redacted]
I've attended all 3 produce symposiums and all have maintained the room chilly. I would keep room a little warmer.	[redacted]
All aspects of logistics were great, don't see how it could be improved.	[redacted]
Provide a more efficient process for lunch. Do not permit researchers to present over the alloted time. Allow for more time to review the poster session.	[redacted]
Very well organized and lunch was great!	[redacted]
N/A	[redacted]
lunch location was a challenge--otherwise, fine	[redacted]
Increase the event to 1.5 days allowing presenters more time, and for allowing more time for review of posters and networking. Avoid meeting conflicts such as was the case with IFT.	[redacted]
Lunch line could have been split into 2-3 lines for speed on a very hot day. California, Georgia, Florida and Texas are the best locations for this symposium (most attendees)	[redacted]
More time for a poster session.	[redacted]
Registration - smooth and simple Location of session - comfortable Lunch break - unreasonably short for the number of people needing to be fed. Poster session - not enough time to review. Area too tight to move through Wash water session - went on too long Final session - Not a lot of meat on the bone	[redacted]
Logistics was good.	[redacted]
Excellent venue, spacious, acoustics were perfect. Registration was very efficient/easy. Hospitality was wonderful. Not much to improve!	Anonymous
Registration was acceptable, as were the logistics and certainly the location was exemplary. There are significant areas of opportunity for improvement with respect to the amount of information and sessions that were attempted to be covered in one day. At least three buffet stations were needed to manage the number of attendees.	[redacted]

Lunch was awesome -- they just needed to have two lines going through the buffet -- other than that it was great!	[redacted]
Bottle-necked during the lunch hour.	[redacted]
Everything seemed to go seamlessly. Not sure what to suggest.	[redacted]
Not be so egalitarian and having next year's in a locale that makes industry participation more expensive and difficult. Traveling to New York from California and Arizona (where most vegetable production occurs) is a three day exercise.	[redacted]
Should have wireless internet in auditorium for those of us who need to get other work done - multitask.	[redacted]
Lunch break is a little short. The last session could have been skipped-- it was getting long by then. Overall a well-run, well-paced, informative symposium.	[redacted]
More frequent breaks. One hour is about all some of us can sit.	[redacted]
Facilities and planning were excellent except for the lunch accommodations where space was limited.	[redacted]
I thought the day went a little long. By the time the food industry /government discussion was up, I was in information overload. Then I needed to go socialize. Lunch and social times were great (food was also great). Perfect time to network.	[redacted]
2-days for meeting. People, many of them very rare to be around, were in one place. Many important conversations did not take place and so we did not get done what could have been gotten done. Lunch - a bit too many carbos - less carbos keeps people awake. Name tags - font needs to be larger, logo smaller.	[redacted]
The lunch line was far too slow!	[redacted]
Provide more opportunity for networking over lunch -- we spent most of our time in line for lunch and relatively less time was available for talking with others while eating. The Tues dinner and Wednesday reception were both GREAT opportunities to connect with others.	[redacted]
the only logistical issue was the lunch line being too long.	[redacted]
I was not able to attend the reception after the symposium because I had to catch a flight home. I would like to see the reception & poster sessions shifted to the night before the event.	[redacted]
Find a way to have food stations rather than one long line for the lunch.	[redacted]
This year I felt there was not enough time to network. I'm not sure if the times were different, but it would be nice to have an extra half of a day with a bit more information, time for questions and networking time.	[redacted]
Not much, it was very good!	[redacted]
Lunch was slow on delivery, and then rushed to finish and get back to the conference. Could breaks be another five minutes longer for networking purposes?	[redacted]
With so much information to present and such a large number of people to network with a 2-day format with more time for networking and social-interaction might be better. This year the lunch session was very-short, and the food was very slow which led to a lot of people missing the after lunch session.	[redacted]
Is there anyway to have a wifi connection during the meeting? if yes it should be easier to find.	[redacted]
I think you arleady know the answer to lunch! I thought everything else went well.	[redacted]
It seemed very rushed. There was little time to hunt down researchers for follow-up questions. That proved especially difficult for those who presented in the afternoon - there just wasn't enough time!	[redacted]
Everything was great except the lunch logistics and menu.....could have been not so fancy offerings.	[redacted]
Lunch could have been sit-down to speed the process up.	[redacted]
Being that there were food safety experts from all walks of life at the symposium, perhaps you can explain why just about every person at the conference did not wash their hands before going to lunch? or the reception?	[redacted]
Its great.	[redacted]
Expand to two days...Need more time	[redacted]
All of these portions were very well done.	[redacted]
Try to stay on schedule and have more serving lines at lunch.	[redacted]

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Text answer(s) for:

15 What additional comments would you like to share with the CPS?

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36 Responses

Answer	Respondent
This Symposium has really developed into a magnet for cross-functional interactions of researchers and industry leaders engaged in food safety. Well done; the momentum is on the side of those who value research and technology as key components to meeting the challenges as the industry feeds more and more people.	[redacted]
Good job.	[redacted]
You are clearly doing relevant work and collaborating well with the industry. The intro talk was very good at putting the meaning of quality control in front of everyone as a process everyone should want in all food processing.	[redacted]
None at this time	[redacted]
The questions during the opening session with the young girl were terrible. A case study or letting her present would have been much better. Give Bob a break and have someone else ask questions. I think he gets tired and by the afternoon it would be good to have another person. He is great but all day on is just too much to ask.	[redacted]
Pleased with the collaborative process in CA the last five years between research, industry, and growers.	[redacted]
I would like more note taking space below each research topic in the booklet like there was in the first years booklet.	[redacted]
The introduction with the girl was too much. We all care deeply about food safety already. Do other conferences start out with someone who has been hurt?	[redacted]
participants allowed to question both the presenters and panelists	Anonymous
Although I found the panels to be an asset For almost every question, each panelists was asked to weigh in. In the interest of time, we may be best served to limit the number of panelists that respond to each question. Moreover, there were a lot of audience members that wanted to ask questions, but w/limited time did not have a chance	[redacted]
The benefits of chlorine were well stated while disadvantages like safety, corrosion, adulteration of quality, and overall cost were not discussed. This 200 year old technology is outdated and has many limitations. Comparing benefits of chlorine to alternative antimicrobials would have been a nice addition.	[redacted]
N/A	[redacted]
need more time for Q&A with scientists after each presentation--panel discussion did not allow time for real audience participation--as a result, overall the sessions felt too "scripted" with very little interactivity	[redacted]
Opportunities for Advertisers at the Symposium? Would you sell opportunities to meet with farm reps for 10 min each?	[redacted]
I would have liked to had a summary/abstract that reflected the research results not just the proposed objectives.	[redacted]
I was disappointed by the opening session. Everyone in the room is accutely aware of the real cost of food-borne illness. It was distrubing to watch a mother continue to make her 14 year old daughter a victim of a food-borne illness contracted as a pre-schooler of which the child has memories reconstructed by her mother. Manipulative session.	[redacted]
Excellent work - important to continue sharing experience, research and ideas.	Anonymous
I liked the audience interaction with the various panels. The symposium was a great way to gain visibility on the scope of research and hear directly from the scientists involved. Presenting large hard to read spreadsheets populated with data that was difficult to see and sometimes understand was not effective. I liked the "take-home" format.	[redacted]

none	[redacted]
Tim was the wrong person to be interviewing the young lady. Too stiff. Someone with minimal media training would have been better.	[redacted]
I thought the first session was more emotion than fact based "here is a problem we need to solve". Yes that was a very traumatic event for several people. I was left with the impression that the industry, probably the grower was to blame. These situations are always emotional. Emotion, unfortunately does not always give doable results.	[redacted]
Hard copy literature and supporting documents when possible would be of significant benefit to most attendees. Research which is predicated upon its value to the the production of safe food is invaluable. Proactive sharing and application of information with those unable to attend due to budgetary issues or scheduling conflicts should be considered	[redacted]
What was done well was done well. It is just too rushed. I would also recommend making the poster session an open call to food safety researchers in North America. A lot of other research came out in the IFT meetings - we need to have more access to results faster.	[redacted]
Is it possible for the scientists conducting the research studies and/or the TAC to meet together to come up with more distilled, concrete conclusions and recommendations resulting from the body of work produced overall each year? The main findings could be built upon with each symposium.	[redacted]
Keep up the great work!	[redacted]
I left having a few unanswered questions about research. I'm not sure if everyone felt comfortable airing their questions to the entire audience.	[redacted]
Consider shortening or eliminating the last session on food industry/gov discussion. While the speakers are fine, they really don't say anything of specific value. Much less impact than all the previous sessions.	[redacted]
Very interesting meeting. Excellent organization.	[redacted]
I wish that the opening interview with the victim of salmonellosis would have been a little more informative and less dramatic. I understand that the purpose of the interview and I applaud her advocacy of food safety issues. She was very composted. However, I wish she had been asked better questions.	[redacted]
We may want to eliminate the time it takes to do panel questions and therefore have more time for audience questions.	[redacted]
Very worthwhile work.	[redacted]
Make it two days and give the researchers more time to talk. The pre-prepared questions weren't always on the mark. Some panelists had little to say of note, would have preferred hearing more from the researcher. Some break-out sessions with fewer people would encourage more dialogue between researchers and attendees.	[redacted]
The format with Dr. Bob Whitaker moderating and facilitating the discussion with questions and challenges was excellent. One of the best organized technical sessions I have ever attended.	[redacted]
I would suggest to make the presentations longer and cut down on the discussion.	[redacted]
Next year's session is too far away to attend for a one day meeting. The offer of having a day of wine and visiting the surrounding area could be altered to have group sessions where growers, government and the retailer address food safety expectiations and determine what issues are important to them. I could convince my employeer to attend this.	[redacted]
Keep up the great work.	[redacted]

50 per page Update

Dear Grower,

The California Department of Food and Agriculture (CDFA) is currently working on a new project to highlight and acknowledge the positive impact California's growers are having on the environment as a result of their management decisions and practices through the following survey.

- This voluntary and anonymous survey is designed to be completed by farmers who are directly engaged in growing horticultural crops, fruits and nuts and other specialty crops in California
- Various management practices including soil, water and pest management are covered in the survey
- Results will be used solely for educational purposes and the data will be pooled

Thank you for your participation and support. We greatly appreciate your time and consideration to help accomplish this unique endeavor.

If you prefer to complete the survey online, it is available at https://www.surveymonkey.com/s/CDFAsurvey. If you have any questions, comments, please feel free to contact us (Jessica Sharkey, Erica Anderson or Amrith Gunasekara) at: (916) 654-0433 or email us at EcoSysServices@cdfa.ca.gov

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

Wildlife Habitat and Biodiversity Enhancement: In this section we'd like to learn about activities on your farm that promote a diversity of plants and animals and also provide habitat for wildlife, including birds and predators.

1. **Do you conduct any of the following activities to enhance diversity on your farm?**
(Please circle the letter of **ALL** the following statements that apply to your farm)

    a. Have year-round or perennial vegetation that serves as a border along field edges

    b. Grow more than one crop in the same field at the same time

    c. Plants that are beneficial for bees and other pollinators are located near or within your fields

    d. None of these activities apply to my farm

    e. Other (please specify)____

2. **Are bird boxes and/or bat boxes located in or around your fields?**
(Please circle the letter that most closely applies to you)

    a. I am **CURRENTLY** conducting this activity on my farm

    b. I have **PREVIOULSY** conducted this activity but am not currently

    c. I have **CONSIDERED** but never implemented this activity

    d. I have **NEVER** conducted this activity on my farm

3. **Do you have vegetated shelter strips or hedgerows that provide habitat and/or serve as wind breaks?**
(Please choose one)

    a. I am **CURRENTLY** conducting this activity on my farm

    b. I have **PREVIOUSLY** conducted this activity but am not currently

    c. I have **CONSIDERED** but never implemented this activity

    d. I have **NEVER** conducted this activity on my farm

4. **Are wilderness areas or patches of natural habitat located within or next to your fields?**

    a. Yes

    b. No

Soil Management: In this section we'd like to find out more about how soil resources are managed in your fields.

5. **Do you implement any of the following practices to control soil erosion in your fields?** (Please circle the letter for **ALL** that apply)

    a. Water diversions are used to safely transport runoff

    b. Sediment traps or catch basins collect sediment from fields

    c. Stubble or crop residue is left on soil surface to serve as a mulch

    d. The amount of bare soil is minimized in order to prevent **wind erosion**

    e. None of these practices apply to my farm

    f. Other (please specify)____

6. **Do any of your fields have tiled or subsurface drainage which helps to remove excess water?**

    a. Yes

    b. No

7. **Are any of the following activities used in field preparations?** (Please circle **ALL** that apply to your farm)

    a. The soil is left undisturbed from harvest to planting (No-tillage techniques)

    b. Steep hillsides are not farmed or are stabilized

    c. The number of passes is reduced or combined (Reduced tillage techniques)

    d. Land leveling is used to improve uniformity of soil saturation and reduce erosion

    e. None of these activities apply to my farm

8. **Are residues of previous crops, including cover crops, incorporated before planting of the next crop?**

    a. Yes

    b. No

    c. Not applicable (ex. Orchards)

9. **Have you ever used mulches in your fields (ex. Plastic, straw, crop residue, cover crops)?**

    a. I am **CURRENTLY** conducting this activity on my farm

    b. I have **PREVOUSLY** conducted this activity but am not currently

    c. I have **CONSIDERED** but never implemented this activity

    d. I have **NEVER** conducted this activity on my farm

Nutrient Management: In this section, we'd like to learn about specific activities taking place in your fields which help guide fertilization practices.

For the following questions: Please indicate how frequently each activity takes places on your farm.
(Please circle one letter for each of the statements below)

F -- You **FREQUENTLY** perform this activity on your farm **(Once or more annually)**

O -- You **OCASSIONALLY** perform this activity on your farm **(Once every 2-4 years)**

R -- You **RARELY** perform this activity on your farm **(Once every 5 years)**

N -- You **NEVER** perform this activity on your farm

10. **Do you use any of the following methods to help guide nutrient management decisions in your fields?**

    a. Evaluate fertilization practices in relation to crop yield and quality.................. F O R N

    b. Determine specific nutrient requirements for each crop.................................. F O R N

    c. Use a nutrient budget worksheet to guide fertilizer applications....................... F O R N

11. **Are any of the following activities used to establish fertilization needs**?

    a. Analyze soil samples to determine nutrient concentrations.............................. F O R N

    b. Assess the amount of soil organic matter present in your fields....................... F O R N

    c. Perform soil nitrate quick tests in the field.. F O R N

    d. Conduct plant tissue sampling to assess nutrient status.................................. F O R N

    e. Test irrigation water to determine levels of nutrients and salinity................... F O R N

12. **Which (if any) methods are used for fertilizer application on your fields?**
    (Please circle the letter of **ALL** the following that apply)

    a. Broadcast (without incorporation)

    b. Fertigation (fertilizer applied in irrigation water)

    c. Incorporation

    d. Foliar Spray

    e. Banding

    f. Other (please specify)____

13. **Which (if any) types of ORGANIC soil amendments have been applied on your fields?** (Please circle **ALL** of the following that apply)

    a. Manure (swine, poultry or cattle)
    b. Green manure (cover crops)
    c. Compost
    d. I do not use organic amendments on my farm
    e. Other (please specify) ____

14. **Have you ever adjusted fertilizer rates or timing of applications based on nitrogen concentrations present in soil or irrigation water?** (Please circle the letter that most applies)

    a. Yes
    b. No
    c. Not applicable

15. **Do you make multiple (smaller) applications of nitrogen fertilizer throughout the season instead of a single (larger) application at the beginning of the season?** (Please circle one)

    a. I am **CURRENTLY** conducting this activity on my farm
    b. I have **PREVOUSLY** conducted this activity but am not currently
    c. I have **CONSIDERED** but never implemented this activity
    d. I have **NEVER** conducted this activity on my farm

16. **Have you used crop rotations in any of your fields?**

    a. Not applicable (ex. Tree crops, vineyards)
    b. Never ➡ Please skip to the next question
    c. Yes

    ⬇

    If yes, please rank the following reasons **why you use crops rotations:**
    (With 1 being the most and 5 being the least important to you)

    i. Promote diversity of plants and insects ______
    ii. Pest, disease or weed management ______
    iii. Improve soil characteristics ______
    iv. Enhance water resources ______
    v. Economic considerations ______

Pest, Disease and Weed Management: Now we'd like to learn more about how insects, weeds, pathogens and plant diseases are managed on your land.

For the following questions: Please indicate for each statement which most closely applies to you.
(Please circle one letter for each of the statements below)

C --You are **CURRENTLY** conducting this activity on your farm
P --You have **PREVIOUSLY** conducted this activity on your farm but are not currently
N --You have **NEVER** conducted this activity on your farm
U --You are **UNSURE** about this activity, or it is not applicable to your farm

17. **Do you perform any of the following activities to assist in making management decisions?**
    a. Employ assistance from Pest Control Advisors (PCA) or extension agents………… C P N U
    b. Monitor pest, disease and weed activity year-round………………………………………. C P N U
    c. Determine economic thresholds of acceptable damage…………………………………. C P N U

18. **Regarding pesticide applications made in your fields, do you conduct any of the following activities**?
(Pesticide is used broadly to include: insecticides, fungicides, miticides, rodenticides and herbicides)
    a. Apply reduced-risk (**not** broad-spectrum) pesticides……………………………………… C P N U
    b. Apply chemicals approved for organic production…………………………………………… C P N U
    c. Spray different types of pesticides to prevent development of pest resistance… C P N U
    d. Use spot treatments for "hotspots" of pest activity or disease within fields……… C P N U

19. **Are any of the following activities done to control pests, weeds or disease in your fields**?
    a. Trap crops are used to lure insect pests away from high-value crops………………… C P N U
    b. Strips of non-crops are planted between rows, or intercropping occurs…………… C P N U
    c. Timing of planting or harvesting is altered to avoid periods of peak infestation… C P N U
    d. Equipment is cleaned when moving from infested to non-infested areas………… C P N U
    e. Natural enemies are used to control insect pests……………………………………………. C P N U

20. **Do you use alternative techniques besides pesticides in your fields to control pests, weeds or disease?**
    a. I do not apply commercial pesticides on my fields
    b. Never ➡ Please skip to the next question
    c. Yes
    ⬇
    If YES you use alternative techniques, please briefly explain your methods.

    ____

    ____

Water Management: In this section we'd like to find out more about how water resources are managed and how irrigation takes place on your farm.

21. **Please identify the MAIN source of water used for irrigation needs on your farm.**

    a. Groundwater

    b. Surface water

    c. Municipal water

    d. I do not irrigate my fields

    e. Other (please specify)____

22. **Which irrigation methods are used in your fields or orchards?**
    (Please indicate the percent (%) each method is used to meet your farm's irrigation needs)

    a. Furrow _____%

    b. Flood _____%

    c. Overhead Sprinkler _____%

    d. Drip _____%

    e. Micro-sprinkler _____%

23. **Have you ever visited the California Irrigation Management Information System (CIMIS) website** http://wwwcimis.water.ca.gov/cimis/welcome.jsp **to determine evapotranspiration rates**?

    a. Yes

    b. No

24. **Were any adjustments made (within the past 5 years) to water management practices or irrigation techniques in your fields?**

    a. No ➡ please skip to the next question

    b. Yes

    ⬇

    If YES you have adjusted irrigation practices, please briefly explain the changes made and the result of these changes.

    ____

    ____

25. **Do you conduct any of the following practices to support water management decisions in your fields?** (Please circle the letter of **ALL** that apply to you)

    a. Develop a water management strategy based on previous growing seasons
    b. Develop a water budget (based on soil type and rooting depth)
    c. Determine the efficiency of irrigation systems
    d. None of these practices apply to my farm
    e. Other (please specify)____

26. **Are any of the following activities used to determine irrigation needs in your fields?** (Please circle the letter of **ALL** that apply to you)

    a. Soil water measurements are made to monitor soil moisture (ex. tensiometer, moisture sensors)
    b. Leaf water potential is measured to determine plant water status (ex. pressure bomb)
    c. Use weather data (or CIMIS website) to evaluate crop evapotranspiration
    d. None of these practices apply to my farm
    e. Other (please specify)____

27. **Do you minimize surface water runoff to control the amount of water leaving your fields**?

    a. Yes
    b. No
    c. Occasionally
    d. Not applicable

28. **Which (if any) of the following activities do you use to manage water quality on your land?** (Please circle the letter of **ALL** that apply to you)

    a. Monitor amount of nutrients, salinity or pesticides in tail water
    b. Estimate leaching requirements and maintain salinity levels
    c. Use filter strips to slow down or filter water runoff from your fields
    d. None of these practices apply to my farm
    e. Other (please specify)____

Other Considerations: In this section, we'd like to learn a little bit more about some of the basic characteristics of your farm and management decisions.

29. **Have you ever used improved varieties or hybrid seeds in your field?**
(ex. Improved varieties poses specific desired traits or characteristics)

    a. No ➡ please skip to the next question

    b. Yes

    ⬇

    If yes, please rank the following reasons **why you use improved varieties**
    (With 1 being the most and 5 being the least important to you)

    i. Increased pest resistance ______
    ii. Drought tolerant or resistant ______
    iii. Less fertilizer required ______
    iv. Higher Yield ______
    v. Better quality ______

30. **Have you reduced the amount of fuel or energy required to run operations of your farm?**
(Please select the one that most applies to you)

    a. No ➡ please skip to the next question

    b. Yes

    ⬇

    If YES you have reduced fuel consumption, please briefly describe your methods

    ____

    ____

31. **Do you use renewable energy on your farm?**

    a. No ➡ Please skip to the next question

    b. Yes

    ⬇

    If yes **you have renewable energy on your farm**, please circle **ALL** that apply

    i. Solar power
    ii. Wind power
    iii. Methane gas production
    iv. Bio-fuel production from crops (ex. Ethanol)

32. **Which (if any) recreational activities does your farm provide to the public?**
(Please circle the letter of **ALL** that apply to your farm)

a. Accommodations (Bed & Breakfast, Camping, Farm stays, Guest ranch, Wedding or Event facilities)
b. Direct Sales (Farm stand, Farmers' market, Farm meals, U-pick, Wine tasting)
c. Educational Experiences (Farm tours, classes or workshops, demonstration days, school tours, winery tours)
d. Entertainment (Festivals or fairs, Games or contests, Hay rides or petting zoo, Picnic area, Holiday activities)
e. Outdoor Recreation (wildlife viewing, game/wildlife preserve, horseback riding, nature walks, photography)
f. Other (please specify) ____

33. **How many acres are you currently farming?** _____acre(s)

34. **In what California postal code does the majority of this land reside?** ________________ (zip code)

35. **How many years have you been farming this land** (If less than one year, please enter 1)? _____year(s)

36. **How many acres do you currently have under each of the following uses?**

a. Crop production _____acre(s)
b. Livestock production _____
c. Greenhouse production _____
d. Non-crop vegetation (natural habitat, undisturbed areas) _____
e. Wetlands, pond or streams (seasonal or permanent) _____
f. Conservation easement (not under crop production) _____

37. **How many acres under CROP PRODUCTION are being used for each of the following?**

a. Horticultural crops (vegetables, herbs) _____acre(s)
b. Tree crops (fruit or nut production) _____
c. Non-specialty crops (grains, agronomic crops, feed crops) _____
d. Fuel crops _____
e. Nursery crops _____
f. Flower or ornamental crops _____
g. Vineyard _____

38. **If you engage in conservation practices, what are your main motivations?**
(Please select **ALL** that apply)

    a. Prevent unwanted pests
    b. Encourage predatory pests
    c. Stewardship
    d. Improve productivity
    e. Increase revenues
    f. Other (please specify)____

39. **Do you receive external financial support for the purpose of conservation practices?**

    a. Yes
    b. No
    c. I have **PREVIOUSLY** received funding, but no longer do

40. **If you received a monetary incentive in the future, would you engage in practices that are environmentally beneficial and contribute to ecosystem services?**

    a. Yes
    b. No
    c. Not Sure

41. **Are there other environmental practices which take place on your farm that you feel were not covered in this survey, or if you have additional comments, please feel free to share them below.**

____

____

____

____

____

____

Thank you for taking the time and effort to fill out this survey; your input is invaluable. Additional comments or suggestions are greatly appreciated. Please feel free to contact us at (916) 403-6703 or email us at EcoSysServices@cdfa.ca.gov. Please note, this survey is voluntary and anonymous. If you would like to include your contact information or email address, please use the space below.

Please return completed survey to:

Jessica Sharkey
Erica Anderson
Graduate Student Assistants
California Department of Food and Agriculture
1220 N Street
Sacramento, CA 95814

Memorandum of Understanding
Between California Foundation for Agriculture in the Classroom and
Chatom Elementary School

Central Valley Farm to School Pilot Program

California Foundation for Agriculture in the Classroom (CFAITC) is cooperating with Chatom Elementary to pilot a unique opportunity to educate students about the benefits of healthy eating and California specialty crops.

FARM TO SCHOOL BACKGROUND:
The purpose of the Central Valley Farm to School Pilot Program is to educate students about the importance and benefits of eating fruits and vegetables and introduce them to the abundant supply of these healthy choices that are produced in their community. Through educational resources, a field trip, school wide assemblies, an onsite farmers market, and the installation of a salad bar into the food service program, students will have the opportunity to meet local farmers who grow the produce, learn about the products they grow, taste a variety of produce, and benefit a salad bar as a lunch option at school. The pilot program will begin July 2012 and will run through June 2013.

Objectives:
1. Educate students about the benefits of eating healthy.
2. Increase students' awareness of California specialty crops.
3. Provide opportunities for students to have access to fresh produce.
4. Offer enrichment opportunities with educational resources.
5. Install a salad bar at the school site.
6. Present two school wide assemblies.
7. Arrange a field trip to a local farm.
8. Host a one-day farmers market on the school site.

CFAITC will orchestrate and plan the execution of the above objectives.

SCHOOL RESPONSIBILITY:
It is the responsibility of the school site principal to participate in arranging dates for the following: a teacher in-service event, school wide assemblies, a field trip, a farmers market, and gaining support from the onsite food service provider and educators to ensure the program is a success. The school will distribute and administer pre and post surveys provided by CFAITC. Once the pilot program concludes, it is the responsibility of the school to support the salad bar for the students.

PARTY SIGNATURES TO MOU

I have read all of the provisions outlined in this MOU, and agree to comply with every provision listed herein.

CA Fdn for Agriculture in the Classroom	Chatom Elementary School
Judy Culbertson	Chanda Rowley
Judy Culbertson, Executive Director	Chanda Rowley, Chatom Elementary School Principal

Specialty Crop Farmers Involved	
Peach Taste Test	J & J Ramos
Walnut Taste Test	Paul Wenger
Apple Taste Test	Greene and Hemly
Orange Taste Test	Steve Soderstrom
Honey Taste Test	Orion Johnson
Honey Taste Test	Denise Qualls
Almond Taste Test	Jonnalee Henderson
Almond Taste Test	Mel Machado
Pear Farmer/Presenter	Jim Culbertson
Dried Fruit Taste Test	Bella Viva Orchards
Kale Taste Test/Produce Farmers' Market	Rattos Bothers
Farmers' Market booth	Rich Wright
Farmers' Market booth	Debbie Costa
Farmers' Market booth	Diana Lewis
Farmers' Market booth	Tony Tsymbal
Farmers' Market booth	Kristen Santos

Farmers' Market Participants	
Grandpa Wrights Almonds	Rich Wright
Great Valley Farms	Debbie Costa
Legacy Toffee	Diana Lewis
Golden Comb	Tsymbal
After School Science Club	Kristen Santos
Bountiful Produce	Provided by Rattos Brothers

Farm to School Monthly Taste Test		
Produce	**Farmer**	**Month**
Peaches	J & J Ramos	September
Walnuts	Paul Wenger	October
Apples	Greene and Hemly	November
Citrus	Steve Soderstrom	January
Honey	Orion Johnson/ Denise Qualls	February
Almonds	Henderson/ Machado	March
Dried Fruit	Bella Viva Orchards	April
Kale	Rattos Bothers	May

	Total # of Students	I am a:	I am in grade:	Do you live on a farm?	Do you have friends or relatives who live on a farm?	California is the leading agricultural state in the United States.	Fruit and tree nuts are specialty crops.	California does not have micro-climates that allow farmers to grow many different crops.	Name one place where you can buy specialty crops.	Name one of the top three commodities produced in your county.	Specialty crops grow best in Mediterranean climates.
		Response	Response	Response	Response	Response	Response	Response	Open-Ended Response	Open-Ended Response	Response
KEY						TRUE	TRUE	FALSE	Answers Vary	Milk, Almonds, Chickens, Walnut, Corn	TRUE
Pre Survey	157	Girl- 55 Boy- 45	3- 27, 4- 31, 5-37	Yes- 42, No-58	Yes- 71, No- 29	85%	69%	38%	56%	10%	61%
Post Survey	200	Girl- 55 Boy- 45	3- 33, 4- 27, 5-30	Yes- 35, No-65	Yes- 76, No- 24	85%	70%	64%	70%	36%	57%

Student Survey Pre-project									
I am a:	I am in grade:	Do you live on a farm?	Do you have friends or relatives who live on a farm?	California is the leading agricultural state in the United States.	Fruit and tree nuts are specialty crops.	California does not have micro-climates that allow farmers to grow many different crops.	Name one place where you can buy specialty crops.	Name one of the top three commodities produced in your county.	Specialty crops grow best in Mediterranean climates.
Response	Response	Response	Response	Response	Response	Response	Open-Ended Response	Open-Ended Response	Response
Girl	4	No	Yes	FALSE	TRUE	FALSE	farm	fruit	TRUE
Girl	4	Yes	Yes	TRUE	TRUE	FALSE	store	fruit	TRUE
Girl	4	No	Yes	TRUE	FALSE	FALSE	Walmart	straberry	TRUE
Girl	4	No	No	TRUE	FALSE	TRUE	Cost Less	fruit	FALSE
Girl	4	Yes	No	TRUE	TRUE	FALSE	Farmers	Fruit	FALSE
Boy		No	Yes	TRUE	TRUE	TRUE	super markit	oranges	TRUE
Boy	4	Yes	Yes	TRUE	TRUE	FALSE	store	fruits	TRUE
Boy	4	Yes	Yes	FALSE	TRUE	FALSE	Free market	watermelon	FALSE
Boy	4	No	Yes	TRUE	FALSE	TRUE	Food Max	Fruit	FALSE
Boy	4	Yes	Yes	TRUE	TRUE	TRUE	A store	corn	FALSE
Boy	4	Yes	Yes	FALSE	TRUE	TRUE		tomtws	TRUE
Girl	4	Yes	No	FALSE	TRUE	TRUE	Food Max	orange	TRUE
Girl	4	Yes	Yes	TRUE	TRUE	FALSE		Almounds	FALSE
Girl	4	No	Yes	TRUE	TRUE	FALSE		fruits	FALSE
Girl	4	No	Yes	TRUE	FALSE	FALSE		vedtibals	FALSE
Boy	4	No	Yes	TRUE	TRUE	FALSE	pare	food	FALSE
Boy	4	No	No	FALSE	TRUE	FALSE	on a farm	grapes	FALSE
Girl	4	No	No	TRUE	FALSE	FALSE	gorshye	fruit	FALSE
Girl	4	No	Yes	TRUE	TRUE	FALSE	Food Maxx	apple	FALSE
Boy	4	No	Yes	TRUE	FALSE	FALSE	aspecle store	Turlock	TRUE
Girl	4	Yes	No	FALSE	TRUE	TRUE	farm	mango	FALSE
Boy	4	No	Yes	TRUE	FALSE	TRUE	free market	apple	TRUE
Boy	4	No	No	TRUE	FALSE	FALSE	grosery store	fruit	FALSE
Girl	4	No	Yes	FALSE	TRUE	TRUE	Fle market	fruit	FALSE
Boy	4	No	Yes	TRUE	TRUE	FALSE	Food Max	Stores	TRUE
Boy	4	Yes	No	TRUE	TRUE	FALSE		friuts	TRUE
Boy	4	No	Yes	TRUE	FALSE	FALSE	farms	stores	FALSE
Girl	4	No	No	TRUE	FALSE	FALSE	at a store	water melen	FALSE
Girl	4	Yes	Yes	TRUE	TRUE	FALSE		fruit	TRUE
Boy	5	Yes	No	FALSE	TRUE	TRUE	con	con	TRUE
Boy	5	Yes	Yes	TRUE	FALSE	TRUE			TRUE
Boy	5	Yes	Yes	TRUE	TRUE	TRUE			TRUE
Boy	5	No	Yes	TRUE	FALSE	TRUE		walnuts	TRUE
Boy	5	Yes	Yes	TRUE	TRUE	FALSE	Cost Less	trlock	FALSE
Girl	5	No	No	TRUE	TRUE	TRUE			TRUE
Girl	5	No	No	TRUE	TRUE	TRUE			FALSE
Girl	5	Yes	Yes	TRUE	TRUE	FALSE		Turlock	TRUE
Boy	5	Yes	Yes	TRUE	TRUE	FALSE	cosco	almonds	FALSE
Girl	5	Yes	Yes	TRUE	TRUE	FALSE		turlock	FALSE
Girl	5	No	Yes	TRUE	FALSE	FALSE			TRUE
Girl	5	Yes	Yes	TRUE	TRUE	TRUE			TRUE
Boy	5	No	Yes	TRUE	TRUE	FALSE	groccry store	corn	TRUE

Girl	5	Yes	Yes	TRUE					TRUE
Girl	5	No	Yes	TRUE	FALSE	TRUE	Winton market	Stanislous	TRUE
Girl	5	Yes	Yes	TRUE	TRUE	FALSE	store's	?	
Girl	5	Yes	Yes	TRUE	TRUE	FALSE	store		
Boy	5	Yes	Yes	TRUE	TRUE	FALSE	store		FALSE
Girl	5	No	No	FALSE	TRUE	FALSE	Stores		TRUE
Girl	5	Yes	Yes	TRUE	TRUE	FALSE	farm		TRUE
Boy	5	Yes	Yes	TRUE	TRUE	FALSE	in a store		TRUE
Girl	5	No	Yes	TRUE	TRUE	TRUE	Food Max		TRUE
Girl	5	Yes	Yes	TRUE	TRUE	FALSE		corn, Almonds , and white corn	TRUE
Boy	5	No	No	TRUE	TRUE	FALSE			FALSE
Girl	5	No	No	TRUE	TRUE	FALSE			TRUE
Boy	5	No	Yes	TRUE	TRUE	FALSE			FALSE
Girl	4	No	Yes	TRUE	TRUE	TRUE	walmart , flea market , food max	tomats	FALSE
Girl	4	Yes	Yes	FALSE	TRUE	FALSE	in the story	learn	TRUE
Girl	4	No	No	TRUE	FALSE	TRUE	fruit and trees	toll tree	TRUE
Boy	4	No	Yes	TRUE	TRUE	FALSE	in a field	California	TRUE
Boy	4	No	Yes	TRUE	TRUE	FALSE	safeway	cows	FALSE
Boy	4			TRUE	TRUE	FALSE	TRUE	FALSE	TRUE
Boy	4	No	Yes	TRUE	FALSE	TRUE	Wallmart	Milk	FALSE
Girl	4	No	Yes	FALSE	TRUE	FALSE		milk	FALSE
Girl	4	No	Yes	TRUE	TRUE	FALSE	Savemart	Almonds	TRUE
Girl	4	Yes	Yes	TRUE	FALSE	TRUE	Food masc	cino green	FALSE
Boy	4	No	No	FALSE	TRUE	FALSE	Costoool	water	TRUE
Girl	4	No	Yes	TRUE	FALSE	FALSE	a grocery	milk	FALSE
Boy	4	Yes	Yes	TRUE	TRUE	FALSE	Farm	corn	FALSE
Girl		Yes	Yes	TRUE	TRUE	FALSE	Fruit barn	milk ,corn ,almonds	
Girl	4	Yes	Yes	TRUE	TRUE	TRUE	soderstem stand	almonds and corn	FALSE
Girl	4	Yes	Yes	TRUE	TRUE	TRUE	Grocery store	milk	FALSE
Girl	4	Yes	Yes	TRUE	TRUE	TRUE	Soderston Stard	almonds and corn	FALSE
Boy	4	No	Yes	TRUE	TRUE	FALSE	Walmart	cheese	FALSE
Boy	4	No	Yes	TRUE	TRUE		railies		TRUE
Boy	4	No	Yes	TRUE	TRUE	FALSE	the store	milk	FALSE
Girl	4	Yes	Yes	TRUE	FALSE	TRUE	the store	corn	FALSE
Girl	4	Yes	Yes		FALSE	FALSE	food mack		FALSE
Girl	4	Yes	Yes	TRUE	TRUE	TRUE	Flea Mact	store	TRUE
Girl	4	Yes	Yes	TRUE	TRUE	FALSE	Market	milk,fruit,trees	TRUE
Girl	4	No	Yes	TRUE	TRUE	TRUE	Farmers Market	Milk, yougurt, cheese	FALSE
Boy	4	No	No	TRUE		TRUE		milk	FALSE
Boy	4	No	Yes	TRUE	FALSE	FALSE	Costles	shcool	TRUE
Girl	4	No	No	TRUE	FALSE	FALSE	At the soos	At the top	FALSE
Girl	4	No	Yes	TRUE	TRUE	TRUE	farm's	crop's	TRUE
Boy	5	No	Yes	TRUE	FALSE	TRUE		Mersed county	TRUE
Girl	5	No	Yes	FALSE	FALSE	FALSE	farms	Corn	TRUE
Girl	5	No	Yes	FALSE	TRUE	TRUE	Flea Market	Corn	FALSE
Boy	5	Yes	No	FALSE	TRUE	TRUE	Gorden Mart	fruits	FALSE
Girl	5	No	Yes	TRUE	TRUE	FALSE			FALSE
Girl	5	No	Yes	TRUE	FALSE	TRUE	Cosco	nuts	TRUE
Boy	5	Yes	Yes	TRUE	TRUE	FALSE	Safeway	Almonds	FALSE

Girl	5	No	Yes	TRUE	TRUE	TRUE	Saveway	crops	FALSE
Boy	5	Yes	Yes	TRUE	TRUE	FALSE	Farmers Market	San Waken	TRUE
Girl	5	Yes	Yes	TRUE	FALSE	TRUE	Farmers Market	carrots, meat, vegevels	TRUE
Girl	5	No	No	FALSE	TRUE	FALSE	A farm	Corn	TRUE
Boy	5	No	Yes	TRUE	TRUE	FALSE	Walmart		TRUE
Girl	5	Yes	Yes	TRUE	TRUE	FALSE	grosry stocys		TRUE
Girl	5	No	No	TRUE	TRUE	FALSE			FALSE
Boy	5	No	No	TRUE	FALSE	TRUE	Cost Less	Oak Tree	FALSE
Boy	5	Yes	Yes	TRUE	TRUE	TRUE	Cost Less	Turlock	FALSE
Boy	5	No	Yes	TRUE	TRUE	TRUE	grochrie shop		FALSE
Boy	5	Yes	No	TRUE	TRUE	FALSE	market	San Jacking	TRUE
Girl	5	Yes	Yes	FALSE	TRUE	FALSE	On a farm	A store	FALSE
Girl	5	No	Yes	TRUE	FALSE	TRUE	On a farm		TRUE
Girl	5	No	No	TRUE	FALSE	FALSE	California	San Llwin	TRUE
Girl	5	Yes	No	FALSE	TRUE	FALSE	Market		TRUE
Boy	5	No	Yes	FALSE	FALSE	TRUE	Hilmar		TRUE
Girl	5	No	No	TRUE	FALSE	FALSE	fruit barn	Valley	TRUE
Girl	5	Yes	No	TRUE	FALSE	FALSE	Flea market	Sacermento	FALSE
Girl	5	Yes	Yes	TRUE	FALSE	FALSE	farm	Sacromento	FALSE
Girl	5	Yes	Yes	TRUE	FALSE	FALSE	homedipot	corn	TRUE
Boy	5	No	Yes	TRUE	TRUE	FALSE	store	wallnuts	TRUE
Boy	5	No	Yes	TRUE	TRUE	FALSE	the flee market	San Juaking county	FALSE
Boy	5	No	Yes	FALSE	FALSE	TRUE		Almonds	FALSE
Girl	5	No	No	TRUE	TRUE	TRUE	Cost Less	vegetables	TRUE
Girl	5	Yes	Yes	TRUE	TRUE	TRUE	flea market	watermellons	TRUE
Girl	3	Yes	Yes	TRUE	TRUE	FALSE	At a store	united states	FALSE
Boy	3	Yes	Yes	TRUE	TRUE	FALSE	womort	R I Star	FALSE
Boy	3	No	Yes	TRUE	TRUE	TRUE	Food Market	crops	TRUE
Girl	3	Yes	Yes	TRUE	TRUE	FALSE	Shop	farm	TRUE
Boy	3	No	No	TRUE	TRUE	TRUE	Food Market	crop	TRUE
Boy	3	No	Yes	TRUE	TRUE	TRUE	California	crops	FALSE
Girl	3	Yes	Yes	TRUE	TRUE	TRUE	Food Market	crop	TRUE
Girl	3	Yes	Yes	TRUE	TRUE	TRUE	Fleamarket	crop	TRUE
Girl	3	Yes	Yes	TRUE	TRUE	FALSE	The coco	Abrhamlikn	TRUE
Boy	3	No	No	TRUE	TRUE	TRUE	Super Market	cropes	TRUE
Boy	3	No	No	TRUE	TRUE	FALSE	Walmart	crops	FALSE
Boy	3	No	No	FALSE	FALSE	FALSE			
Boy	3	No		TRUE	FALSE	TRUE			TRUE
Boy	3	Yes	Yes	TRUE	TRUE	TRUE	The store	The corn	TRUE
Boy	3	No	No	TRUE	TRUE	TRUE			TRUE
Girl	3	Yes	No	TRUE	FALSE	TRUE	A Farmer Market	toons	TRUE
Girl	3	No	Yes	TRUE	TRUE	TRUE	California	crop	TRUE
Girl	3	No	No		FALSE	TRUE			TRUE
Boy	3	No	No		FALSE	FALSE	Food Max		TRUE
Girl	3	No	Yes	TRUE	TRUE	TRUE	Food Max	I live in Turlock	TRUE
Girl	3	Yes	No	TRUE	FALSE	TRUE	Food 4 Less	West Mian	TRUE
Girl	3	No	No	FALSE	TRUE	FALSE	Food Max	West Man	TRUE
Girl	3	Yes	Yes	TRUE	TRUE	TRUE	Farm		TRUE
Boy	3	No	Yes	TRUE	FALSE	TRUE	Farm		TRUE

Boy	3	Yes	No	TRUE	TRUE	FALSE	The mrkit		TRUE
Girl	3	No	Yes	TRUE	TRUE	FALSE	A Farm		TRUE
Girl	3	No	Yes	TRUE	TRUE	FALSE	At a Framers Market	At a Farm	TRUE
Boy	3	No	No	TRUE	TRUE	TRUE			TRUE
Boy	3	Yes	Yes	TRUE	TRUE	FALSE	The Market	Wal Mart	TRUE
Boy	3	No	No	TRUE	FALSE	FALSE	Cosco		TRUE
Boy	3	No	No	TRUE	TRUE	TRUE			TRUE
Boy	3	No	No	TRUE	TRUE	TRUE	TRUE		TRUE
Boy	3	No		TRUE	TRUE	TRUE			TRUE
Girl	3	Yes	Yes	TRUE	TRUE	TRUE	California Agricultural	Nuts	TRUE
Boy	3	Yes	Yes	TRUE	FALSE	TRUE	Super Market		TRUE
Boy	3	No	Yes	TRUE	FALSE	TRUE	Mexico	Los Rvegas	TRUE
	3	No	Yes	TRUE	FALSE	TRUE	A Fram		TRUE
Girl	3	Yes	Yes	TRUE	TRUE	TRUE			TRUE
Boy	3	No	Yes	FALSE	FALSE		Savemart		
Girl	3	No	Yes	TRUE	TRUE	TRUE	Food Max	I Live in the US	TRUE
Girl	3	No	No		FALSE	TRUE			TRUE

Student Survey Post-project									
I am a:	I am in grade:	Do you live on a farm?	Do you have friends or relatives who live on a farm?	California is the leading agricultural state in the United States.	Fruit and tree nuts are specialty crops.	California does not have micro-climates that allow farmers to grow many different crops.	Name one place where you can buy specialty crops.	Name one of the top three commodities produced in your county.	Specialty crops grow best in Mediterranean climates.
Response	Response	Response	Response	Response	Response	Response	Open-Ended Response	Open-Ended Response	Response
Girl	5	Yes	Yes	TRUE	FALSE	FALSE	Farm	Milk	TRUE
Girl	5	No	Yes	TRUE	TRUE	FALSE	Any store	Almonds, strawberries, milk products.	FALSE
Boy	5	Yes	Yes	TRUE	TRUE	FALSE	Grocery Store	Dairy	TRUE
Boy	4	No	No	TRUE	TRUE	FALSE	Savemart	Dairy	FALSE
Girl	4	No	Yes	TRUE	TRUE	FALSE	Savemart	Dairy	FALSE
Boy	5	No	Yes	TRUE	FALSE	TRUE	A farm	Dairy	TRUE
Boy	4	No	Yes	FALSE	TRUE	FALSE	Store	Almonds	TRUE
Boy	4	No	Yes	TRUE	TRUE	FALSE	Walmart	Grapes	FALSE
Boy	4	No	Yes	TRUE	TRUE	FALSE	Farmers Market	Nuts	TRUE
Girl	5	Yes	Yes	TRUE	FALSE	FALSE	Field	Grapes	TRUE
Girl	4	No	Yes	TRUE	TRUE	FALSE	Supermarket	Almonds	TRUE
Boy	5	Yes	Yes	FALSE	TRUE	TRUE	Store	Milk	TRUE
Girl	4	No	No	TRUE	TRUE	FALSE	Store	Almonds	TRUE
Boy	4	No	Yes	TRUE	TRUE	FALSE	Savemart	Strawberries, corn, and oranges.	TRUE
Girl	4	No	Yes	TRUE	FALSE	FALSE	Stores	Dairy	TRUE
Boy	4	Yes	No	TRUE	TRUE	TRUE	Stores	Do not know.	TRUE
Girl	4	No	No	TRUE	TRUE	FALSE	Stores	Almonds	FALSE
Girl	5	Yes	Yes	TRUE	FALSE	TRUE	Stores	Grapes	TRUE
Girl	4	No	Yes	FALSE	TRUE	TRUE	Cost Less	Almonds, lemons, and peaches.	FALSE
Girl	4	No	No	TRUE	TRUE	TRUE	Market	Corn	TRUE
Girl	4	No	Yes	TRUE	TRUE	TRUE	Market	Corn	TRUE
Girl	4	Yes	Yes	TRUE	TRUE	FALSE	Garden	Apples, bananas, and oranges.	TRUE
Boy	5	No	Yes	TRUE	FALSE	TRUE	Grocery store	Alfalfa	FALSE
Boy	5	Yes	Yes	TRUE	TRUE	FALSE	Food Maxx	Nuts, almonds, and oranges.	TRUE
Girl	5	No	Yes	TRUE	TRUE	TRUE		Plants and apples.	FALSE
Boy	5	No	Yes	TRUE	TRUE	FALSE		Almonds, alfalfa, and corn.	FALSE
Girl	5	No	Yes	TRUE	FALSE	FALSE		Nuts, almonds, and corn.	FALSE
Girl	5	No	Yes	TRUE	TRUE	FALSE		Almonds	FALSE
Girl	5	No	Yes	TRUE	TRUE	FALSE	Safeway	Almonds, corn, and peaches.	TRUE
Girl	5	Yes	No	TRUE	FALSE	FALSE	Supermarket	Corn	FALSE
Girl	5	Yes	Yes	TRUE	FALSE	FALSE	Food markets	Almonds	TRUE
Girl	5	Yes	Yes	TRUE	TRUE	FALSE	In a market.	Nuts and almonds	TRUE
Girl	5	Yes	Yes	TRUE	FALSE	FALSE	Costless	Walnuts, apples, and oranges.	TRUE
Girl	5	Yes	Yes	TRUE	TRUE	FALSE	Costless	Strawberry, tree, and dairy.	FALSE
Girl	5	Yes	Yes	TRUE	TRUE	FALSE	Food Max	Corn, trees, fields.	FALSE
Boy	5	Yes	No	TRUE	FALSE	TRUE	Farmers Market	Almonds	FALSE
Girl	5	No	Yes	TRUE	TRUE	FALSE	Cost Less	Oranges	FALSE
Boy	5	Yes	Yes	TRUE	FALSE	FALSE	99 cent Store	Almonds, corn, and peaches.	TRUE
Girl	5	No	Yes	TRUE	FALSE	FALSE	Flea Market	Nuts, almonds, and grapes.	FALSE
Girl	5	Yes	Yes	FALSE	TRUE	FALSE	Safeway	Corn	TRUE
Boy	5	No	Yes	TRUE	FALSE	FALSE		Corn, hay, and almonds.	TRUE
Girl	5	Yes	Yes	TRUE	FALSE	FALSE	Flower Shop	Almonds, corn, and oranges.	TRUE
Girl	5	No	Yes	TRUE	FALSE	FALSE	Savemart	Apples, corn, and walnuts.	TRUE
Boy	5	No	Yes	TRUE	FALSE	FALSE		Almonds, corn, and apples.	FALSE
Girl	5	No	Yes	FALSE	FALSE	TRUE	Walmart	Oranges, almonds, and apples	FALSE
Boy	5	Yes	Yes	TRUE	TRUE	FALSE	Safeway	Almonds	FALSE
Boy	3	No	No	TRUE	FALSE	FALSE	A farm	Corn, apples, and oranges	TRUE

Girl	3	No	No	TRUE	TRUE	FALSE	Costco		
Boy	3	Yes	No	FALSE	TRUE	FALSE	Supermarket		FALSE
Boy	3	No	No	FALSE	FALSE	TRUE	Farmers Market	Ranch	FALSE
Boy	3	Yes	Yes	TRUE	FALSE	TRUE	Food Max		TRUE
Girl	3	Yes	Yes	FALSE	TRUE	FALSE	Farmers Market	Almonds, walnuts	
Boy	3	Yes	Yes	TRUE	TRUE	FALSE	Flea market		FALSE
Boy	3	No	Yes	FALSE	TRUE	TRUE		Nuts, corn, and alfalfa.	TRUE
Boy	3	No	Yes	FALSE	FALSE	TRUE	Farmers Market		TRUE
Boy	3	No	Yes	TRUE	TRUE	FALSE	Food market		TRUE
Boy	3	No	Yes	TRUE	FALSE	FALSE	Food Max		TRUE
Boy	3	No	No	FALSE	FALSE	FALSE	Farmers Market		TRUE
Boy	3	No	Yes	FALSE	FALSE	TRUE	Food Max		TRUE
Girl	3	No	Yes	TRUE	TRUE	FALSE	Your own garden or farm.	Almonds	TRUE
Boy	3	No	Yes	TRUE	TRUE	FALSE			TRUE
Boy	3	No	Yes	TRUE	TRUE	FALSE	Market		TRUE
Girl	3	Yes	Yes	TRUE	TRUE	FALSE	Farmers Market	Corn and vegetables	FALSE
Girl	3	No	Yes	TRUE	TRUE			Almonds	FALSE
Girl	3	No	Yes	TRUE	TRUE	FALSE	Cost Less	Fruit	TRUE
Girl	3	No	Yes	TRUE	TRUE	FALSE	On a farm		TRUE
Boy	3	No	Yes	TRUE	TRUE	FALSE			FALSE
Boy	3	No	Yes	FALSE	FALSE	TRUE	Farmers Market	Almonds	TRUE
Boy	3	No	Yes	TRUE	TRUE	TRUE	Food Max		FALSE
Girl	3	No	Yes	TRUE	FALSE	TRUE	Market		TRUE
Girl	3	Yes	Yes	TRUE	TRUE	TRUE	Market	Almonds	FALSE
Girl	3	Yes	Yes	TRUE	TRUE	FALSE	Farmers Market		FALSE
Boy	3	No	Yes	TRUE	TRUE	FALSE	Supermarket		TRUE
Boy	3	No	No	TRUE	FALSE	FALSE	Home Depot	Fruit	TRUE
Girl	3	No	No	TRUE	TRUE	FALSE	Michel's		FALSE
Girl	3	No	Yes	TRUE	TRUE	TRUE			TRUE
Boy	3	No	No	TRUE	TRUE	FALSE	Turlock	Corn, lemons and watermelon.	FALSE
Girl	3	Yes	Yes	TRUE	TRUE	FALSE	Cost Less		FALSE
Boy	3	No	No	TRUE	TRUE	TRUE		Fruit	TRUE
Girl	3	No	Yes	TRUE	TRUE	FALSE	Feed Store	Alfalfa	TRUE
Girl	3	No	Yes	FALSE	TRUE	FALSE	Food Max	Walnuts	TRUE
Boy	3	Yes	Yes	TRUE	TRUE	TRUE	Walmart		FALSE
Girl	3	Yes	Yes	TRUE	TRUE	FALSE			FALSE
Girl	3	No	No	TRUE	FALSE	TRUE	At the store.	Corn	TRUE
Girl	3	No	Yes	TRUE	TRUE	TRUE	Farm		FALSE
Boy	3	No	Yes	FALSE	TRUE	TRUE	Food Max		TRUE
Girl	3	Yes	Yes	TRUE	FALSE	FALSE	Food Max	Strawberries	TRUE
Boy	3	No	Yes	FALSE	TRUE	FALSE	Crop Stores		TRUE
Girl	3	No	Yes	FALSE	FALSE	FALSE	Flea Market	Cherries	TRUE
Boy	3	Yes	No	TRUE	FALSE	TRUE	A farm	Fruits and other food.	TRUE
Girl	3	Yes	Yes	TRUE	TRUE	TRUE	Flea Market	Cherries	TRUE
Boy	3	No	Yes	TRUE	FALSE	TRUE	Supermarket	Peanut Butter	FALSE
Girl	3	Yes	No	TRUE	FALSE	TRUE	Supermarkets	California	FALSE
Boy	5	Yes	Yes	TRUE	TRUE	FALSE	Walmart	Apples	FALSE
Boy	5	Yes	Yes	FALSE	FALSE	FALSE	Savemart Store	Fruit, nuts, specialty crops	FALSE
Girl	5	No	Yes	TRUE	TRUE	FALSE	Cost Less	Corn	FALSE
Girl	5	No		FALSE	TRUE	FALSE	In a garden.	Corn	TRUE
Girl	5	No		FALSE	TRUE	FALSE	In a garden.	Corn	TRUE
Boy	5	No	Yes	TRUE	TRUE	FALSE	Cost Less	Corn	TRUE
Girl	5	Yes	Yes	TRUE	TRUE	FALSE	Store	Corn	FALSE
Girl	5	No	No	TRUE	TRUE	FALSE	Store	Corn	FALSE

Girl	5	No	No	TRUE	FALSE	TRUE	Market	Corn	
Girl	5	No	Yes	TRUE	TRUE	FALSE	Food Maxx	Almonds, peaches, and oranges	FALSE
Girl	5	Yes	Yes	TRUE	TRUE	FALSE	Food Max or Cost Less	Corn, Milk, Almonds	TRUE
Girl	5	Yes	Yes	TRUE	FALSE	FALSE	Cost Less	Corn	FALSE
Girl	5	No	No	TRUE	TRUE	TRUE	Cost Less	Corn	FALSE
Boy	5	No	Yes	TRUE	FALSE	FALSE	Cost Less	Nuts	FALSE
Boy	5	Yes	Yes	FALSE	TRUE	TRUE	Store	Nuts	FALSE
Girl	5	No	Yes	TRUE	TRUE	FALSE	Supermarket	Apples	TRUE
Girl	5	Yes	Yes	TRUE	TRUE	FALSE	Food Max	Almonds	FALSE
Girl	5	No	Yes	TRUE	FALSE	TRUE	Food Max	Almonds	FALSE
Girl	5	Yes	Yes	TRUE	TRUE	FALSE	Costless	Corn	FALSE
Girl	5	Yes	Yes	TRUE	TRUE	TRUE	Fruit Market	Vegetable markets	FALSE
Boy	5	No	Yes	TRUE	FALSE	TRUE	Farmers Market	Almonds	TRUE
Girl	5	Yes	Yes	FALSE	TRUE	FALSE	Free Market	Corn	TRUE
Girl	5	Yes	No	TRUE	TRUE	FALSE	Supermarket	Corn	TRUE
Boy	5	Yes	Yes	TRUE	TRUE	FALSE	Blue Diamond	Almonds	FALSE
Boy	5	Yes	Yes	TRUE	TRUE	FALSE	Costco		TRUE
Boy	5	Yes	Yes	FALSE	TRUE	FALSE	Stores	Corn	TRUE
Girl	5	Yes	Yes	TRUE	TRUE	FALSE	Grocery Store	Corn	TRUE
Boy	5	No	Yes	TRUE	TRUE	TRUE	Target	Almonds	FALSE
Boy	4	No	No	TRUE	TRUE	TRUE	Food Max	Watermelons, grapes, and oranges	TRUE
Girl	4	Yes	Yes	TRUE	TRUE	FALSE	Tractor supply	Water	TRUE
Boy	4	No	No	TRUE	TRUE	FALSE	Food Max	Grains, corn, and fruits	FALSE
Girl	4	No	No		TRUE	TRUE	California		FALSE
Girl	4	No	No	TRUE	TRUE	FALSE	The market	Fruits, vegetables, and corn	TRUE
Boy	4	No	Yes		TRUE	FALSE	California		FALSE
Boy	4	No	No	FALSE	TRUE	TRUE			FALSE
Girl	4	No	No	TRUE	TRUE	FALSE	Food Max	Corn, grapes, nuts	TRUE
Girl	4	No	No	TRUE	TRUE	FALSE	Food Max	Watermelons, grapes, and apples	TRUE
Boy	4	Yes	Yes	TRUE	TRUE	FALSE	Flea Market	Watermelons, grapes, potatoes	TRUE
Boy	4	No	Yes	TRUE	TRUE	FALSE	Food Max	Watermelons, grapes, apples	TRUE
Girl	4	Yes	No	TRUE	TRUE	FALSE	Free Market	Grapes, tomatoes, watermelons	TRUE
Boy	4	No	Yes	TRUE	FALSE	TRUE	Grocery store	Fruits	TRUE
Girl	4	No	No	TRUE	TRUE	TRUE	Food Max	Watermelon, mango, strawberries	TRUE
Girl	4	No	Yes	TRUE	TRUE	FALSE	Grocery store		TRUE
Boy	4	No	Yes	TRUE	FALSE	FALSE	A shop	Grapes, carrots, watermelon	TRUE
Girl	4	Yes	Yes	TRUE	TRUE	FALSE	Supermarket	Watermelons, grapes, cherries	FALSE
Girl	4	Yes	Yes	TRUE	TRUE	FALSE	Supermarket	Watermelons, grapes, cherries	FALSE
Girl	4	Yes	No	TRUE	FALSE	FALSE	Foodmax		TRUE
Boy	4	No	No	TRUE	FALSE	FALSE	Food Max		TRUE
Boy	4	Yes	Yes	TRUE	TRUE	FALSE	Savemart	Watermelons	TRUE
Boy	4	No	Yes	TRUE	TRUE	FALSE		Watermelons	TRUE
Girl	4	No	Yes	TRUE	TRUE	FALSE	Walmart		TRUE
Girl	4	No	Yes	TRUE	FALSE	FALSE	Walmart	Grapes, Almonds	FALSE
Boy	4	Yes	Yes	TRUE	TRUE	TRUE	Stores	Watermelons	TRUE
Girl	4	Yes	No	TRUE	TRUE	FALSE	Food Maxx	Almond	TRUE
Boy	4	No	Yes	TRUE	FALSE	FALSE	Grocery store	Almonds	TRUE
Girl	4	No	Yes	TRUE	FALSE	FALSE	Foodmax	Fruit	TRUE
Girl	4	No	Yes	TRUE	TRUE	FALSE	Costco	Corn	TRUE
Boy	4	Yes	Yes	TRUE	TRUE	TRUE		vegetables	FALSE
Boy	4	No	Yes	TRUE	TRUE	FALSE	Supermarket	Grapes, apples, oranges	TRUE
Girl	3	No	Yes	TRUE	FALSE	FALSE	Food Market	Cows crops	TRUE
Boy	3	Yes	No	TRUE	TRUE	TRUE	Market	Cows	FALSE
Boy	3	No	No	FALSE	TRUE	TRUE	Corn	Crop	FALSE

Boy	3	No	Yes	TRUE	TRUE	FALSE	Stores	Trees	FALSE
Girl	3	Yes	No	TRUE	FALSE	TRUE	Stores	Cows	TRUE
Boy	3	No	No	TRUE	TRUE	FALSE	Food Max	Corn	FALSE
Girl	3	No	No	TRUE	FALSE	FALSE	Dog	almonds	TRUE
Boy	3	Yes	Yes	TRUE	TRUE	TRUE		Cows	TRUE
Boy	3	No	No	TRUE	FALSE	FALSE	Fruit	veggies	FALSE
Girl	3	No	No	TRUE	TRUE	TRUE	papaia	cows	FALSE
Girl	3	No	Yes	TRUE	FALSE	FALSE	Farm	Cow	TRUE
Boy	3	No	Yes	FALSE	FALSE	TRUE	Walmart	Apples	FALSE
Boy	3	No	Yes	TRUE	FALSE	TRUE	Store	Cow	FALSE
Boy	3	No	No	TRUE	TRUE	FALSE	Food Max	Corn	TRUE
Girl	3	No	Yes	TRUE	FALSE	TRUE	The store	Crops	FALSE
Boy	3	No	Yes	TRUE	TRUE	TRUE	At a crop store		
Boy	3	No	No	TRUE	FALSE	FALSE			TRUE
Girl	3	No	No	TRUE	FALSE	FALSE	Stores	Stores	FALSE
Boy	3	No	Yes	FALSE	FALSE	FALSE			TRUE
Boy	4	No	No	FALSE	TRUE	FALSE	Store	almonds	FALSE
Girl	4	No	Yes	TRUE	TRUE	TRUE	Grocery Store	Almonds	TRUE
Boy	4	No	Yes	TRUE	TRUE	FALSE	Farmers Market	Almonds	TRUE
Girl	4	Yes	Yes	FALSE	TRUE	TRUE	Cost less	almonds	TRUE
Girl	4	Yes	No	TRUE	FALSE	TRUE	Safeway	Almonds	FALSE
Boy	4	No	Yes	TRUE	TRUE	TRUE	Walmart	Almonds	TRUE
Girl	4	No	Yes	TRUE	TRUE	TRUE	Savemart	Almonds	FALSE
Boy	4	No	Yes	TRUE	TRUE	TRUE	Farms market	Almonds	TRUE
Girl	4	Yes	Yes	TRUE	TRUE	FALSE	Grocery store	Almonds	FALSE
Girl	4	No	Yes	TRUE	TRUE	TRUE	Walmart	Almonds	FALSE
Boy	4	No	Yes	TRUE	TRUE	TRUE	Food Max		
Girl	4	No	Yes	TRUE	TRUE	TRUE	Save-mart	Almonds	TRUE
Girl	4	No	Yes	FALSE	TRUE	FALSE	A store	Almonds	TRUE
Boy	4	Yes	Yes	TRUE	TRUE	TRUE	Farm	Nuts	TRUE
Girl	4	No	Yes	TRUE	TRUE	FALSE	The Fruit Store	Almonds	FALSE
Girl	4	Yes	Yes	TRUE	TRUE	FALSE	Walmart	Almonds	FALSE
Girl	4	Yes	Yes	TRUE	TRUE	FALSE	Walmarts		FALSE
Girl	4	No	Yes	TRUE	TRUE	FALSE	Farmers Market	Almonds	TRUE
Boy	4	Yes	Yes	TRUE	TRUE	TRUE	Store	Almonds	FALSE
Girl	4	Yes	Yes	TRUE	TRUE	FALSE	Food Max	all tree	TRUE
Boy	4	No	Yes	TRUE	TRUE	TRUE	Savemart	Almonds	TRUE
Boy	4	No	Yes	TRUE	TRUE	FALSE	Farmers Market	Grapes, strawberries	TRUE
Boy	4	No	Yes	TRUE	TRUE	TRUE	Stores	California	TRUE
Girl	4		Yes	TRUE	TRUE	TRUE	Stores	California	TRUE
Girl	4	No	Yes	TRUE	TRUE	TRUE	Farm market	Apple	FALSE
Boy	4	No	Yes	TRUE	TRUE	TRUE	Grocery store	Almond	FALSE
Girl	4	No	Yes	TRUE	TRUE	TRUE	Stores	Almonds	TRUE
Girl	4	No	Yes	TRUE	FALSE	TRUE	Farmers Market		TRUE
Girl	4	Yes	Yes	TRUE	FALSE	TRUE	Grocery store	Almonds	FALSE

Climate Change Impacts on Specialty Crops: Survey of Consortium Members

SurveyMonkey

1. Please assess your understanding of the following topics and terms using the scale below. choose the one answer that is the best self-assessment of your knowledge.

	Very Knowledgeable	Mildly Knowledgeable	Not Sure	Mildly Unknowledgeable	Very Unknowledgeabl
Statewide Agricultural Production Model	6.3% (1)	**50.0% (8)**	12.5% (2)	18.8% (3)	12.5% (2)
Projected minimum and maximum temperature	**62.5% (10)**	31.3% (5)	0.0% (0)	6.3% (1)	0.0% (0)
Agricultural vulnerability index	31.3% (5)	**62.5% (10)**	0.0% (0)	6.3% (1)	0.0% (0)
Winter chill requirements for fruit and nut trees	**56.3% (9)**	43.8% (7)	0.0% (0)	0.0% (0)	0.0% (0)
Winter chill models	43.8% (7)	**50.0% (8)**	0.0% (0)	0.0% (0)	6.3% (1)
Pest lifecycles and degree days	37.5% (6)	**43.8% (7)**	18.8% (3)	0.0% (0)	0.0% (0)
Pest distribution	12.5% (2)	**56.3% (9)**	25.0% (4)	6.3% (1)	0.0% (0)
Ecosystem services	37.5% (6)	**43.8% (7)**	12.5% (2)	6.3% (1)	0.0% (0)
Temperature effects on plant phenology	43.8% (7)	**56.3% (9)**	0.0% (0)	0.0% (0)	0.0% (0)
Impact of high temperatures at stages of plant growth	31.3% (5)	**56.3% (9)**	6.3% (1)	6.3% (1)	0.0% (0)
Climate change impacts on pollination services	37.5% (6)	**62.5% (10)**	0.0% (0)	0.0% (0)	0.0% (0)
Greenhouse gas emissions	**66.7% (10)**	33.3% (5)	0.0% (0)	0.0% (0)	0.0% (0)
Climate change scenarios	**56.3% (9)**	43.8% (7)	0.0% (0)	0.0% (0)	0.0% (0)

Changes in precipitation	43.8% (7)	**50.0% (8)**	6.3% (1)	0.0% (0)	0.0% (0)
Impacts of early snowmelt	**75.0% (12)**	25.0% (4)	0.0% (0)	0.0% (0)	0.0% (0)
Plant breeding for climate change	25.0% (4)	**62.5% (10)**	6.3% (1)	6.3% (1)	0.0% (0)
Definition of climate change adaptation	**81.3% (13)**	12.5% (2)	0.0% (0)	6.3% (1)	0.0% (0)
Definition of climate variability	**75.0% (12)**	18.8% (3)	0.0% (0)	6.3% (1)	0.0% (0)
Climate change impacts on occurrence of extreme events	**62.5% (10)**	37.5% (6)	0.0% (0)	0.0% (0)	0.0% (0)
Impact of sea level rise on water availability	25.0% (4)	**62.5% (10)**	12.5% (2)	0.0% (0)	0.0% (0)
Deficit irrigation	37.5% (6)	**56.3% (9)**	6.3% (1)	0.0% (0)	0.0% (0)
Water delivery modernization	**43.8% (7)**	37.5% (6)	12.5% (2)	6.3% (1)	0.0% (0)
Potential impacts of climate change on soil quality	13.3% (2)	**53.3% (8)**	26.7% (4)	6.7% (1)	0.0% (0)
Institutions involved in climate change adaptation research	25.0% (4)	**56.3% (9)**	12.5% (2)	6.3% (1)	0.0% (0)
Ongoing climate change research in California	18.8% (3)	**62.5% (10)**	6.3% (1)	12.5% (2)	0.0% (0)
					answered questio
					skipped questio

2. Please rank your level of concern regarding the following agricultural issues. 1 is very concerned, 5 is not concerned.

	1	2	3	4	5	Rating Count
Decreased water availability	**87.5% (14)**	0.0% (0)	0.0% (0)	0.0% (0)	12.5% (2)	16
Fuel costs	6.3% (1)	18.8% (3)	**62.5% (10)**	0.0% (0)	12.5% (2)	16
Climate change	**56.3% (9)**	6.3% (1)	25.0% (4)	6.3% (1)	6.3% (1)	16
Labor availability	25.0% (4)	**37.5% (6)**	31.3% (5)	6.3% (1)	0.0% (0)	16
New environmental regulations	**31.3% (5)**	25.0% (4)	12.5% (2)	25.0% (4)	6.3% (1)	16
					answered question	**16**
					skipped question	**0**

3. Please rank the following possible impacts of climate change indicating your severity of concern. 1 is very concerned, 5 is not concerned.

	1	2	3	4	5	Rating Count
Increased pests	25.0% (4)	**56.3% (9)**	0.0% (0)	12.5% (2)	6.3% (1)	16
Increased flooding	**37.5% (6)**	25.0% (4)	18.8% (3)	12.5% (2)	6.3% (1)	16
Plant heat stress	**43.8% (7)**	25.0% (4)	18.8% (3)	0.0% (0)	12.5% (2)	16
Decreased water availability	**87.5% (14)**	0.0% (0)	0.0% (0)	0.0% (0)	12.5% (2)	16
Less predictable climate	**43.8% (7)**	**43.8% (7)**	0.0% (0)	0.0% (0)	12.5% (2)	16
Loss of pollination opportunities	7.1% (1)	**42.9% (6)**	35.7% (5)	7.1% (1)	7.1% (1)	14
					Other (please specify)	2
					answered question	**16**
					skipped question	**0**

4. Are there benefits that California specialty crops may experience due to climate change?

	Response Percent	Response Count
Yes (answer question 5)	**81.3%**	**13**
No (skip to question 6)	6.3%	1
Not sure (skip to question 6)	12.5%	2
	answered question	**16**
	skipped question	**0**

5. If there are benefits to California specialty crops due to climate change, do those benefits outweigh the risks?

	Response Percent	Response Count
Yes	7.7%	1
No	**53.8%**	**7**
Not sure	38.5%	5
	answered question	**13**
	skipped question	**3**

6. Do specialty crop growers need to consider climate change when making farming decisions?

	Response Percent	Response Count
Yes	**100.0%**	**14**
No	0.0%	0
Not sure	0.0%	0
	answered question	**14**
	skipped question	**2**

7. Rank the following barriers to adaptation of specialty crops in order of importance. 1 being the largest barrier and 5 being not a barrier.

	1	2	3	4	5	Rating Count
Cost	**43.8% (7)**	37.5% (6)	6.3% (1)	0.0% (0)	12.5% (2)	16
Lack of technology	25.0% (4)	25.0% (4)	**37.5% (6)**	0.0% (0)	12.5% (2)	16
Lack of government support	25.0% (4)	**37.5% (6)**	25.0% (4)	12.5% (2)	0.0% (0)	16
Public awareness	**46.7% (7)**	20.0% (3)	13.3% (2)	6.7% (1)	13.3% (2)	15
					Other (please specify)	3
					answered question	**16**
					skipped question	**0**

8. If you have seen impacts of climate change, what steps, if any, are you currently taking to adapt to these impacts?

	Response Count
	10
answered question	**10**
skipped question	**6**

9. What steps, if any, should specialty crop growers take now to adapt?

	Response Count
	15
answered question	**15**
skipped question	**1**

Climate Change Impacts on Specialty Crops: Survey of Consortium Members

1. Please assess your understanding of the following topics and terms using the scale below. choose the one answer that is the best self-assessment of your knowledge.

	Very Knowledgeable	Mildly Knowledgeable	Not Sure	Mildly Unknowledgeable	Very Unknowledgeabl
Statewide Agricultural Production Model	15.0% (3)	**30.0% (6)**	25.0% (5)	15.0% (3)	15.0% (3)
Projected minimum and maximum temperature	9.5% (2)	**57.1% (12)**	4.8% (1)	14.3% (3)	14.3% (3)
Agricultural vulnerability index	15.0% (3)	20.0% (4)	**25.0% (5)**	20.0% (4)	20.0% (4)
Winter chill requirements for fruit and nut trees	28.6% (6)	**38.1% (8)**	4.8% (1)	9.5% (2)	19.0% (4)
Winter chill models	9.5% (2)	**33.3% (7)**	19.0% (4)	19.0% (4)	19.0% (4)
Pest lifecycles and degree days	19.0% (4)	**47.6% (10)**	0.0% (0)	23.8% (5)	9.5% (2)
Pest distribution	19.0% (4)	**38.1% (8)**	14.3% (3)	19.0% (4)	9.5% (2)
Ecosystem services	**33.3% (7)**	28.6% (6)	14.3% (3)	14.3% (3)	9.5% (2)
Temperature effects on plant phenology	28.6% (6)	**38.1% (8)**	9.5% (2)	14.3% (3)	9.5% (2)
Impact of high temperatures at stages of plant growth	28.6% (6)	**47.6% (10)**	0.0% (0)	9.5% (2)	14.3% (3)
Climate change impacts on pollination services	4.8% (1)	**38.1% (8)**	23.8% (5)	23.8% (5)	9.5% (2)
Greenhouse gas emissions	38.1% (8)	**47.6% (10)**	0.0% (0)	9.5% (2)	4.8% (1)
Climate change scenarios	23.8% (5)	**38.1% (8)**	14.3% (3)	14.3% (3)	9.5% (2)

Changes in precipitation	23.8% (5)	**42.9% (9)**	19.0% (4)	4.8% (1)	9.5% (2)
Impacts of early snowmelt	19.0% (4)	**47.6% (10)**	14.3% (3)	9.5% (2)	9.5% (2)
Plant breeding for climate change	9.5% (2)	**38.1% (8)**	19.0% (4)	19.0% (4)	14.3% (3)
Definition of climate change adaptation	**28.6% (6)**	**28.6% (6)**	**28.6% (6)**	9.5% (2)	4.8% (1)
Definition of climate variability	**35.0% (7)**	20.0% (4)	30.0% (6)	10.0% (2)	5.0% (1)
Climate change impacts on occurrence of extreme events	28.6% (6)	**47.6% (10)**	14.3% (3)	0.0% (0)	9.5% (2)
Impact of sea level rise on water availability	19.0% (4)	**38.1% (8)**	19.0% (4)	14.3% (3)	9.5% (2)
Deficit irrigation	28.6% (6)	**47.6% (10)**	9.5% (2)	0.0% (0)	14.3% (3)
Water delivery modernization	9.5% (2)	**42.9% (9)**	19.0% (4)	19.0% (4)	9.5% (2)
Potential impacts of climate change on soil quality	4.8% (1)	19.0% (4)	28.6% (6)	**38.1% (8)**	9.5% (2)
Institutions involved in climate change adaptation research	5.0% (1)	30.0% (6)	20.0% (4)	**35.0% (7)**	10.0% (2)
Ongoing climate change research in California	5.0% (1)	**35.0% (7)**	20.0% (4)	25.0% (5)	15.0% (3)
					answered questio
					skipped questio

2. Please rank your level of concern regarding the following agricultural issues. 1 is very concerned, 5 is not concerned.

	1	2	3	4	5	Rating Count
Decreased water availability	**81.0% (17)**	9.5% (2)	4.8% (1)	0.0% (0)	4.8% (1)	21
Fuel costs	9.5% (2)	19.0% (4)	**57.1% (12)**	9.5% (2)	4.8% (1)	21
Climate change	33.3% (7)	19.0% (4)	**38.1% (8)**	4.8% (1)	4.8% (1)	21
Labor availability	**42.9% (9)**	19.0% (4)	19.0% (4)	14.3% (3)	4.8% (1)	21
New environmental regulations	33.3% (7)	**38.1% (8)**	19.0% (4)	4.8% (1)	4.8% (1)	21
					answered question	**21**
					skipped question	**0**

3. Please rank the following possible impacts of climate change indicating your severity of concern. 1 is very concerned, 5 is not concerned.

	1	2	3	4	5	Rating Count
Increased pests	28.6% (6)	**33.3% (7)**	23.8% (5)	14.3% (3)	0.0% (0)	21
Increased flooding	23.8% (5)	**42.9% (9)**	9.5% (2)	23.8% (5)	0.0% (0)	21
Plant heat stress	23.8% (5)	**42.9% (9)**	9.5% (2)	23.8% (5)	0.0% (0)	21
Decreased water availability	**85.7% (18)**	4.8% (1)	4.8% (1)	0.0% (0)	4.8% (1)	21
Less predictable climate	**42.9% (9)**	28.6% (6)	19.0% (4)	4.8% (1)	4.8% (1)	21
Loss of pollination opportunities	14.3% (3)	**33.3% (7)**	28.6% (6)	14.3% (3)	9.5% (2)	21
					Other (please specify)	7
					answered question	**21**
					skipped question	**0**

4. Are there benefits that California specialty crops may experience due to climate change?

	Response Percent	Response Count
Yes (answer question 5)	**75.0%**	**15**
No (skip to question 6)	10.0%	2
Not sure (skip to question 6)	15.0%	3
	answered question	**20**
	skipped question	**1**

5. If there are benefits to California specialty crops due to climate change, do those benefits outweigh the risks?

	Response Percent	Response Count
Yes	0.0%	0
No	46.7%	7
Not sure	**53.3%**	**8**
	answered question	**15**
	skipped question	**6**

6. Do specialty crop growers need to consider climate change when making farming decisions?

	Response Percent	Response Count
Yes	**75.0%**	**15**
No	10.0%	2
Not sure	15.0%	3
	answered question	**20**
	skipped question	**1**

7. Rank the following barriers to adaptation of specialty crops in order of importance. 1 being the largest barrier and 5 being not a barrier.

	1	2	3	4	5	Rating Count
Cost	42.9% (9)	**47.6% (10)**	4.8% (1)	4.8% (1)	0.0% (0)	21
Lack of technology	14.3% (3)	**42.9% (9)**	33.3% (7)	9.5% (2)	0.0% (0)	21
Lack of government support	14.3% (3)	9.5% (2)	**38.1% (8)**	19.0% (4)	19.0% (4)	21
Public awareness	**28.6% (6)**	19.0% (4)	23.8% (5)	19.0% (4)	9.5% (2)	21
					Other (please specify)	7
					answered question	**21**
					skipped question	**0**

8. If you have seen impacts of climate change, what steps, if any, are you currently taking to adapt to these impacts?

	Response Count
	13
answered question	**13**
skipped question	**8**

9. What steps, if any, should specialty crop growers take now to adapt?

	Response Count
	19
answered question	**19**
skipped question	**2**

Attachment 3

2013

Climate Change Consortium for Specialty Crops: Impacts and Strategies for Resilience

Photo courtesy of Jocelyn Gretz, Rio Farms

California Department of Food and Agriculture

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Executive Summary

The California Department of Food and Agriculture (CDFA) convened the Climate Change Consortium with a diverse group of individuals involved in California specialty crop agriculture to identify specific climate change adaptation strategies for growers. Changes to the climate as a result of anthropogenic activities are well recognized and acknowledged by the scientific community. Therefore, the Consortium assumed, as charged by CDFA, that climate change is and will take place now and in the future. The realities of climate change was not debated, nor were mitigation measures identified although, some adaptation measures could also be also considered mitigation measures.

> *"As we head into another summer with less than 20 percent of normal snowpack in the Sierra-the lifeblood of Central Valley agriculture- we worry about the future"*
>
> *-Ward Burroughs, Merced County farmer; Modesto Bee opinion page June 6, 2013*

The Consortium was asked to evaluate climate change impacts and to propose potential strategies for adaptation so that California agriculture and CDFA can prepare for impacts. The Consortium discussed and documented challenges faced by growers due to climate change. The Consortium addressed climate change impacts to temperature, water resources, pests and pollination. Growers will face new challenges from changed environmental averages, trends, variability, and extremes. These challenges are summarized below. While specialty crops are the focus of this report, the Consortium's work on climate change impacts can be applied widely to California agriculture.

Challenges:

- *Increased average, minimum, and maximum temperatures in all seasons*
- *More frequent and longer-lasting heat waves in the summer*
- *Reduced number of winter chill hours and fog*
- *Uncertainty in temperature change projections and forecasts*
- *High spatial variability of climate change and impacts of climate change*
- *Reduced precipitation (drought), increased precipitation (floods), and more variable precipitation and snowpack accumulation*
- *Decreased winter snowpack, earlier timing of snowmelt and spring river runoff, and reduced spring runoff*
- *Altered reservoir storage regimes*
- *Reduced natural groundwater recharge*
- *Reduced water quality due to reduced fresh water supplies*
- *Complex and unpredictable alterations to plant, pest, and pollinator species abundance and spatial distributions*
- *Altered inter-species dynamics in agricultural ecosystems*
- *Reduced effectiveness of managed pollinators*
- *Vulnerability to pest and pollinator changes*

The Consortium discussed creative solutions to be investigated and implemented at the level of individual growers; local communities, cities, and counties; and through regional and state planning processes. There was a general consensus within the Consortium that growers are managing their lands in consideration of dynamic environmental and agronomic variables and therefore, existing efforts can contribute to adapting to climate change impacts. However, for specialty crop agriculture in California to adapt and be prepared for climate change events, growers require agricultural support services, scientific answers to fundamental climate change impact questions, investment in planning and preparedness, and technological innovations. These requirements were categorized and prioritized under the categories of Outreach and Education, Planning and Resource Optimization, Research Needs, and Technology and Innovation. Listed below are some of the leading recommendations identified by the Consortium.

Leading Recommendations for CDFA:

1. *Support economic and environmental studies of the costs, benefits, and risks of adaptation strategies*
2. *Facilitate a reinvestment in grower technical assistance and trainings specific to climate change adaptation, such as for water, soil, and pest management.*
3. *Advocate for inclusion of grower interests in the Integrated Regional Water Management (IRWM) process*
4. *Perform or fund a review of regulatory barriers to adaptation mechanisms, food safety and other regulations*
5. *Facilitate interagency coordination on the recommendations of the Climate Change Consortium*
6. *Compile a list of grower needs for weather data and forecast products*
7. *Develop research plots to study adaptation strategies and new technologies and products*
8. *Promote farmland conservation*
9. *Recognize growers who develop or adopt novel strategies to adapt to climate change*
10. *Support USDA NRCS in a review and/or creation of policies to improve growers' ability to adapt to climate change.*

This report is a synthesis and summary of scientific information shared by experts in and outside of California who are working on climate change at the interface of agriculture, information from discussion that ensued in the Consortium meetings, and recommendations proposed by the Consortium. The purpose of this document is two-fold: one is to provide growers, agricultural associations, specialty crop commodity groups, the general public, state agencies, and other agricultural stakeholders with examples of climate change impacts and potential adaptation strategies, specifically as they relate to agriculture in California. Second, the document lists adaptation recommendations (beginning on page 48) that the Consortium developed, providing CDFA direction on future climate change activities.

Chapter 1: Introduction

California is the nation's leading agricultural state in gross cash receipts; $43.5 billion in 2011. A large portion of the crops grown in the state are "specialty crops." Specialty crops are defined as fruits and vegetables, tree nuts, dried fruits, horticulture, and nursery crops including floriculture. In 2011, global exports of California specialty crops reached nearly $10.9 billion. California is the United States' sole producer of several crops such as Clingstone peaches, olives, pistachios, walnuts, almonds and artichokes (California Department of Food and Agriculture 2013a). The state's unique environmental zones and Mediterranean climate allow for a diversity of crops to be produced throughout the year for local, national, and global distribution. California's specialty crop commodities are known for being a healthy, affordable, safe food source.

Impacts to agriculture from changes in weather will be felt differently in different parts of California. Temperature, rainfall, humidity, and wind are some common weather variables. Long-term patterns of weather are referred to as the "climate," and changes in weather patterns over time are defined as "climate change." Climate is essentially the *average* pattern of weather for a region, which could be a county, state, continent, or the entire world. Climate change occurs when an area's weather pattern, as indicated by weather variables, deviates significantly from the "average," or from the historically observed "normal."

Due to the many human and environmental factors influencing climate change, and due to increased variability in weather over time and across space, climate change effects are difficult to predict for a specific agricultural operation. Nevertheless, rigorous analysis of California weather data shows that climate change is already occurring in some parts of the state. Future climate trends have been predicted for California. California can expect to see increased average and more extreme temperatures; altered rainfall, snowpack accumulation, and snowmelt timing regimes; increased variability in both temperature and rainfall; and increased *and* more variable durations and frequencies for heat waves, droughts, and floods.

Temperature changes are generally used as an indicator for climate change. Below are several temperature-based examples of climate change provided to highlight the climate change effects at the global and local scales.

Climate change is well documented at the global scale. It has been demonstrated through many scientific studies and global data collection that anthropogenic activities have contributed to historically high greenhouse gas levels in the atmosphere. Consequently, there has been a global increase in average temperatures. This process of greenhouse gas induced temperature increase is known as "global warming"(Houghton & IPCC Working Group I 2001). The increase in greenhouse gases (specifically carbon dioxide) and temperatures are provided in Figure 1. Figure 1 shows increased temperatures corresponding closely with increase carbon dioxide concentrations over the last 150 years.

Figure 1: Ten-year moving average of global temperatures between 1750-2000 (black) and temperature predicted by CO_2 and volcanic emissions (red). The large negative extremes in the early temperature records are likely explained by volcanic activity; the upward trend in the recent record is an indication of anthropogenic change. This demonstrates the strong relationship between CO_2 concentrations and global warming. The grey area is the 95% confidence interval. From Berkeley Earth Surface Temperature (Anon 2013b).

Similarly, Figure 2 below shows that California has seen similar, more recent evidence of increased temperatures. Investigation and prediction of climate change in California is still an active area of research, but experts agree there has been, and will continue be changes in regional and statewide weather patterns stemming from climate change. Scientists anticipate an acceleration of warming across the western United States (Moser et al. 2009). California should see between a 1° F and 3° F increase in average daily temperature by 2050, and between a 2° F and 6° F increase by 2100[a] (Lobell et al. 2006; Cayan et al. 2008; Nakićenović et al. 2000). California is expected to experience increases in average temperatures in all seasons, and greater warming in the summer than in the winter (Cayan et al. 2008).

[a] These estimates are generated by a model known as a coupled ocean-atmosphere general circulation model (GCM) run using climate scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) of low- to high-emissions trajectories (Nakićenović et al., 2000). The IPCC is a scientific intergovernmental body formed by the United Nations to provide scientific assessments of information worldwide about the risks of climate change, its potential consequences, and options for adaptation to and mitigation of consequences.

Figure 2: Ten-year moving average of temperatures in the San Joaquin Valley near Modesto, Merced, and Turlock shows temperature increases in recent years. Other areas in California's San Joaquin Valley and Southern California show similar trends. From Berkeley Earth Surface Temperature (Anon 2013a).

California's many unique microclimates allow farmers to grow a diversity of crops. The scientific consensus is that climate change will affect these microclimates, although there may be some regions that remain unaffected. Depending on the degree of change experienced in a region across several variables (e.g. temperature, rainfall, humidity, presence of plant and insect communities), there may be both negative and positive impacts to crop production. In some areas, certain crops will no longer be viable; simultaneously, there may be opportunities to grow these same crops (or new ones) in other regions of the state.

Several studies indicate that climate change will negatively impact many specialty crop yields and profits by the year 2050 and certainly by the year 2100 (Deschenes & Kolstad 2011; Medellín-Azuara et al. 2011; Lobell et al. 2006). For example, California has already observed a significant loss of winter chill hours, due to an increase in average winter temperatures (Baldocchi & Wong 2008). Winter chill hours are defined as the number of hours spent below 45° F, necessary for the flowers of fruits and nuts to bloom, and are required by certain crops to achieve high yields. Increased invasive pests, changes to plant and pest interactions, and plant and animal diseases in agriculture are some additional potential impacts from climate change.

An Agricultural Vulnerability Index that takes into account climate change, crop vulnerability, land vulnerability such as urbanization and soil degradation, and socioeconomic pressures has been developed for California (Jackson et al. 2012). When climate vulnerability alone is considered, the majority of the Central Valley is "vulnerable," coastal agricultural regions have "low" vulnerability, and the San Joaquin Valley and Southern California growing regions remain "moderately" vulnerable. But when climate change impacts are coupled with other vulnerability factors (such as soil degradation and urbanization), the regions where much of California's agricultural production occurs, including the Central Valley and coastal growing regions, become the most vulnerable.

Growers in California are innovative leaders in agriculture. They continually develop their own adaptations to address inter-annual variability in weather as well as other changing environmental variables. Growers employ strategies such as diversifying their water portfolios, diversifying their crops, or diversifying revenue through agro-tourism or other opportunities in order to grow strong businesses. Thinking about climate change, however, requires thinking about these strategies on a generational timeframe and on a regional scale. According to a survey of about 160 growers in Yolo County, climate change was *not* listed as a high priority concern, although over 50% of the growers agreed "the global climate is changing" (Jackson et al. 2011). Although growers may not prioritize climate change as their primary concern, they have long been concerned about issues that are likely to be exacerbated by climate change such as unpredictable water supplies, the spread of invasive pests and plant and animal diseases and reduced availability of pollinators.

The severity of the impacts of climate change on food production will be variable and crop-specific. Growers should be made aware of adaptation measures available to them. Ensuring sustainable agricultural adaptation to climate change will require a concerted collaborative effort by growers, government agencies, and agricultural service organizations. The importance of this effort is highlighted in the California State Board of Food and Agriculture report, *California Agricultural Vision: Strategies for Sustainability*. Specifically, strategy nine is titled "Assure Agricultural Adaptation to Climate Change" and has the following objective – "Assure that all sectors of California agriculture can adapt to the most likely climate-related changes in seasonal weather, water supply, pests and diseases, and other factors affecting agricultural production." (California Department of Food and Agriculture 2012)

To identify specific strategies to assure agricultural adaptation to climate change, the California Department of Food and Agriculture (CDFA) convened the Climate Change Consortium workgroup in the fall of 2012 for two purposes:

1. To determine specific adaptation strategies that can be implemented now, and on-the-ground by specialty crop growers;
2. To provide direction and action measures to CDFA that can be initiated over the next several years, based on available resources, to help California agriculture adapt to climate change.

The Consortium includes representatives from several specialty crops commodity groups in California, growers from each of the top ten specialty crops in the state, scientists from the University of California and the California State University systems, University of California Extension Specialists, a member from the California Resource Conservation District, a member from the California Agricultural Commissioners and Sealers Association, and a Certified Crop/Pest Control Advisor.

Over the course of six months in 2012 and 2013, the Climate Change Consortium met four times to hear from leading scientific researchers in various fields of climate change at the interface of agriculture. The following chapters provide information presented and discussed at these meetings, and related recommendations for adaptation strategies. Understandably, a large number of adaptations highlight the need for further research. While the CDFA does not perform experimental research studies directly, the Department funds research activities and may submit proposals and refine request for proposals for research based on grower needs. The Department also provides growers with information on emerging research and research results. The development of strategic solutions with specific short- and long-term recommendations to address climate change impacts will help sustain California's diverse specialty crop food production into the future.

Chapter 2: Temperature

Introduction

This chapter covers temperature change impacts to California's specialty crops, and proposed adaptation strategies to temperature change. This chapter addresses only *direct* temperature change impacts on California crops, such as warmer air temperatures, and proposed adaptations to those changes. Changes in temperature can be linked to other climatic factors. For example, higher winter temperatures may result in reduced snowpack accumulation, which reduces irrigation supplies to agriculture; reduced water availability would therefore be an indirect temperature change impact.

Challenges:

- *Increased average, minimum, and maximum temperatures in all seasons, and increased temperature variability*
- *More frequent and longer-lasting heat waves in the summer*
- *Reduced number of winter chill hours and fog*
- *Uncertainty in temperature change projections and forecasts*
- *High spatial variability of climate change and impacts of climate change*

Crops are sensitive to the magnitude of change in temperature, extreme temperatures (minimums and maximums) and the timing of temperature changes (night vs. day, spring vs. summer). The combination of these factors constitutes "temperature change."

Across the western U.S., average annual minimum and maximum temperatures have increased since 1950; frost days[b] have declined over this same period (Bonfils et al. 2008). Since 1920, California annual daytime temperatures have increased 0.1 °F per decade, and nighttime temperatures have increased 0.33 °F per decade (Moser et al. 2009). Statewide average temperatures increased approximately 1.7°F between 1895 and 2011, warming has been greatest in the Sierra Nevada foothill and mountain region (Moser et al. 2012). Data from weather stations located throughout the California Central Valley show increasingly warmer winters since the 1940s (Dettinger & Cayan 1995; Cordero et al. 2011). Over the entire 20th century there has been a significant rate of warming for San Joaquin Valley *minimum* temperatures in all seasons, with the greatest rate of warming in the summer and fall (Christy et al. 2006).

In general, warming is expected on an annual, seasonal, and even daily basis, with impacts differing by region. The significant, overall outcome of warming is the likely reduction in yield of some of California's most valuable specialty crops, particularly perennial crops.

[b] Frost days are a count of days (within some defined period, such as a year) that have a daily average temperature below the freezing point.

Temperature Sensitivity of Crops

Temperature sensitive crops include US staple crops such as corn, soybeans, wheat and cotton (Schlenker & Roberts 2009), as well as valuable California specialty perennial crops such as almonds, grapes, berries, citrus and stone fruits (Lobell & Field 2011; Lobell et al. 2006). Global-level data suggest there is limited historical adaptation of staple crop seed varieties or management practices to counter warmer temperatures (Schlenker & Roberts 2009). Perennial crops are semi-permanent, and therefore potentially more vulnerable to climate change impacts than are annual crops (Lobell et al. 2006). For California specialty crops, sensitivity to temperature extremes varies by crop, crop variety, and by month. For example, almond yield is strongly influenced by the temperature in the February before harvest (harvest occurs in late summer). Almond yields are higher when the nighttime temperatures in February is low (Lobell & Field 2011).

The modeled, combined impact of increasing and more variable temperatures *and* variable rainfall is to increase the probability of abnormally low yields in any given year for perennial crops such as almonds, table grapes, walnuts, and avocados (Lobell et al. 2006). While there may be some positive impacts and opportunities associated with new temperature regimes due to climate change, such as the ability to cultivate some crops in new areas, all negative impacts ultimately stand to reduce crop quality (such as decreased size and yields (Ackerman & Stanton 2013).

Risks of temperature change to crops in general include: altered phenology (timing) of leafing, flowering, harvest and fruit production; decreased winter chill[c]; and asynchrony between flowering and pollinators (Baldocchi & Wong 2008; Baldocchi 2012). Increased spring temperatures have been shown to induce earlier spring blooms across western states (Cayan et al. 2001; Pope et al. 2013). Heat waves may cause early bolting[d] in annual crops and reduced pollination success (Cavagnaro et al. 2006). While temperature changes may not affect average statewide crop yields for some crops, uncertainty in all climate and yield model projections is great, and impacts to regional and local crop yields may occur even where impacts to statewide averages may not (Bonfils 2012; Lobell et al. 2006).

Warming and Heat Waves

Statistical model projections based on historic crop yield and temperature data suggest a 2° F warming will have differential impacts on yield across crops; yield in some crops like almonds may increase due to warming, while yield in others like wine grapes and cherries could decrease dramatically to economically unsustainable levels (Lobell & Field 2011; Jackson 2012). Warmer temperatures may contribute to greater loss of carbon in the form of carbon dioxide from agricultural and forest soils, which in turn could slightly increase total vegetative growth, although scientific understanding of this matter is limited (Cavagnaro et al. 2006; Ackerman & Stanton 2013).

[c] Accumulation of winter chill, often measured in chill hours - the number of total hours per season between 0°F and 45°F, is necessary to convince trees that evolved in a cool winter climate that winter has passed and it is safe for their tender young flowers and leaves to emerge.

[d] Bolting is when a plant prematurely produces flowering stems before the crop is harvested, which diverts resources away from the edible parts of the plant.

Warmer spring temperatures also have negative effects on crop pollen germination, and flower and ovule size that can result in reduced fruit yields in the form of smaller, deformed (double), and fewer fruits (Pope 2012; Karapanos et al. 2010; DeCeault & Polito 2008; Beppu & Kataoka 2011). Additionally, warm springs may encourage earlier planting and early plant development. Plants that are out of the ground earlier are more susceptible to spring frost. If springs are warmer, but frost dates do not also change, there will be greater losses due to spring frost events.

Extremely high summer temperatures decrease photosynthesis and increase respiration, which may result in less overall plant growth and poorer quality of harvested product. Though the exact temperature thresholds for respiration and photosynthesis vary, in peach, for example, leaf photosynthesis decreases from its maximum above 86° F to 50-70% between 95°-100° F (Flore 1994). Fruit growth declines above 95° F as well (Byrne 2007). Reduced photosynthesis decreases the energy supply (carbohydrates) available for plant growth, in turn reducing yield (Pope 2012; Sage & Kubien 2007). In general, high temperatures increase the rate of development of the fruit, leading to fruit that is ripe earlier and at a smaller size (Ben Mimoun & DeJong 1998).

The number of degree-days (count of days equal to or greater than a particular temperature) and frost-days (count of days during which there is frost) provide a cumulative measure of temperature extremes to which crops respond. The impacts of warming in wine grape regions include: longer frost-free periods; increasing degree-days; less winter chill and a shift to earlier bud break, bloom, and veraison (onset of ripening) – all with negative yield quantity and potential quality implications (Battany 2012).

Wine grape color and concentrations of phenolics (chemical compounds that effect the taste, color, and feel of wine) change with temperature; optimal concentrations for individual varieties are found at very specific temperatures. Therefore temperature change stands to affect wine grape color and phenolics (Poudel et al. 2009). Balance of soluble solids concentration (SSC) and titratable acidity (TA) are also important, and may be affected by temperature. Unfortunately, there is little scientific research in this area and no available temperature response information for fruit development or composition. Temperature effects on wine grape and other fruit quality are observed, but not well understood (Matthews 2012).

Singular hot spell events can also impact crop phenology. In a study of Sémillon wine grapes, vines exposed to a heat 'treatment' during ripening (onset and/or mid-stage) suffered impeded sugar flow into grape bunches – again, ultimately compromising crop quality (Greer & Weston 2010). Thus, higher temperatures in the form of hot spells may delay rather than accelerate ripening of wine grapes (and other crops where SSC is important as well). Because berries are very sensitive to direct radiation, they are susceptible to sunburn in extreme temperature events as well (Matthews 2012).

There is more research on Central Valley crop trends and responses to climate, yet Coastal region agriculture, with valuable "cool season" crops such as berries and lettuce, will be affected by temperature change as well. A statistical analysis of California historical data suggests that different coastal regions crops will experience different effects. Yield decreases are expected for lettuce, but yield increases for strawberries; both crops, however, may benefit (in terms of yield) from a warm, early, and dry spring, which may become more frequent with climate change (Lobell et al. 2007). More scientific research is required on climate impacts to valuable cool season coastal region crops.

Winter Chill

California's temperate tree crops (deciduous tree and vine crops, such as fruits and nuts), which evolved in climates with distinct seasons, suffer reduced yields if they do not experience adequate winter cold (Baldocchi & Wong 2008; Pope 2012). An inadequate number of chill can cause late or irregular blooming, which decreases fruit quality and reduces economic yield (Moser et al. 2009). There are approximately three million acres of orchards with chilling requirements in California (Jackson 2012). Throughout Central California, the number of winter chill hours has decreased since the 1950's (see Figure 3 below), and models project continued decreases by the end of the century to around half the number of chill hours seen in 2000 (Baldocchi & Wong 2008; Luedeling et al. 2009). Downward trends in winter chill are found across California's Central Valley and some coastal areas, including the growing regions of Monterey County, east Contra Costa County, the northern Sacramento Valley, Red Bluff, Davis, and Fresno (Baldocchi & Wong 2008).

Figure 3: Map of long term trends in the change in winter chill accumulation (hours per year) over the course of the dormant period for fruit and nut crops. The axes of the map show latitude and longitude of the data points. Each dot on the map represents a change in the accumulation of chill hours in a year. Data are derived from the California Climate Archive (Baldocchi and Wong, 2008).

There is a reduction in chill that tree plant tissue (including buds) perceive due to a downward trend in winter fog which has been observed in the Central Valley. Winter chill accumulation, and the associated reduction is calculated based on air temperature. However, with observed and projected increases in clear warm days, buds in the sunlight will be exposed to greater warmth than they would have been if shrouded by fog. Consequently, the process amplifies the downward trend in the amount of winter chill that occurs. Although fog is potentially very important because a reduction in it corresponds to a reduction in the number of chill hours, fog is not explicitly accounted for in most climate models and its role in climate change is therefore not fully understood (Baldocchi 2012).

Adaptation Strategies

The Climate Change Consortium recognized the following strategies as potentially alleviating the direct impacts of increased temperatures to specialty crops. Each of these strategies are discussed in detail below.

Crop Breeding

The Consortium identified the need for breeding of crops resilient to heat spells and low chill winters, the predominant temperature threats to California specialty crops. A systematic search of heat tolerant crop varieties should be conducted and information disseminated to growers, ideally through an easily accessible and user-friendly online database.

> ***On-Farm Strategies for Adaptation to Increased Temperatures***
>
> - *Switch to an established heat-tolerant or low-chill tolerant variety*
> - *Consider management practices that provide cooling to sensitive crops such as shade structures, intercropping, or spray materials*
> - *Alter planting and harvesting schedules*

Row crops, such as tomatoes, are susceptible to loss by heat waves during summer months. On the other hand, tree crops are already being impacted by decreased winter chill during winter months. Many high value tree crop industries in California are based on varieties with medium to high chilling requirements, in particular cherries, pistachios and walnuts. For all of these crops, there are less well-known varieties or wild relatives with lower chilling requirements. Thus, a candidate priority breeding program with a high probability of success would be winter chill requirement reduction in tree crops.

Overall, breeding efforts should be prioritized by the crops that are most at risk. For fresh fruits, low chill cultivar options are available for apricots, peaches, plums, and cherries, for which there are low chill breeding programs in the US, Brazil, and South Africa. However, many of these varieties are considered less palatable or marketable than the high chill counterparts. Because pistachios, prunes and walnuts have a longer shelf-life, and because new varieties need to be agreeable to processors (shellers, dryers, etc.) as well as consumers, there are few to no low chill varieties of these crops on the market in California. Short-term adaptation strategies would be to increase breeding in these crops, and encourage cross-border cultivar trading. For crops vulnerable to summer temperature increases (this includes most temperate tree crops and cool season vegetables), breeding to increase heat tolerance is necessary. (Pope 2012)

Wine grape growers could switch to longer-season varieties and harvest later, although this potentially poses an economic challenge in the form of marketplace acceptance of 'non-traditional' California varieties (Battany 2012). Nevertheless, for wine grapes, there are varieties that seek lower acid and a longer ripening season; these varieties are more amenable to warmer temperatures (Allen et al. 1990).

Crop Fertility

The scientific literature shows that high temperatures can impact crop fertility. The Consortium recommended that a literature review on the climate change impacts on crop flower fertility and an electronic clearinghouse (e.g., website) for this information, with links to literature, would be useful to specialty crop growers. Additional research in this area would be beneficial. More research is needed on germination tube formation in relationship to high temperatures.

Research Plots for Management Practices

Methods that physically manipulate a crop, such as training for a specific height or amount foliage canopy, can be used to deal with high daytime temperatures. The Consortium recommended broad research on the use of different physical plant growth training infrastructures for stone fruits and other crops to provide protection from heat stress and sunburn.

Shading and light reflection are another option for high summer temperatures. Physical structures (structures similar to hail netting) and spray materials (e.g. clay and calcium carbonate based substances) could also reduce summer heat stress. For shading, trellis and canopy structures could be used to expose or shade crops from full sun during different parts of the day, and moveable trellis structures could be used to fully expose fruits at night. Again - for cherries, shading above 50% was shown to reduce fruit deformation. (Battany 2012)

However shading in the manner similar to controlled studies may be difficult or financially infeasible on an agro-industrial scale (Beppu & Kataoka 2011; Pope 2012). Convective cooling – either through vineyard design or structures, could be used, however there is no existing information on impacts of wind in different crop canopies. Design of lower cost shading techniques is needed in order to make it practical for use in a variety of crops.

Additionally, the Consortium recommended more research on intercropping and cover-cropping, which could have a cooling effect by increasing transpiration in the field, thereby reducing heat stress. Research is needed to: 1) determine which crop combinations can be effective and practical, and 2) determine if this strategy is applicable in arid production areas where water is limited. Intercropping may also provide an additional benefit in the form of crop diversification, which may contribute to economic resilience for growers.

The Consortium recommended that funding be identified for research plots that investigate new techniques for temperature change (and other climate change) management, and provide proof-of-concept before new practices are adopted by growers. CDFA should help to coordinate the research projects with other partners such as USDA and UC Cooperative Extension. Recommended areas of research include:

- Study the use of fans, cooling, shade netting, spray materials and other cultivation practices that can reduce heat stress;
- Study the use of photovoltaic panels as shade structures over crops;
- Study intercropping to reduce heat stress, determine which crop combinations can be effective and practical, and determine applicability of intercropping in arid regions;

- Investigate what California products and markets support the cost of climate-controlled cultivation (greenhouses);
- Study climate analogs (Ramírez-Villegas et al. 2011): locations where the present climate compares with the projected future climate of other locations, with a focus on the potential to maintain crop yield and quality in e.g. new (warmer) areas;
- Encourage the incorporation of heat stress factors (not only sunburn) in developing plant training systems, especially for those systems where training methods do not traditionally address this variable, such as many tree crops.

Transitional use of rest-breaking materials

The Consortium encouraged continued research in the development and use of rest-breaking chemicals, and to the extent possible, streamlining the registration process while ensuring that human health and environmental concerns are adequately addressed, as well as alternatives for organic producers investigated. As a transitional strategy, before the introduction of lower chill varieties, there should be options for growers to use rest-breaking chemicals that address chill deficits. For rest-breaking chemicals addressing chill deficits, more research is needed, but a short-term solution would be to have such chemicals approved for medium to high chill requirement crops.

Chapter 3: Water Resources

Introduction

Crops are sensitive to the availability of water, the quality of water, and the timing of water application. Altered climate regimes (temperature magnitudes, variation, and seasonal timing of extreme heat and cold) can exacerbate water availability and quality challenges. California agriculture's water supply can be split into three regions: 1) the snowpack/runoff dependent Central Valley, 2) groundwater and reservoir dependent Coastal areas, and 3) the Colorado River dependent Imperial Valley. In general, and regardless of the source, water resources for agricultural irrigation are expected to decrease and become more variable with risks of flooding expected to increase. Impacts will differ greatly by region. This chapter covers changes to water resources systems in California due to climate change and adaptation strategies proposed by the Climate Change Consortium to address water resource challenges.

Challenges:

- *Reduced precipitation (drought) or increased precipitation (floods)*
- *Decreased winter snowpack, altered (earlier) timing of snowmelt and spring river runoff, and reduced spring runoff*
- *More variable temperatures resulting in more variable precipitation and snowpack accumulation*
- *Altered reservoir storage regimes*
- *Reduced natural groundwater recharge*
- *Reduced water quality due to reduced fresh water supplies*
- *Uncertainty in predictions*

Changes in California Hydrology

Climate change will likely impact the magnitude, timing, and frequency of precipitation, river runoff, and flood events through changes to the land surface, atmosphere, and oceans. California flow regimes rely both on the atmosphere, the interaction of the atmosphere with the land surface, and the state of that land surface; time of year (season) matters, as does the location. (Anderson 2013; Bales 2013)

All growers, whether pumping groundwater or using surface water for irrigation, ultimately depend on an influx of winter precipitation. California precipitation is seasonal, and uniquely variable (Anderson 2013; Dettinger 2011). Fresh water supplies in the form of precipitation come mainly from seasonal and brief north-Pacific storms during October-May (Cayan 2013). About two-thirds of the precipitation that falls on the Sierra Nevada Mountains is evaporated from the ground surface and transpired by vegetation, and the remaining one-third moves to rivers (some of which recharges groundwater aquifers). In an average year, the Sierra Nevada mountains receive 27% of the state's annual precipitation and provide more than 60% of the state's consumptive use of water in the form of runoff. (Bales 2013)

Mountain hydrology is complex, and the amounts of water found in rivers, surface water reservoirs, and snowpack 'storage' at any given time are determined by many factors: precipitation, infiltration into soil and groundwater, snowmelt rates and the timing of melt onset, runoff, groundwater and surface water exchange, sublimation (the conversion of snow to water vapor with no intermediate melted liquid stage), and evapotranspiration (ground surface evaporation and plant transpiration). These many, interacting factors make it very difficult to predict climate induced changes to California's hydrology. Changes that do occur will impact precipitation, snowpack, runoff, and evapotranspiration. (Bales 2013)

Precipitation Changes

Change in the total annual volume of fresh water in California is driven by the occurrence of sporadic, heavy rainfall events, generated from an 'atmospheric river' that flows landward from the Pacific Ocean (Cayan 2013; Dettinger 2011). It is the landfall of these atmospheric rivers that generate extreme California storm events. Climactic changes impact the nature of the atmospheric river as well as the land surface environment that contributes to storm formation (Anderson 2013; Dettinger 2011).

California has also experienced the highest national number of extreme historical episodes of rainfall events with precipitation greater than 12 inches (Anderson 2013). Simulations predict increases in the frequency and magnitude of extreme temperatures with certainty. However, predictions for precipitation extremes are less certain. Historical observations (1950-2000) of trends in precipitation, which include intensity (total precipitation per number of wet days), percentage of precipitation in very wet days, and maximum 5-day total precipitation, differ across the state, and none of the observed increased or decreased intensity trends appear statistically significant[e]. This implies that precipitation change will vary by location, but may not change dramatically (unlike temperature). The number of days with precipitation greater than 10 mm has increased across the state over this time period, but again, not significantly. Model simulations to year 2100 identify that the number of days of precipitation greater than 10 mm will decline over the entire state, but no other significant changes were projected (no increases in precipitation intensity, percentage of precipitation in very wet days or maximum 5-day total precipitation). (Mastrandrea et al. 2011)

Snowpack Changes

Much of the water supply for the semi-arid Western US, including California, comes from mountain snowpack (Bales 2013). An increase in temperature of as small as 2°C is known to drive significant changes in: rain versus snow storms, snowpack amounts, snowmelt timing, stream flow timing, and growing seasons. There are also concerns that snowpack changes will drive changes in flooding potential, low base flows (non-peak flows in a river or stream), groundwater recharge, and soil moisture levels in summer (Bales 2013). The influence of a 3°C increase on U.S. western states is projected to be interconnected trends of more rain and less snow, earlier snowmelt, and more winter floods (Bales 2013).

[e] Lack of statistical significance in increases or decreases in precipitation intensity simply means that none of the observed trends fall outside the range of what historical trends describe as 'normal' – the observed intensity trends are not (numerically) abnormal.

Figure 4: Snowpack in the Sierra Nevada Mountains. Photo by Noah Molotch of University of Colorado.

Direct stream runoff from storms may increase due to warmer air temperatures, which increases the portion of precipitation that falls as rain instead of snow. Consequently, snowpack (effectively winter storage) and spring snowmelt runoff could be reduced (Anderson et al. 2008).

In observations of snowpack in the Sierra Nevada Mountains between 1961-1990, 100% of the winter snowpack remained on April 1st of the year; in two different climate change scenario projections for the 2070-2099 period, only 52% and 35% remained on April 1st (indicating earlier winter snow melt in a climate-changed future). General warming and drying in California is projected to result in an average decrease in Sierra Nevada April 1st snow water equivalent (the amount of water stored in winter snow present on April 1st of the year) by 2050, with the number of cases of minimal April 1st snow water equivalent becoming more frequent (Cayan 2013).

There is a large amount of uncertainty in snowpack predictions. Most California snowmelt comes from elevations above where most measurements of snowpack are currently made (Bales 2013). Snowpack and snowmelt runoff at the mountain snow-rain transition line are impacted by forest vegetation evapotranspiration and soil properties (Hunsaker et al. 2012; Bales 2013). Forest management decisions will influence snow accumulation, snowmelt timing, and water yield (the amount of runoff). The knowledge base to inform adaptive management of Sierra Nevada forests to climate change is currently insufficient (Bales 2013).

Runoff Changes

Annual river discharge from the Sierra Nevada Mountains, the source of the majority of California's freshwater, varies considerably. However, Sierra Nevada flow is associated with a larger regional pattern, and along with other major river systems like the Columbia and Colorado, flows generally alternate between high and low phases. According to historical annual flow records, repeated, or 'clustered' dry years are common in California, while wet year clusters are not. Climate change projections for runoff are uncertain, but a drier system is possible, as drier regions are projected worldwide. (Cayan 2013)

Figure 5: Historical Monthly River runoff in the San Joaquin River showing an increase in winter flow since 1956 and a decrease in spring flow.

Monthly average runoff in both the Sacramento River and San Joaquin River systems between 1956-2007, as compared to 1906-1955, has increased in winter months, and decreased in spring and early summer months (Figure 5) (Anderson 2013).

Over the past 100 years, April-July runoff has decreased by 23% for the Sacramento River basin and by 19% for the San Joaquin River basin. This indicates that a greater percentage of annual runoff in these two major river systems are occurring outside the traditional snowmelt season, potentially as a result of earlier onset snowpack melting. If runoff shifts to earlier in the year, runoff would occur when flood control dominates reservoir storage requirements, and the amount of runoff stored for future use (primarily for agriculture) would be reduced. (Anderson et al. 2008)

Increased Water Use to Meet Increased Crop Evapotranspiration

California crop evapotranspiration (ET) accounts for an estimated 75-80% of consumptive use of state project water supplies (Anderson et al. 2008; Mukherjee 2013). Projected increases in air temperature may lead to changes in the amount of irrigation water needed due to changing rates of evapotranspiration (the combination of evaporation from the ground and transpiration from plants).

The effects of climate change on ET on California are difficult to quantify, but could potentially be significant: ET changes not only with temperature but also with CO_2 concentrations in the air, humidity and with types of plants or crops covering a landscape. According to a Department of Water Resources (DWR) model, rates of ET in California will increase most dramatically with increases in temperature alone, and less so with simultaneous increases in both temperature and humidity (Anderson et al. 2008).

Saltwater Intrusion and Sea Level Rise

In addition to the above-mentioned rainfall, runoff, and groundwater depletion concerns, coastal areas face the additional problem of saltwater intrusion to surface waters (e.g., Sacramento – San Joaquin Delta) and into groundwater aquifers (e.g., Central Coast counties of Monterey, Santa Cruz, San Benito, and Santa Clara).

Where land lies at or below sea level, declining groundwater levels (due to overdraft) enable seawater to move inland into underground aquifers, contributing to saline groundwater, which can be unsuitable for irrigation and many other beneficial uses. California's coastal farm communities rely on groundwater rather than water delivered through California's state and federal surface water. Areas like the agricultural Central Coast region which rely primarily on groundwater face both limited water supplies and saltwater intrusion. Saltwater inundation is likely to be exacerbated by both reduced freshwater supplies and rising sea levels associated with climate change. (Levy & Christian-Smith 2012)

Delta salinity is currently at or above the highest salinity levels found in the past 2,500- to-4,000 years, and it is well known that decreased freshwater availability (either through increased diversions or decreased rainfall and river flows) causes the boundary between salt and fresh water to move further into the Delta – from marshlands into agricultural areas (CCWD 2010). Because the Delta is the hub of the State Water Project (SWP) and Federal Central Valley Project (CVP) conveyance system, saltwater intrusion also stands to impact freshwater provision to the rest of the state, not just to coastal areas – this is discussed below.

Water Supply Management

Reductions in winter snowpack, and the connected changes in timing of spring runoff, are expected to alter the reliability of fresh water supplies in the state (Cayan 2013). According to climate modeling applied to the Colorado River region, runoff from the Colorado River is expected to decrease by 10-30% (Barnett & Pierce 2009). Trends for the Colorado River system are historically in concert with Sierra Nevada rivers. The Colorado River is itself a source of water to southern California (Cayan 2013).) With climate change (and even under continuation of current mean annual flows), scheduled water deliveries from the Colorado River are unsustainable; drought- reduced water availability could nevertheless be mitigated through reduced average deliveries to water users (Barnett & Pierce 2009).

Farmers reliant on water deliveries through large infrastructure projects such as the State Water Project (SWP) or the Central Valley Project (CVP) are well aware that water allocations are reduced during water shortages. During the most recent drought in California, from 2007-2009, annual total (SWP and CVP) allocations ranged between 60% - 80% of average; the most junior CVP contractors received between 0-18% of their contract in each year of the drought (Christian-Smith et al. 2011).

According to model simulations using both drier and wetter climate change scenarios, median annual water deliveries from the State Water Project were projected to decrease in the long-term, alongside an increased likelihood of reduced SWP carryover storage in the drier climate case. Federal Central Valley Project south-of-Delta deliveries and carryover storage are also projected to decrease in the drier climate scenario, but increase in a wetter scenario. Northern Delta deliveries were not as sensitive to climate change. (Anderson et al. 2008)

Predicted sea level rise, leading to increased saltwater intrusion from the ocean into the San Francisco Bay Delta, could necessitate increased freshwater releases from upstream reservoirs and/or reduced pumping from the Delta to southbound state and federal water projects in order to maintain compliance with Delta water quality standards. This could reduce the amount of water supplied through the state and federal projects to agriculture south of the Delta. Additionally, saltwater intrusion could impact the quality of water delivered through the state and federal projects, potentially increasing the concentration of salt by 11% from current levels. (Anderson et al. 2008)

Drought

California's history is marked by extended dry spells known as droughts (Cayan 2013). In farming regions worldwide, extremes in water availability (droughts and floods) have increased in frequency and intensity over the past 50 years (Bailey-Serres et al. 2012). Semi-arid and arid regions are experiencing less precipitation, more aridity, and longer periods without precipitation (Mukherjee 2013). Simultaneously, demand for water is increasing due to population growth and environmental concerns (maintenance of stream flows for aquatic species), and water supply is becoming more variable and scarce (Mukherjee 2013).

Models indicate the US Southwest is likely to become drier and experience more severe droughts in the second half of the 21st century due to reduced precipitation, reduced spring snowpack, reduced late spring and summer soil moisture levels, and reduced runoff. Drought duration, according to indicators like soil moisture, has historically ranged from 4 to 10 years, while some droughts in the 21st century simulations persisted for 12 years or more. (Cayan et al. 2010)

Climate change can impact agriculture directly via negative impacts on yield; many crops are sensitive to drought during specific development phases (Mendelsohn et al. 1994; Hayes 2013). In higher-temperature locations in California, irrigation systems help compensate for higher temperatures (they reduce impacts that would otherwise be felt by increased temperatures and decreased precipitation), indicating that irrigation itself will help agriculture adapt to climate change (Mendelsohn & Dinar 2003). Nevertheless, water supplies are likely to decrease alongside any increased use of irrigation for temperature management.

The predicted decrease in water availability in California is expected to have a significant, negative impact on farmland values due to impacts to agricultural productivity (Schlenker et al. 2007). An empirical study of the benefits of accounting for "water portfolios," defined as different levels of access to water supplies by farms, in California showed that different climate and water factors impact farmland sale values differently according to whether or not a farm has access to more than one sources of water (such as water districts and groundwater wells) (Mukherjee 2013). For example, a farm's access to multiple sources of water reduces the impacts on a farm's value (in the form of sale price) by salinity, high summer temperatures, and lower mean and more variable surface water supplies (CVP deliveries) (Mukherjee 2013). In the past, reduced water supplies have been shown to affect agricultural property values (Mendelsohn & Dinar 2003).

Water experts often recommend improved water use efficiency on farms in order to reduce excess agricultural runoff, improve yields, and in some cases conserve water for other non-agricultural uses (Department of Water Resources 2009; California Department of Water Resources, Division of Statewide

Integrated Water Management Water Use and Efficiency Branch 2012). Irrigation efficiency is generally achieved through use of irrigation equipment such as sprinkler and drip systems, or improved management practices, such as field leveling or use of soil moisture information systems (Burt 2013; Gleick et al. 2011). However, irrigation efficiency in different locations can take different forms (e.g., drip irrigation and sprinkler systems) and have different results – depending on local geographies and management practices (Burt 2013).

Many water districts and farms in California – especially in the water-limited San Joaquin Valley and southern California, already employ many water-saving measures that fall under known best water management practices (Burt 2013). Across California, there has already been steady conversion to high-tech irrigation systems and practices; improved grower knowledge of evapotranspiration and soil moisture management; and improved distribution uniformity for efficiency (Burt 2013; Orang et al. 2008). In some regions and at some scales (such as individual field or farm scales), improved irrigation efficiency may be a valid climate change adaptation for reduced water supplies, but in other locations and scales (particularly at the basin scale), the only way to reduce total water use may be to fallow agricultural land (Burt 2013).

Flooding

Flooding in terms of agricultural impacts is a collective term for 1) water logging, where soil is saturated with excess water; and 2) submergence, where unwanted standing water covers a land area. Submergence can occur as a result of flash floods, stagnant (medium-length) floods, and deep-water (long) floods. Effects of floods include low oxygen, low light, and low rates of gas exchange – all of which can damage crops although some crops are more susceptible to damage from flooding than others. (Xu 2013)

Some of the most substantial historical variations in crop production in California can be traced to individual extreme weather events, such as freezes, floods, or hailstorms. Six out of ten of the most extreme historical events impacting California agriculture since 1993 were floods resulting in crop damages and losses. (Lobell et al. 2009)

Research on direct flood impacts to agricultural regions in California is lacking, although floods risks will directly impact the management of water projects and the Delta system that delivers surface water supplies to Central Valley agriculture. Reservoir operations that best manage a climate-changed flood regime in the state may or may not agree with operations that best manage water supplies for agriculture. Flood damages, such as flood-induced failure of aging levee systems, may also disrupt freshwater conveyance through the Delta and throughout the Central Valley. (Das et al. 2011)

In the United States, crop losses due to flooding ranked second to drought in many of the past 12 years (Bailey-Serres et al. 2012). California is highly vulnerable to flooding due to its topography and storm systems, and placement of communities and infrastructure in low-lying areas, which include agricultural regions (Das et al. 2011). However, predictions of flood likelihoods and magnitudes with climate change are very uncertain, as flood generating mechanisms include a complex and unpredictable set of climate variables (Das et al. 2011).

California has winter and spring flood events. Winter floods occur in the October-March "wet season," and are atmospheric river events. Climate indications of winter flood likelihood are not clear enough for definitive climate change predictions. Spring floods occur in the April-July "melt season." Temperature and solar radiation are climate factors that contribute to spring floods since spring floods stem from snowpack melt. (Anderson 2013; Dettinger 2011)

Floodwaters may be fresh, stagnant, or saline and affect plants once or multiple times in a growing season. Agricultural regions can be flooded as a result of flash floods, seasonal rises in surface water at low elevations, or tidal surges (Bailey-Serres et al. 2012). For California, the type of flood would be regional. For example, seasonal rises in surface water at low elevations with tidal surges would likely affect the Sacramento-San Joaquin Delta. Consequently this could affect statewide water conveyance. The Salinas River flood of February 1988 is an example of a coastal flood event where intense continuous winter rainfall resulted in widespread landslides and mudslides. Monterey County agriculture-related losses totaled over $7 million, and involving approximately 29,000 damaged acres (Monterey County Water Resources Agency n.d.).

The most extreme historical floods in California occurred before the collection of modern data (in the 1800s). However moderately extreme Central Valley floods occurred in 1986 and 1997, both of which nearly overwhelmed flood-control systems in Sacramento (Dettinger et al. 2012). Climate-change projections suggest that larger-than historical storms in California might become more common with warming temperatures (Dettinger et al. 2012). Simulations of floods generated on the western slopes of the Sierra Nevada mountains over the period between 1951-2099 yielded significantly larger magnitude 3-day floods along both the north and south of the mountain range in two out of three climate model scenarios (Das et al. 2011).

Projected climate changes may affect the state's flood regimes in several ways, including the potential to intensify or ameliorate flood magnitudes, the potential for both increased and decreased flood frequencies, and changing flood seasonality (Das et al. 2011). Major climate change concerns related to flooding include temperature changes on land that impact the land surface/watershed condition, atmospheric river characteristics and changes in a warmer atmosphere, ocean temperature and circulation patterns impacting storm formation, and if year to year variability in climate factors contributing to flooding (Anderson 2013).

Altogether, flood impacts on California agriculture will likely be felt in the form of alterations to freshwater reservoir and conveyance systems– not only in the case of a major flood event, but also in standard annual operations that account for flood risks in the future (e.g. new timing regimes for water supply releases and potentially reduced water availability).

Adaptation Strategies

Participate in a Regional Approach to Water Management

The Consortium proposed that CDFA support a regional systems approach to water management. Integrated Regional Water Management (IRWM) is the practice of bringing all stakeholders together to manage regional water resources collaboratively, with the goal of meeting the needs of stakeholders effectively. The California Department of Water Resources supports IRWM through grants and technical assistance and currently 87% of the geographic area of the state is organized into IRWM regions (California Department of Water Resources 2012). Grower interests should be represented in IRWM activities.

There are actions that growers can take to help manage regional water sources but these activities are specific to the conditions of watersheds and aquifers in different regions. Growers can work with partners in their area, through the IWRM process or otherwise (as appropriate) to pursue the following strategies when appropriate:

- Identify locations suitable for flood control (e.g. floodplains), groundwater recharge, and multi-benefit habitat restoration (e.g. wetlands);
- Investigate options for utilizing excess (flood) waters and rainfall for reuse, storage, or groundwater recharge;
- Exercise water conservation practices, and utilize the most efficient water delivery and irrigation systems available and appropriate (such as use of pressurized water systems and improved irrigation uniformity);
- Re-evaluate reservoir capacity and reservoir operations to manage water availability with a changing climate;
- Research appropriate regulation, management, and use of recycled/reused water;
- Improve water quality by properly managing farm water runoff, and reducing runoff where appropriate;
- Increase water holding capacity (WHC) of soil by improving soil structure and increasing soil organic matter (such as through the use of mulching, composting, permaculture, green manure);

Groundwater Recharge

As part of IRWM there should also be an effort to manage groundwater on an aquifer scale. IRWMs need to define the best use for an aquifer and integrate this information into land-use planning for the region.

Figure 6: Through a public-private partnership in Pajaro Valley, stakeholders partnered to implement a managed aquifer recharge basin (the Bokariza Managed Aquifer Recharge Basin) with the goal to infiltrate 100 acre-feet of water to the underlying aquifer. Driscoll's Strawberry Associates, Reiter Affiliated Companies, Landowners, Resource Conservation District of Santa Cruz, NRCS, University of Santa Cruz, and California State University of Monterey Bay worked collaboratively to design, construct, monitor and study the recharge basin. This project is now tracked by Pajaro Valley's Community Water Dialogue, whose goal is to highlight Bokariza as a model to inspire many managed aquifer recharge basins within the watershed. Photo courtesy of Emily Paddock, Driscolls.

Research is also needed to predict the decline in quality and quantity of groundwater on a local scale so that the CDFA can work with stakeholders to identify ideal locations for groundwater recharge projects and facilitate permitting and planning discussions with regulatory agencies. The Consortium recommended that CDFA should advocate for an incentive, if the situation is appropriate, for growers to install groundwater recharge basins on their properties. One example of a suitable incentive could be mitigation banking so that growers receive some compensation for the use of land for environmental benefit. CDFA can also advocate for the use of flood waters to recharge groundwater: flood control plans that focus on moving water through a system quickly could instead consider strategies to retain flood waters in order to increase groundwater recharge.

Water Recycling

Limited surface water and groundwater supplies and saltwater intrusion are problems that have been faced for many years by Central Valley and Central Coast farmers. In saltwater inundated coastal regions, water supply problems are being in part addressed with water recycling. In some cases, such as the Pajaro Valley in Monterey County, a combination of both groundwater recharge and recycling are used to deal with limited water supplies, and represent a valid climate change adaptation strategy for regions facing future reductions in both surface and groundwater supplies (Levy & Christian-Smith 2012). In the Salinas Valley, a three-part solution based on increased local reservoir storage; conservation through improved management practices and new technologies such as soil moisture meters, flow meters and drip irrigation; and wastewater recycling have provided stable water supplies to the region alongside reduced groundwater use (Krieger 2013; Salinas Valley Water Coalition 2001).

Changes to Water Distribution Systems

The Consortium identified several changes to water distribution systems that could be advantageous for groundwater recharge and water conservation.

- Remove canal linings in some locations if there is potential at the location to recharge groundwater;
- Research covering irrigation canals with solar panels or other methods of reducing evaporation from canals.

Forest Management to Maximize Available Water Resources

Climate change will impact evapotranspiration rates in the Sierra Nevada possibly exacerbating water resource challenges. The Consortium recommended that CDFA support further research of sustainable forest management as a tool to improve available water resources. Specifically, methods of forest management that can maximize water available for dry season irrigation should be studied. Additionally, the development of new tools for measuring snowpack and forecasting water availability is needed.

Water Conservation Outreach and Education

As CDFA moves forward with outreach and education about climate change adaptation, the Consortium recommended, there should be an emphasis on California’s vulnerability especially to drought. This is important at the state, regional, and community planning levels. The general public also needs to be aware of the impact of drought on food supply.

In the context of IRWM processes, agricultural stakeholders can advocate for urban water conservation, improving the quality of urban run-off water, and increasing infiltration to groundwater aquifers underlying joint urban and agricultural areas. As an example, The Local Government Commission, a non-profit group that works to promote healthy and sustainable communities, has outlined elements of community planning that can protect water resources. Community design should be compact, mixed use, walkable and transit-oriented so that automobile-generated urban runoff pollutants are minimized and the open lands that absorb water are preserved to the maximum extent possible. Permeable surfaces should be used for hardscape. Impervious surfaces such as driveways, streets, and parking lots should be minimized so that land is available to absorb storm water, reduce polluted urban runoff, recharge groundwater and reduce flooding (see Local Government Commission Ahwahnee Water Principles for Resource-Efficient Land Use). CDFA can support and advocate for the adoption of these concepts by city and county governments.

Flood Plain Decision Making

The Consortium recommended creating an online clearinghouse for existing resources and programs that provide information on planting crops in flood plains. CDFA could facilitate the communication between growers and resource managers such as the California Department of Water Resources, counties, and the U.S. Army Corps of Engineers. For example, CDFA could notify growers on how climate change will exacerbate flooding and flood impacts. Further, the Department in collaboration with the California Department of Water Resources, can distribute informational maps that show the likely movement or growth of floodwater in flood plains during a storm or high runoff event to help growers make decisions about what crops to plant flood plains. One potential method of distributing parcel specific flood risk maps to growers is through the County Agricultural Commissioner's annual pesticide permitting process.

Research Needs

Pilot Projects

The Consortium suggested the development of pilot research projects on practices and products that can increase agriculture's resilience to drought:

- Research cover-cropping systems and effective crop rotation cycles for water conservation (e.g. tomato grown with drip irrigation combined with another crop type);
- Research the design, regulatory feasibility, and benefits of groundwater recharge projects;
- Develop technology and/or chemicals that can reduce evaporation from water transport systems;
- Research the impact (in terms of volume and quality) on the water system of the use of pressurized irrigation systems at field, farm, and regional scales;
- Research the feasibility and economics of using recycled water or desalinated water for agriculture.

Crop Breeding

The use of drought tolerant crops, or breeding of drought tolerant crops, may be required if climate change reduces surface water supplies (for irrigated crops) or alters rainfall conditions (for non-irrigated crops) during the growing season in order to stabilize yields (Hayes 2013). The Consortium suggested that crop breeding would play a role in climate change adaptation for drought and flooding. The Department could support continued research on crop breeding to improve drought tolerance with a prioritization of crops most susceptible to drought.

Currently, there is extensive research on the molecular biology of water stress in plants and breeding drought tolerant cereal crops (wheat, rice, barley, corn) in terms of yield benefits. There is limited research on the diverse irrigated specialty crops grown in California, but breeding for improved drought tolerance may be possible in these crops as well. For irrigated crops, use of drought tolerant varieties could help reduce the impacts of climate change in terms of water by simply reducing the volume of water used in agriculture. This could make more water available for other uses. (Hayes 2013; Morison et al. 2008)

On-Farm Strategies for Adaptation to Drought and Flooding

- *Investigate opportunities for the installation, management, and monitoring of groundwater recharge basins*
- *Do not plant in flood plains, or, choose appropriate flood tolerant crops when planting in a flood plain*
- *Reduce erosion caused by flood events by cover cropping; not planting in hilly areas; and maintaining appropriate vegetation in riparian areas that will stabilize the soil, but not hinder the movement of water.*
- *Utilize new technologies such as soil moisture sensors, tensiometers, and field level water meters to track irrigation practices.*
- *Reduce water run-off through the following management practices:*
    - *Prepare a farm water conservation or irrigation plan*
    - *Install on-farm water storage to capture rainfall*
    - *Install efficient irrigation systems*
    - *Build appropriate drainage systems such as tail water ponds and tile drains*
    - *Increase organic matter in the soil, increase worm activity and enhance soil moisture holding capacity*
- *Use crop rotation and crop diversification, allow some land to remain fallow, develop crop rotations that are compatible with drip irrigation, and, when feasible, incorporate annual crops into perennial crop systems.*
- *Switch to less water-intensive crops*
- *Choose alternatives to water for frost protection such as wind machines, site planning, cover management, or other management techniques.*

Some crops are more flood tolerant than others, and there exist more flood tolerance plants and/or genotypes, which are those that can survive a period of flooding significantly longer than others of the same species (Xu 2013). In areas where floods are expected to increase as a result of climate change, flood-tolerant crops may be a viable adaptation option for some crop types. There is significant research on rice crops, which are grown in flood-prone regions worldwide but limited research on flood tolerance for the types of specialty crops grown in California (Xu 2013; Hayes 2013).

Chapter 4: Increased Pests and Impacts on Pollination

Introduction

Crop production (yield and quality) is sensitive to weed and insect populations. Crop production and pests are both sensitive to changes in climate. With climate change, pest and pollinator populations are expected to move higher in elevation and northwards in latitude depending on the species and location. Climate change will not have simple, linear effects, on pests and pollinators (e.g. warming resulting in the decrease of a single weed or bee species), but will impact ecosystem dynamics, which are multi-faceted and highly complex. Climate change impacts to pests and pollinators in California are therefore difficult to predict but some research work has been completed in this area. This chapter covers changes to plant and insect pest intensification and climate change impacts on pollinators in California, and proposed adaptation strategies to current and future pest and pollination challenges.

Changes in pest and pollinator populations in California are connected to other climate variables discussed in this report: specifically temperature, precipitation and hydrology/water resources. Temperature and CO_2 effects on plants and insects are more widely studied. Studies on altered precipitation and water availability regime effecting plants and insects are virtually absent in terms of climate change. Insect activity and population responses may also be altered in response to changing wind conditions, but effects on winds due to climate change are poorly understood.

Challenges:

- *Altered temperature, CO_2, and water availability will have direct impacts on individual plant, pest, and pollinator species*
- *Climate change will alter inter-species dynamics and the larger ecosystems upon which agriculture depends*
- *Over-reliance on managed pollinators poses a potential risk to agriculture in light of climate change*
- *Conventionally grown, monoculture agriculture will likely be more vulnerable to pest and pollinator changes*
- *Climate change impacts to plant, pest, and pollinator species are complex and unpredictable.*

Pest management adaptation strategies amidst climate change will not change substantially from the pest management strategies that exist today. However, growers and pest control managers will need to respond to new pest communities in consideration of more rapid changes in those communities than in the past.

Invasive Species

Invasive species are non-native species that threaten California's agricultural areas and wildlands by displacing native species, hybridizing with native species, altering biological communities, or altering ecosystem processes. Invasive species include weeds such as the familiar California giant reed (*Arundo donax*), yellow starthistle, and scotch broom; aquatic organisms such as the water hyacinth and hydrilla; diseases such as the beet curly top virus (BCTV); and insects such as pink bollworm (California Invasive Plant Council 2013; California Department of Food and Agriculture 2013b). The invasive species discussed here are invasive plants, insects, and crop diseases whose populations (and role in natural and agricultural ecosystems) are anticipated to change with climate change (Mills 2013).

On average, California acquires six new invasive species per year. Trade and travel primarily determine the route of invasion, but sources may change with climate change (Mills 2013). Climate-altered invasive species populations will have impacts on mixed anthropogenic and natural ecosystems. These impacts include not only agricultural, range, and timberland systems, but also vegetation zones in general. Climate change impacts will also influence hydrology and geomorphology (landform dynamics), fire regimes, wildlife populations, recreation areas, and infrastructure (Johnson & California Invasive Plant Council 2013).

Agricultural impacts from climate-change include altered crop weed presence, water supply impacts (such as clogging of conveyance or pumping systems from increased presence of aquatic plants), and changes to pollination (discussed in more detail below) (Johnson & California Invasive Plant Council 2013).

Increased Pest Pressures

Direct impacts of climate change on plant communities, pollination and pest control will become apparent via range shifting of plants and insects (Parmesan et al. 1999; Parmesan 2006; Chen et al. 2011; Deutsch et al. 2008), and from climate related changes to crop physiology such as plant respiration, photosynthesis and water use (Long et al. 2006; Tubiello et al. 2007; Georgescu et al. 2011). Available climate change predictions for pests are based primarily on individual studies on a specific individual plant and insect population. Increased temperatures have the potential to result in more invasive species introductions through expanded habitat range (and continued global trade and travel that regularly introduces new species), and greater potential for destructive pest outbreaks (Trumble 2013; Butler & Trumble 2012; Bale et al. 2002).

The literature on increased atmospheric CO_2 concentration effects on plants and insects suggests there are several effects on plant and insect species individually as well as on their interactions (Trumble 2013). Increased atmospheric CO_2 leads to *increased:* plant consumption by caterpillars, reproduction of aphids, predator growth and altered feeding preferences (e.g. lady beetle growth and aphid consumption), carbon-based plant defense, and effectiveness of foliar (leaf) applications of *Bacillus thuringiensis* (*Bt*, a bacterial pesticide) (Osbrink et al. 1987; Coviella & Trumble 1999; Bezemer et al. 1999; Coviella & Trumble 2000). Alternately, increased CO_2 leads to *decreased:* insect development rates (which can alter phenological synchrony with host plants), response to alarm pheromones by aphids, parasitism, effectiveness of transgenic *Bt*, and nitrogen based plant defenses (Osbrink et al. 1987; Awmack et al. 1997; Roth & Lindroth 1995; Coviella & Trumble 1999; Coviella & Trumble 2000).

Therefore, collectively the combined effect of temperature warming and CO_2 enrichment of the atmosphere will include (mostly complex unknowns) impacts on biological control, pest damage, and crop production. Pest damage effects include increased damage from loss of biological control, movement of pests from south to north due to range changes, and increased damage by chewing insects and variable (unknown) damage by 'sap suckers' due to CO_2 increases. Overall, impacts to crop production will be varied, with production increases or decreases depending on crop tolerance to new pest regimes, reduced plant nitrogen content, and increases in plant defense mechanisms due to CO_2 increase. (Mills 2013)

Weeds

Major direct effects of climate change that will impact weeds include elevated atmospheric CO_2, increasing temperatures, and changing rainfall patterns. Elevated CO_2 increases rates of photosynthesis, increases plant growth, and increases drought resistance (Osbrink et al. 1987; Trumble 2013). There will be major changes to plant resistance to pests and disease and nitrogen use (Trumble 2013). The major categories under which climate change will affect plant populations (and insects – discussed below) include the abundance, the geographic range, and the phenology (developmental timing) of different species.

Abundance

Weeds are "generalists," meaning they can adapt to many different types of environments and therefore have great reproductive capacity (Johnson & California Invasive Plant Council 2013; Dukes & Mooney 1999). Increases in atmospheric CO_2 will results in increased plant growth, as well as potentially increased water use by plants, increased combustibility of plants, and reduced herbicide effectiveness (Johnson & California Invasive Plant Council 2013). An example of this is provided by a study of Canada thistle, where CO_2 induced increases in root biomass indicating that perennial weeds could be harder to control in a higher CO_2 world. In the study, thistle root and shoot biomass increased with CO_2 levels, as did resistance to a common herbicide, glyphosate (Ziska et al. 2004).Human activities make agricultural and wildlands even more vulnerable to weeds for multiple reasons. They include the disruption of soil and native plant populations for urban and/or rural development that would otherwise keep weed populations in check, emissions that increase atmospheric CO_2 concentrations/nitrogen deposition to the ground surface which supports weed growth and roadside or power line maintenance activities leading to the spread of weeds (Johnson & California Invasive Plant Council 2013).

Range

Modeling of southeastern U.S. weed (kudzu, privet, and cogon grass) geographic range response to climate change showed weeds would greatly expand northward due to increased climatic suitability in those regions (Bradley et al. 2010). Similarly, in the Western U.S., climate change could lead to expanded invasion from new species, such as through higher precipitation enabling the spread of non-native grasses (D'Antonio & Vitousek 1992; Smith et al. 2000; Martin-R et al. 1995). The California weed, yellow starthistle, has been identified as already moving northeast up into the Sierra Nevada foothills (Johnson & California Invasive Plant Council 2013).

Phenology

It is unknown if the phenology (seasonal timing) of weed growth will change with climate change, as it has shown to change in other western U.S. plants (Trumble 2013).

Insects

Similar to weeds, the major direct effects of climate change that will impact insects include: elevated atmospheric CO_2, increasing temperatures, and changing rainfall patterns (Trumble 2013). Temperature directly affects development, survival, range and abundance of insect herbivores, which in turn impacts agricultural production as well as wildlands ecology (Bale et al. 2002). Increasing temperatures will generally benefit species that reproduce to create more than two generations per year (Bale et al. 2002). Overall, climate change scenario studies suggest that outcomes will include local (insect) extinctions, changes to endangered species and pest status of some insects and shifted geographic distributions for some insects along with shifts in their host plant ranges (Coviella & Trumble 1999).

Mitigating declines in agricultural production will require compensation for potentially increased insect pest feeding on plants; increases in insect pest development rates and altered insect development timing are expected to hinder pest control by traditional natural or chemical means (Trumble 2013; Musolin & Numata 2003).

Abundance and phenology

There is a cascading effect of climate change on plant-insect interactions. Due to climate change, host plant suitability may change, leading to changing developmental rates of pests, leading to altered windows of opportunity for parasitism, and finally to altered nutritional status for parasites (Trumble 2013). Insect outbreaks are expected to increase in frequency and intensity with projected global climate change through direct effects of weather change (e.g. temperature or precipitation) on insect populations, and through disruption of community interactions and/or controls (Stireman et al. 2005). While little research exists, the impact of climate variability on species interactions is illustrated by a study of caterpillar–parasitoid interactions across multiple geographic regions found that precipitation variability impairs the ability of the parasitoid to track its host caterpillar population (Stireman et al. 2005). Therefore, increased climate variability may increase the frequency and intensity of herbivore pest outbreaks by disrupting natural enemy–herbivore interactions.

Insect herbivores with a large geographic range will be less affected by temperature increases than those with localized habitats. The main effect of temperature in temperate regions (including California) is to influence winter survival. In northern regions higher temperatures extend the summer and this will impact the timing of insect reproduction. This can have the effect of either increasing or decreasing the abundance of a particular insect species depending on how climate change simultaneously affects plant growth. Insect herbivores are adapted to exploit plants with different growth forms and strategies, which will also be differentially affected by climate warming. (Bale et al. 2002; Powell & Logan 2005)

Range

Scientific research indicates that insects will move towards the earth's poles (Parmesan 1996; Parmesan 2006; Crozier 2001; Walther et al. 2002; Root et al. 2003; Andrew & Hughes 2004; Logan & Powell 2001). Some insects may become better competitors at higher temperatures. An example is the Argentine ant (Dukes & Mooney 1999). Warming could expand the geographic range of the cold-intolerant pink bollworm in cotton into the San Joaquin Valley, a region that has been inhospitable to the pest due to heavy frost. The distribution and abundance of other cold-intolerant and/or invasive pests such as the olive fly and the Mediterranean fruit fly may also change (Gutierrez, Ponti, et al. 2008). Global warming is predicted to change the geographic distribution of the vine mealybug, an invasive pest of vineyards, and change the relative importance of its natural enemies (Gutierrez, Daane, et al. 2008). In California, climate change simulations suggest the mealybug will become less abundant and move north while enemy parasitoids become less effective. (Gutierrez, Daane, et al. 2008).

Crop and pest group geographic ranges may expand or contract. For example, California olive tree and the olive fly ranges are predicted to contract in southern deserts but expand in northern and coastal regions (Gutierrez et al. 2009). Climate change will also results in changes to insect responses to pathogens, especially fungi (Stacey & Fellowes 2002).

Complexity

Responses of biological interactions are complex and cannot be predicted by single variables (e.g. increase in temperature or rainfall). Thus far, most risk assessment research on pest intensification has focused on single species performance or geographic distribution. Also, the focus has been on a single climate factor such as temperature or CO_2 with few research studies accounting for the complex interactions between multiple species and climate variables. (Mills 2013; Dyer et al. 2013)

Elevated CO_2 can increase rates of photosynthesis and plant growth simultaneous to increasing pest population success. In a controlled experiment, nitrogen content of plant leaves decreased as CO_2 increased, and pest larvae consumption of plant leaves thereby increased with increased CO_2. However, CO_2 simultaneously resulted in increased plant growth – ultimately resulting in no change in the percentage of leaf area consumed by the pest. (Osbrink et al. 1987; Trumble 2013)

Overall, not enough scientific data is available to accurately predict the effect of increased atmospheric CO_2 on insect plant consumption (herbivory) but it is expected that impacts will be species-specific (Coviella & Trumble 1999).

Impacts from changing rainfall and storm patterns, and soil moisture/water availability to plant and insect dynamics are unknown at both global and local scales. Many classes of plant pathogens are sensitive to changes in soil moisture, and initial modeling frameworks suggest crop pathogen risk responds to precipitation, soil, and plant host properties collectively. (Thompson et al. 2013).

Increased temperatures will affect the interactions between pollination and seed dispersal (by animals), as well as predator-prey and parasites/pathogen-host relationships. Generally, negative impacts on ecosystem function are expected with an increased potential for species co-extinctions. Maintenance of species diversity may be the key to ensure adaptation to new and potentially more variable climate regimes. (Traill et al. 2010)

Parasitoid-Host Relationships and Biological Control

Parasitoid (an organism that spends a significant portion of their life attached to or within a host organism) and host (animal, plant) relationships provide a good example of the types of complex interactions that will change with climate. The relevance to agriculture of parasitoids is that climate change may modify existing biological control programs (the rearing and release of appropriate natural enemies to invasive pests and weeds) for agriculture by reducing the effectiveness of certain parasite populations but new untapped opportunities may exist (Hance et al. 2007).

A majority of parasitoid species is already affected by climate change, and even a mid-range warming scenario predicts a significant fraction of those may become extinct. The impact of climatic change on plant and animal species is important in higher trophic (food chain) levels that depend on the capacity of the lower levels to adapt to new conditions; parasitoids are therefore organisms for which severe impacts are expected, as they are high on the trophic chain. (Hance et al. 2007)

Addressing the lack of research on multiple variable impacts to biological interactions, one study examined increased CO_2 and temperature on alfalfa, armyworm caterpillars, and parasitoid wasps. The beneficial effects of parasitism disappeared at elevated temperatures due to asynchrony between pest and parasitoid development stages. The results suggest that the effectiveness of biological control and insect predators will decline with climate change. (Dyer et al. 2013)

Climate change (specifically temperature and CO_2) impacts on parasitoids may reduce the effectiveness of biological control by increasing seasonal variation in natural enemy activity and geographic variation in natural enemy success (Mills 2013; Stireman et al. 2005; California Department of Food and Agriculture 2013b). For example, the future success of biological control for weeds like the yellow starthistle is difficult to predict because climate change will affect both the weed and the control species (Gutierrez, Ponti, et al. 2008). A study of chrysomelid beetles, used for biological control of St. John's wort, showed that one species of beetle is a more successful control in regions with a cold winter while another species is more suitable for regions with mild winters, due primarily to the fact that the beetles' reproductive success depends on the synchronization of their phenologies with climate (Schöps et al. 1996). Therefore, climate change adaptation efforts must take into account "multitrophic" interactions – interactions that occur at multiple levels of a food chain and between each other (Mills 2013).

Impacts on Pollination

Many crops depend on pollination by insects and animals for food production. Globally, more and more acreage is being allocated to producing animal-pollinated crops (Rader 2013; Klein et al. 2007). Honey bees are the principal pollinator and visit 95% of the world's crops. Other species of wild pollinators are known to visit at least 42% of the world's crops (Klein et al. 2012). Both honey bees and wild bees are important contributors to pollination of crops in California.

Pollinator-dependent crops consist of 40% of California's crops by value (2007) (Chaplin-Kramer et al. 2011a; Klein et al. 2007). Crop types whose production is highly dependent on animal pollination include: apples, avocados, plums, peaches, cherries, apricots, pears, raspberries, blackberries, blueberries, and almonds, among others (Klein et al. 2007). California crops that require bee pollination, but for which honey bees are poor pollinators include kiwi, blueberry, alfalfa (seed), eggplant, tomato, and pepper (Klein et al. 2007; Kremen 2013).

Climate change will impact plant pollination by altering the geographic ranges and phenologies of plants and their pollinators including the daily activity patterns of their pollinators (Parmesan et al. 1999; Parmesan 2006; Chen et al. 2011; Deutsch et al. 2008; Long et al. 2006; Tubiello et al. 2007; Georgescu et al. 2011). Mutualistic interactions (such as between insects and insect-pollinated plants) may be especially vulnerable to climate change because of the potential for phenological mismatching - if the species involved do not respond similarly to changes in climate (Kremen 2013). Thus a plant may shift its range or phenology but its pollinators may not shift their ranges or phenologies.

Crop pollinators are mostly generalists. Generalist species are expected to adapt best to climate change. Similarly, most crop plants can be pollinated by an array of species. Thus as crops and insect visitors both shift in ranges and seasonality, it is likely that new mutualisms will form. California is rich in native pollinators, with 1,500 native bee species. California's diverse native pollinator populations may confer some resilience to range and phenological shifts induced by climate change. But, even if climate change poses perhaps less risks for crop pollination than other components of agriculture, contemporary crop pollination systems are already highly vulnerable because agriculture relies almost completely on a single pollinator species - the honey bee. (Kremen 2013)

While the Consortium discussed primarily animal (bee) pollination, many crops are wind pollinated. Furthermore, pollination - both from wind and bees - is sensitive to wind speed and temperature. High winds, as well as abnormally high or abnormally low temperatures, can impact pollination and fertilization of certain crops. The impacts of climate change on wind pollination are unknown, and would be a useful area for research.

Wild vs. Managed Pollinators

There are two types of pollinators – managed and wild pollinators. There are only about a dozen managed commercial pollinator species in use around the world today. The honey bee (*Apis*) comprises more than 95% of the managed pollinators. The USDA has attempted to develop new managed bees from wild bee populations but with little success. Global demand for pollination services from managed honey bees is increasing, and therefore management for pollination has become a critical input for farmers. (Kremen 2013)

Meanwhile, there are serious concerns about honey bee health. There have been long-term losses in honey bee colony populations in the U.S. for over 70 years which included serious overwintering losses in the late 1980s due to Varroa mite and current annual losses of 30% since the winter of 2006 due to the little understood Colony Collapse Disorder (CCD) (Vanengelsdorp & Meixner 2010). These high levels of colony losses are not unique to the United States but now occur in most regions of the global North. There are many potential causes of CCD (and the broader phenomenon of enhanced colony losses), including disease, lack of proper nutrition, drought, pesticide exposure, poor mite control, and climate change (Potts et al. 2010; Kremen 2013).

Recently, honey-bee scientists have hypothesized that the severe droughts in the Midwest in 2012 resulted in stunted sunflower plants that produced less pollen and nectar, resulting in poor honey bee nutrition. This led to greater winter die-offs of bees in the almond orchards in 2013. Another climate/drought-related hypothesis is that concentrations of pesticides in nectar (e.g. in sunflower production) under drought conditions may be higher, leading to negative impacts on bees. (Kremen 2013)

The diversity and abundance of wild insect pollinators have declined in many agricultural regions worldwide. In many places, honey bee pollination replaces wild insect pollination. However, wild insects often pollinate crops more effectively. The result is enhanced fruit set compared to crops pollinated by honey bees. A synthesis of pollinator studies from around the world found that crop productivity is more strongly related to wild bee visits than to honey bee visits: all studies included in the synthesis showed a positive relationship between fruit set and native pollinator visitation but only 14% of studies showed that result for honey bees. Nevertheless, the most effective pollination is achieved through combined pollination by honey bees and wild insects. (Garibaldi et al. 2013).

In California, native bees are known to enhance the effectiveness of honey bees as pollinators of almonds and sunflower through interactions that affect how honey bees forage (Brittain, Williams, et al. 2013; Greenleaf & Kremen 2006b). Furthermore, retaining a diversity of pollinators in the system can confer resilience to environmental change (Brittain, Kremen, et al. 2013; Rader 2013).

Pollinator-dependent crops in California that are grown in large monocultures are heavily dependent on managed honey bees for their pollination. However, a recent study estimated that overall, about 35-39% of the pollination provided by insects to Californian crops comes from wild bees (e.g., from native Californian bees rather than honey bees) (Chaplin-Kramer et al. 2011b). In a study of how pollination by wild bees affects tomato production in northern California, wild bees substantially increased the production of field-grown tomatoes most likely by promoting cross pollination of the hybrid variety (Greenleaf & Kremen 2006a). The tomato crop used in the study is otherwise self-pollinating and honey bees rarely visit tomato flowers (Greenleaf & Kremen 2006a). This example demonstrates that even where it is assumed pollinators are not necessary, they may contribute to greater productivity in agriculture.

Landscape Quality and Management

The quality of the farm landscape (organicversus conventional, monoculture versus diversified) and surrounding landscape (amount and proximity of wildlands surrounding the farm) impacts pollinator populations. A global synthesis (including 39 studies, 23 crops, and 14 countries) of how surrounding landscape and farm type impacts native pollinators showed that improved landscape quality improved bee abundance. The highest bee abundances occur on fields that are both organically managed and have crop diversity including some natural habitats (Kennedy et al. 2013; Allen 2012). In California, due to the proximity of farms to high quality habitats – chiefly rangelands, native bees supply an estimated 35-39% of the value of total pollination services (Chaplin-Kramer et al. 2011b). In California, various studies have demonstrated in almonds , watermelon, tomato and strawberry fields, the important role of surrounding natural habitat, on-farm diversification, and organic management for promoting populations of wild pollinators (Morandin & Kremen 2013; Kremen et al. 2002; Klein et al. 2012; Greenleaf & Kremen 2006a; Kremen 2013). While many of the studies of the benefits of wild and managed pollinators on crop production are not climate change studies – they are relevant due to the fact that climate change stands to change agricultural environments. With little understanding of what these changes will be, diverse pollinator species presence is a safeguard against collapse of agricultural crops otherwise dependent on the managed honey bee.

Adaptation Strategies

Public Outreach Opportunities

The Consortium recommended that CDFA should continue to lead on informing the public and agricultural community about anticipated pests of concern, including plant diseases and weeds. Some possible outlets for information sharing are school agricultural days, county fairs, and the Departmental website. Education to the public should emphasize the impacts of agricultural pests on fire, the food supply and environment, and stress the public's role in protecting California's resources from pests.

CDFA currently maintains a database of pest, plant disease, and invasive weed occurrences throughout the state. This data is collected by Pest and Damage Records submitted to CDFA's laboratory. The Climate Change Consortium recommended that CDFA could expand the function of the database to make information available to growers and farm advisors via an accessible, public online system. The addition of some interactive tools, such as mapping abilities, or links to other resources could be useful to farm operators.

Pest Detection and Exclusion Activities

Early detection of invasive species coming into California is critical. CDFA's Pest Detection and Pest Exclusion programs need secure funding to track and monitor invasive species movement into and within California. A streamlined, quick response approach for eradication of those species in California must be developed and implemented.

Provide Habitat for Native Pollinators and Beneficials

Crop production will benefit most from the combined use of different pollinator species, pollinator habitat augmentation, and management practices to provide reliable and economical pollination of crops. There is ongoing research in this area, in particular with the Integrated Crop Pollination Project funded by the Specialty Crop Research Initiative of the USDA. Overall, reducing the risk of crop failures due to inadequate pollination, and improving crop yields, means diversifying pollinator sources, which include honey bees, other managed bee species, and habitat enhancements for both wild and managed pollinators (USDA Specialty Crop Research Initiative 2013; Kremen 2013).

Growers can reduce their reliance on managed honeybees and encourage native pollinators and predators by providing necessary habitat for these species on their farms, including use of polyculture, hedgerows and flower strips. CDFA can distribute documents about the costs and benefits of, managing and maintaining hedgerows and flower strip plantings to growers. UC Cooperative Extension and Resource Conservation Districts can connect with growers to promote the advantages of improving pollinator habitat. These are also appropriate organizations to educate growers on the pollination services that native species provide.

Figure 7: Hedgerows (bottom) and flower strips (top) can provide habitat and needed nutrition to pollinators and beneficial insects. Photos provided by Claire Kremen, University of California, Berkeley

Growers are not the only group that can improve habitats for native pollinators and beneficial predators. The Consortium recommended that CDFA should provide outreach to partners regarding the value of native pollinators to agricultural systems. CDFA can work with other agencies, cities, counties, Caltrans, irrigation districts, and utilities to find opportunities to create and or restore habitat. For example, CDFA could advocate that Caltrans consider locally-appropriate options for vegetated (as opposed to sprayed and mowed) roadsides when making decisions about roadside maintenance. Some other possibilities for planned habitat areas could be canal banks, storm drainage basins, right-of ways, power pole alleyways, and agricultural buffer zones. Agencies should consider the costs and benefits of habitat restoration in these areas and compare them with the costs and benefits of the conventional management practices such as spraying or mowing. Cities and counties could begin to incorporate pollinator habitat into their climate action plans.

Research Needs

Some questions require further study in regards to habitat restoration on farms:

- What are the actual food safety risks of habitat restoration on farms? The Consortium recommended that documenting the food safety concerns of habitat restoration and risks to consumers would be beneficial.
- Research is needed to quantify the damage done by vertebrates such as ground squirrels, gophers, and voles and how to counter the impact.
- Research is needed on application of habitat restoration in large conventional agriculture settings. For example, at many locations in the San Joaquin Valley monocultures are grown over large areas. How can components of pollinator habitat be integrated into this type of land management?

Quantify the Economic Benefits of Providing Habitat to Beneficials

The Consortium recommended that the Department can partner with growers who have implemented habitat restoration on their properties and use historical records to quantify the costs and benefits of cover crops, hedges, and poly mixtures. One possibility would be to compare pesticide use records in areas where restoration was implemented to areas where the practices have not been implemented.

Honeybee Health

Production of many of California's specialty crops such as almonds and melons relies heavily on managed honey bees and honey bee health has been in decline, and is therefore a cause of concern. Research on honey bee health is ongoing, and the Consortium recommended additional support for research on the following:

- Identify and register new and safe products or biocontrol methods to deal with Varroa mite;
- Study bee species for breeding, especially with regard to species' resistance to Varroa mite;
- Study pesticide impacts on honey bee health;
- Study nutritional needs of honey bees and methods of supplying this nutrition (e.g. hedgerows, flower strips).

Crop Breeding

Breeding is needed for self-fertile varieties, starting with breeding for species completely reliant on pollination, such as almonds.

Pest Forecasting and Biocontrol

CDFA should adopt pest forecasting tools and/or models that incorporate climate change and pest-specific observational data on pest distribution. CDFA could generate a list of pests that will likely be a threat to specific agricultural regions in California under future climate conditions. The Consortium recommended the Department should support research for biocontrol for expected pests and ensure that the process for importing a specific biocontrol agent remains in place.

California has generalist beneficial species that may provide control of many new invasive pests. There is a need to study the interactions of these species with the anticipated pests to see if the generalist species can provide effective control.

On-Farm Strategies for Adaptation to Increased Pest and Pollination Pressures

- *Diversify crops*
- *Stay informed on emerging pests of concern through CDFA's website*
- *Practice Integrated Crop Pollination: the use of managed honeybees combined with native pollinators*
- *Attract native pollinators and other beneficials with hedgerows, flower strips, and polyculture*
- *Provide nesting sites for native pollinators*

Chapter 5: Additional Recommendations

The Climate Change Consortium identified several over-arching themes that can lead to better communication and the streamlining of resources with the goal of increasing specialty crop agriculture's resilience to climate change.

Involve Growers in the Climate Change Adaptation Discussion

There is a need to improve growers' understanding about climate change impacts and focus on adaptation strategies that are practical and with purpose. The Consortium noted that it was important to encourage growers to recognize and integrate adaptation measures into operational decisions. Also, it was important to encourage growers to share their adaptation experiences for better monitoring and to inform future research and funding needs.

The California Energy Commission sponsored a study on climate change adaptation in Yolo County, *Adaptation Strategies for Agricultural Sustainability in Yolo County, California* (Jackson et al, 2012). In this study, growers were surveyed about their perspectives of climate change impacts and how these impacts influence their decision-making about farming practices. It would be helpful to continue to survey grower perspectives and attitudes about climate change on a statewide level. What have growers experienced about climate change? What adaptation strategies have growers already taken? Why or why not are growers interested in doing certain actions? Growers are likely to have insights into adaptation strategies that are regional and crop-specific.

Grower Technical Assistance and Incentives

Climate change impacts increase grower needs for technical assistance. Resource Conservation Districts, UC Cooperative Extension, and USDA Natural Resource Conservation Service are appropriate programs or agencies for this type of technical assistance. These agencies can provide one-on-one training and expertise to growers about climate change impacts and adaptation strategies. These resources need to be locally available to growers at any scale of operation. CDFA can support these efforts through advocacy to public agencies and private stakeholder groups for reinvestment into technical assistance agencies.

The Consortium recommended that it is important to encourage industry to provide leadership in finding solutions to offset climate change impacts by providing incentives to growers. CDFA can support USDA Natural Resource Conservation Service in a review and creation of policies to improve grower's ability to adapt to climate change. It would be necessary to consider new technologies for water, soil, and pest management and suggest ways to scale BMPs to farms of all sizes. Best management practices would be incentivized through cost-sharing or low interest loans and would include (among other BMPs):

- implementation of water conservation plans;
- use of water efficient technology and improved irrigation uniformity (see Figure 8);
- soil moisture and groundwater monitoring;
- water budgeting (such as metering, where appropriate) (see Figure 9);
- on-farm water storage;

- groundwater recharge projects;
- building water holding capacity of the soil;
- habitat restoration projects;
- managing hedgerows or flower strips.

Figure 8 (top): An on-farm water meter used as part of conservation efforts. Photo courtesy of Jocelyn Gretz, Rio Farms.

Figure 9 (bottom): Irrigation uniformity testing in a sprinkler irrigated field. Photo courtesy of Jocelyn Gretz, Rio Farms.

The Consortium also encouraged growers to incorporate climate change into their normal and long-term business planning, and thereby leverage existing grower capabilities that may otherwise go unrecognized.

Educational Events

CDFA can partner with NGOs, industry groups, and academics to inform growers of the benefits of building climate change resiliency into their farming practices. The Consortium recommended that CDFA should tailor some climate change outreach programs to target pest control advisors and plant nutrient managers since these agricultural support service personnel works closely with growers and often initiate decision-making on-farm in regards to water use, pest control, and other management strategies. This information distribution pathway will help facilitate the transfer of technical scientific information to growers.

The Consortium suggested it would be beneficial to host an annual or bi-annual winter conference on climate change adaptation for the agricultural community. Multiple state agencies, researchers, and growers could participate in order to share recent research and discuss adaptation activities.

Interagency Cooperation

Inter-agency coordination with key partners, such as California's Strategic Growth Council, on the recommendations of the Climate Change Consortium, to ensure cross-agency efforts are critical to support the adaptation needs identified by the Consortium.

Recognition for Innovative Growers

Recognizing growers that implement climate change adaptation strategies on a CDFA website and through creation of a Climate Change Adaptation Award will be useful. The award would be designed as an incentive for growers to plan for climate change and would draw positive attention to grower brands. Outreach to the broader public through media would be integral to this effort. A food-focused media campaign might include recognizing growers at farmers markets, events with celebrity chefs, press releases, and other venues to publicize the benefits of agriculture to the community and environment.

International Information Sharing and Grower-to-Grower Exchange

The Consortium recognized that CDFA should partner with the agricultural industry to establish an international grower-to-grower information sharing program. California growers with expertise in production, who are also early innovators, can be identified by commodity groups and be connected through an exchange in order to share adaptation practices specific to their commodities. These growers could exchange information and potentially visit with other growers in California, out-of-state and internationally to learn about cropping patterns and cultivation practices that can be applied to promote resiliency to climate change. In particular, the program should consider climate analogues - places with climates similar to California's future climate zones.

CDFA should work with commodity groups to identify partnerships (growers here and elsewhere); help facilitate webinars or other meetings; assemble a comprehensive list of other existing programs/documents that work to offset climate change impacts in other states and countries. CDFA can coordinate the dissemination of this information to growers through a comprehensive climate change adaptation information website and promote farmer-to-farmer education.

Establish an Online Research Needs Forum

Management techniques, alternate crops, and cultivars identified as part of a California-specific adaptation portfolio will need to be studied further in California before they are recommended to growers. Research plots can substantiate and maximize the value of new techniques and cultivars before they are adopted by California growers.

The Consortium recommended the development of an online forum to match the needs of industry groups and growers to researchers. The forum would be a place for growers to express their needs, and for researchers to propose research projects based on those needs. The forum would likely appeal to researchers that often need to meet an outreach requirement for funding. Additionally, the forum could include a function to identify funding and encourage the cooperation of growers in the research process so that projects can be completed "on-farm."

Farmland Conservation and Smart Growth

Conserving irrigated farmland may reduce the impact of urban heat islands and mask the regional climate warming effects of greenhouse gases (Jackson 2012; Bonfils & Lobell 2007; Kueppers et al. 2007). A recent study shows that urban land use in Yolo County, California, had average emissions of more than 70 times that of irrigated cropland (Haden et al. 2013). CDFA should work to educate local and state governments about the climate benefits that adjacent agriculture can provide, and to encourage smart growth regulations, which include boundaries on development. The Consortium recommended that CDFA should also advocate for policies that provide financial incentives for farmland protection prioritizing farmland near urban boundaries and identifying farmland with highly productive soils. Capacity for farmland preservation currently exists through the Williamson Act (State of California, Department of Conservation 2007).

Investigate Regulatory Barriers to Adaptation

Growers need to be able to react quickly to changing weather or year-to-year variations in weather or pests. Some regulations may not allow for short-term flexibility. Regulations should be studied to identify if there are any barriers that may limit the adaptation of agriculture to climate change. In particular, the following regulations need to be investigated to make sure that they do not hinder climate change adaptation:

- EPA and DPR registration of pesticides relative to climate change threats;
- Special local need registrations and emergency exemptions (Section 24(c) and Section 18 of the Federal Insecticide, Fungicide, Rodenticide Act);
- Water rights, and water trading rules;
- Federal crop insurance program for specialty crops to address California conditions.

Crop Breeding

The Consortium recommended crop breeding specifically for resilience to climate change impacts. Growers support crop breeding as a practical solution for environmental pressures. A poll taken by farmers in Iowa indicated that 63% feel that the seed industry should develop crop varieties that will be resistant to future weather patterns (Iowa State University 2011).

CDFA can be a centralized location for organizing and advocating for breeding needs, and can provide guidance to breeders regarding potential future crop stresses. CDFA should work with specialty crop industry groups to create a list of breeding priorities so that crops with more vulnerability to climate change pressures are targeted first for research. For example, due to grower demand and clear climate trends, the breeding of low-chill cherry varieties should be a priority since cherries are already impacted by decreased winter chill hours in California.

Federal, State and Industry partnerships are needed to support and fund University research programs that use modern genetic techniques to identify genes that promote climate change resilience (heat-tolerance, low-chill, drought-resistant, flood-resistant, disease or pest-resistant). Similar partnerships are needed to translate basic research discoveries into new crop varieties that will serve the California agricultural industry and consumers. CDFA also can help by supporting the development of crop breeding collections with known genetic inheritance and by facilitating field testing of new varieties in collaboration with federal agencies.

Integral to any breeding program will be the successful marketing of new varieties. The marketability of new cultivars will weigh considerably during the breeding process. Yield and quality of the product must be maintained.

As new varieties of crops are developed, the Consortium believes it is vital to continued agricultural success that the genetic materials of crops are preserved and diversity maintained. CDFA can support preservation of genetic resources by pursuing funding and working with private partners.

Identify Infrastructure and Economic Opportunities and Barriers to Relocating Crops

The Consortium noted that CDFA should initiate a study of the infrastructure and economics of relocating crops within the state as well as to outside of the state. For example, what infrastructure (such as processing facilities) is required to produce avocados in another region of the California? This project would involve quantifying the costs of infrastructure building, comparative cost studies of moving or losing certain crops, identifying possible partnerships with existing organizations and groups in order to make relocation more feasible. Studies of climate analogs (mentioned previously) can be used in this process. For example, projections suggest that mid-range warming scenarios will result in winters in Yolo County resembling current winters in Kings County (Pope 2012). Given this projection, what opportunities might exist for expansion of certain crops into Yolo County? To complete this type of study, cooperation between multiple agencies and research institutions would be required, not only to conduct the study, but also to validate the findings.

Invest in Improved Weather Forecasting and Communication

Growers need access to the specific forecast and historical data through intuitive and accessible interfaces. The Consortium recommended identifying specific weather-related needs for growers. For example, using farming expertise, CDFA can work with growers to identify what data is important to their particular crop cycle (such as ET rates, chill hours) and see that these parameters get incorporated into agency and commercial products. CDFA should provide growers with links to services and new research/tools on their website, serving as a portal for existing programs such as the Department of Water Resources'

Commercial Opportunities for New Technologies and Products

- *Farm equipment suitable for multi-cropping and increasingly diversified farming operations*
- *Shade-producing structures and products*
- *Heat and drought, low-chill, and flood tolerant crop breeds*
- *User friendly weather prediction and climate monitoring tools for growers*

California Irrigation Management Information System (CIMIS) and the National Integrated Drought Information System (NIDIS).

Improvements in Technology

Climate change may represent a business opportunity for the development of technologies and equipment to meet new demands in the marketplace. For example, the development of a practical tool to measure bud development and chill accumulation could help growers make decisions about applying rest-breaking materials.

Marketing Efforts

California's high standards in labeling and import requirements must be maintained. CDFA should be involved with marketing the benefits of California grown products because they meet truth in labeling requirements, pesticide safety requirements, and have a reduced risk of spreading invasive pests. Under future climate change conditions, growers will count on additional marketing efforts to offset economic losses and increased expenses. The Department can be involved in this effort.

Summary of Recommendations

The Climate Change Consortium recommended ways that CDFA can help growers adapt to climate change through the categories of Outreach and Education, Planning and Resource Optimization, Research Needs, and Technology and Innovation. Table 1 below lists the recommendations in these categories. Further information about each recommendation is provided in Table 2.

Table 1. Summary of categories and recommendations by title. More detail for each recommendation is provided in Table 2 below.

Recommendation	Corresponding Page Number in Table 2	Corresponding Page Number in Final Report
Outreach & Education		
Grower Technical Assistance	50	42
Interagency Cooperation	51	44
Recognition for Innovative Growers	52	44
International Information Sharing and Grower-to-Grower Exchange	52	44
Establish an Online Research Needs Forum	53	44
Pest and Beneficial Species Outreach	53	38
Flood Risk Outreach	53	27
Interagency Habitat Restoration Projects	54	39
Climate Change Adaptation Conference	54	43
Planning and Resource Optimization		
Participation of Agricultural Interests in Integrated Regional Water Management Process	55	25
Review Regulatory Barriers	56	45
Farmland Conservation	56	45
Improve Growers' Ability to Adapt to Climate Change	57	42
Secure Funding for Pest Programs	57	38
Marketing Efforts	57	47
Research Needs		
Economic and Environmental Studies of the Costs, Benefits, and Risks	58	15, 26-28, 40, 46
Research Plots for Experimental Study	59	15
Crop Breeding	59	14, 28, 41, 45
Improve Honeybee Health	59	40
Study Impacts of Saltwater Intrusion	60	25-26

Recommendation	Corresponding Page Number in Table 2	Corresponding Page Number in Final Report
Pest Forecasting	60	41
Augmentative Biocontrol	60	41
Crop Fertility	60	15
Technology and Innovation		
Weather Information	61	46
Field Level Monitoring Tools	61	47

Table 2. Further explanation of each recommendation by category.

These Consortium recommendations were made for CDFA as the principal agency, but given the overlap of agriculture with other sectors (e.g., water), the importance of collaborating with other state, federal, and research agencies are noted. The following ranges have been adopted for "Timeframes": short = 0-6 months, medium = 6-18 months, long = > 18 months. The following expense distributions have been approximated for "Potential Cost": Low = $ 0-1,000, Medium = $ 1,001-10,000, High => $10,000. UC ANR is the University of California Agricultural and Natural Resources which includes agricultural Extension Services (e.g., farm advisors).

Recommendation	Key Partners	Level of Priority	Timeframe	Potential Cost to CDFA
Outreach & Education				
Grower Technical Assistance CDFA should facilitate an increase in grower technical assistance and trainings specific to climate change adaptation, such as for water, soil, and pest management, by doing the following: 1. Advocate for *public* (e.g. CA Public Utilities Commission, California Energy Commission, etc.) and *private* (e.g. commodity groups) re-investment in grower technical assistance such Resource Conservation Districts and UC Cooperative Extension; 2. Increase grower awareness of existing technical assistance and training programs; 3. Act as a clearinghouse for climate change adaptation-specific best management practices (BMPs), and coordinate with other groups to disseminate this information to growers; 4. Coordinate with agencies and education institutions to develop new trainings, (optional) certification programs, and continued education units (CEUs), for pest, soil, and water management practices that help growers adapt to climate change. CDFA should: • Coordinate trainings through existing training funding programs carried out by agencies and groups like DWR and Irrigation districts; • Tailor climate change outreach programs to pest control advisors and nutrient managers.	• Resource Conservation Districts • UC ANR Cooperative Extension • California State Universities • Regional Water Boards • Ag Associations & Commodity Groups • Agricultural Commissioners • Growers • Department of Water Resources (DWR) • Irrigation Districts • Natural Resource Conservation Service • California Certified Crop Advisors • California Association of Pest Control Advisors • Association of Applied IPM Ecologists • Xerces Society • Audubon California	Primary	Medium	Low

Recommendation	Key Partners	Level of Priority	Timeframe	Potential Cost to CDFA
Interagency Cooperation CDFA should ensure that staff are present and advocating for growers during agency and cross-agency discussions (e.g., Strategic Growth Council, California Energy Commission, Public Utilities Commission) regarding energy and water use efficiency and other matters relevant to climate change adaptation. CDFA should ensure cross-agency efforts support the adaptation needs identified by the Consortium.	• California Strategic Growth Council • GO Office and Planning and Research • State Board on Food and Agriculture • Climate Action Team • Local Agency Formation Commissions (LAFCOs) • California Public Utilities Commission (PUC) • California Energy Commission (CEC) • California Department of Water Resources (DWR) • Regional Water Boards	Primary	Short	Low

Recommendation	Key Partners	Level of Priority	Timeframe	Potential Cost to CDFA
Recognition for Innovative Growers CDFA should recognize growers who adopt climate change adaptation and resilience practices. The CDFA should acknowledge growers in a publically accessible, *food-focused* context, using: • Grower case studies posted to the CDFA website; • A food-focused media campaign that includes farmers markets, events with celebrity chefs, California grower "branding"; • A CDFA "Climate Change Adaptation" award.	• CDFA Environmental Farming Act Science Advisory Panel • UC ANR • Resources Conservation Districts • Ag Associations & Commodity Groups • Agricultural Commissioners • Non-governmental organizations • Media outlets • California Farm Bureau Federation	Secondary	Medium	Low
International Information Sharing and Grower-to-Grower Exchange CDFA should fund and coordinate the development of an international grower-to grower information-sharing exchange that will help California growers: • Identify low chill and heat tolerant varieties used in locations outside California (nationally and internationally); • Identify alternative crops that may be grown successfully in the various regions of California under future conditions; • Investigate management practices that can counter the weather impacts of climate change such as heat stress, drought, and flooding; • Identify management practices for pests that may be helpful with increased pest pressures, and that support beneficial pests and pollinators.	• International Embassies • International Consulate General offices • International Universities • California Farm Bureau Federation • University of California System • Ag Associations & Commodity Groups • Growers • Agricultural Coalitions • Agricultural Commissioners • UC ANR	Tertiary	Short	Low

Recommendation	Key Partners	Level of Priority	Timeframe	Potential Cost to CDFA
Establish an Online Research Needs Forum CDFA should fund and establish on online research needs forum to match grower adaptation needs with researchers in the field.	• Growers • Agricultural Coalitions • Ag Associations & Commodity Groups • UC ANR and Other Universities • Agricultural Commissioners	Tertiary	Short	Low
Pest and Beneficial Species Outreach CDFA should inform the public about pest and plant disease threats as well as beneficial plants, insects, and pollinators, relevant to climate change adaptation. Outreach could be conducted through: • Events such as school Ag Days, fairs and media outlets; • A newly created database of pest and damage records available to growers and farm advisors; • Distribute educational materials to growers about the benefits, costs, management and maintenance of hedgerows and flower strips.	• CDFA Plant Health Division • CDFA Environmental Farming Act Science Advisory Panel • California Department of Pesticide Regulations • California State Association of Counties • Agricultural Commissioners • UC ANR • California Invasive Species Council	Tertiary	Short/Medium	Low/Medium
Flood Risk Outreach CDFA should inform growers of the increased flooding risk due to climate change and: • Compile an online list of existing resources and programs that deal with flooding; • Distribute parcel-specific maps that predict movement or growth of flood plains to help growers make decisions about planting in those areas.	• California Department of Water Resources (DWR) • Resource Conservation Districts • Agricultural Commissioners • Municipal Water Districts • Ag Associations & Commodity Groups • Agricultural Coalitions	Tertiary	Medium	Low

Recommendation	Key Partners	Level of Priority	Timeframe	Potential Cost to CDFA
Interagency Habitat Restoration Projects The CDFA should work with Key Partners to identify opportunities to create habitat for beneficial native pollinators. CDFA should provide outreach to Key Partners regarding the value of native pollinators to agricultural systems.	• Caltrans • Local (City, County) Governments • Utility companies and California Public Utilities Commission (PUC) • Irrigation districts • Resource Conservation Districts • CDFA Environmental Farming Act Science Advisory Panel	Tertiary	Long	Low/Medium
Climate Change Adaptation Conference The CDFA should host a winter (annual or bi-annual) statewide conference on climate change adaptation for all agricultural stakeholders: agencies, growers, agricultural groups, and researchers. Information about the conference would be shared on a website including research abstracts.	• Multiple State Agencies • Growers • Ag Associations & Commodity Groups • Agricultural Commissioners • UC ANR and other Universities	Tertiary	Medium	Medium

Recommendation	Key Partners	Level of Priority	Timeframe	Potential Cost to CDFA
Planning and Resource Optimization				
Participation of Agricultural Interests in Integrated Regional Water Management Process CDFA should advocate for inclusion of grower interests in the Integrated Regional Water Management (IRWM) process (beyond Irrigation district representation) and any future *regional* water planning processes coordinated by the Department of Water Resources (DWR). Grower needs to be addressed in these efforts including: • Identifying locations for flood control (e.g. floodplain), groundwater recharge, and multi-benefit habitat restoration (e.g. wetland); • Options for utilizing excess (flood) waters for reuse, storage, or groundwater recharge; • Utilizing pressurized water systems where appropriate; • Re-evaluating reservoir capacity and reservoir operations to manage water availability with a changing climate; • Appropriate regulation, management, and use of recycled/reused water; • Existing or emerging conflicts between urban and agricultural water use (expected to increase with climate change); • Water quality (expected to decrease with climate change); • Promotion of water conservation and efficiency at field, district, and regional scales; • Low impact development to improve urban-impacted infiltration to groundwater aquifers.	• Department of Water Resources (DWR) • Regional Water Boards • Irrigation Districts • Growers • Ag Associations & Commodity Groups • Agricultural Commissioners • Caltrans • Department of Fish and Wildlife • Resource Conservation Districts • California Farm Bureau Federation • Other local stakeholders	Primary	Long	Low

Recommendation	Key Partners	Level of Priority	Timeframe	Potential Cost to CDFA
Review Regulatory Barriers The CDFA should perform or fund a review of regulatory barriers to climate change adaptation including food safety. Safe and sustainable revisions of the following should be considered: • EPA and DPR registration of pesticides relative to climate change threats; • Section 18 and Section 24(c) of FIFRA • Water rights, and water trading rules; • Federal crop insurance program for specialty crops to address California conditions. • Food safety regulations	• California Department of Pesticide Regulations • Pesticide/Chemical Manufacturers • California Department of Public Health • Ag Associations & Commodity Groups • Agricultural Commissioners • Food and Drug Administration • Leafy Green Products Handler Marketing Agreement (LGMA) • State Water Resources Control Board • California Department of Water Resources (DWR)	Primary	Medium/Long	Low
Farmland Conservation The CDFA should promote farmland conservation through Key Partners to increase agriculture's economic resilience to decreased revenue and increased costs associated with climate change. Also ensure adequate time for agricultural land transition to alternative crops in the long-term instead of to urban development in the short-term.	• California Department of Conservation • Local (City, County) governments • Land trusts • Local Agency Formation Commission • USDA Natural Resource Conservation Service (NRCS)	Secondary	Medium/Long	Low

Recommendation	Key Partners	Level of Priority	Timeframe	Potential Cost to CDFA
Improve Growers' Ability to Adapt to Climate Change CDFA should support USDA Natural Resources Conservation Service in a review and/or creation of policies to improve growers' ability to adapt to climate change. These policies should: • Promote new technologies for climate change relevant to water, soil, and pest management; • Incentivize grower adoption of technologies and practices for improved water management, which includes use of: water meters, soil moisture sensors, on-farm water storage, and groundwater recharge where possible; • Suggest ways to scale best management practices (BMPs) to all sizes of farms.	• USDA Natural Resources Conservation Service (NRCS) • Ag Associations & Commodity Groups • Growers • Resource Conservation Districts • UC ANR Cooperative Extension • Irrigation districts • California Department of Water Resources (DWR)	Secondary	Medium	Low
Secure Funding for Pest Programs CDFA should maintain and secure additional funding for pest exclusion and detection programs.	• Legislature • Ag Associations & Commodity Groups • State Board of Food and Agriculture • Agricultural Commissioners • USDA Animal and Plant Health Inspection Service (APHIS) • California Department of Fish and Wildlife	Tertiary	Ongoing	Medium
Marketing Efforts CDFA should coordinate with USDA to promote and market California brands to offset expected economic losses and/or increased expenses due to climate change.	• USDA • Grower Associations • Commodity groups	Tertiary	Medium/Long	Low

Recommendation	Key Partners	Level of Priority	Timeframe	Potential Cost to CDFA
Research Needs				
Economic and Environmental Studies of the Costs, Benefits, and Risks of: • Crop relocation, including infrastructure considerations, and climate analogs; define where crops will be best suited under future climate conditions considering soil type, topography, water availability, and potential hazards; • Crop-specific sustainability of hothouse/greenhouse production and the development of BMP's for individual crops; • Water Management, in terms of: - Increasing above and below ground water storage capacity; - Groundwater recharge; - Use of recycled/reused or desalinated water; - Efficient irrigation technology implementation; - Reduction of evaporation from irrigation canals using solar panels or chemicals; - Sustainable forest management practices to enhance water resource availability for agricultural systems downstream. • Maintaining wild or restored habitat areas in agricultural, urban and non-urban areas (including road sides and utilities' right-of-ways), while ensuring food safety components of agricultural operations.	• University of California • Ag Associations & Commodity Groups • California Department of Water Resources (DWR) • Xerces Society • Audubon California • Resource Conservation Districts • US Bureau of Reclamation • Regional Water Boards • Irrigation Districts • California Department of Public Health • Food and Drug Administration • Produce Marketing Association • United Fresh • Local Governments • Caltrans • Utilities (PG&E) • California Public Utilities Commission	Primary	Long	High

Recommendation	Key Partners	Level of Priority	Timeframe	Potential Cost to CDFA
Research Plots for Experimental Study: Locate research plot space for the study of: • Structural, mechanical, or biological methods to reduce crop heat stress; • Crop training systems for perennial crops to protect them from heat stress and sunburn; • Climate-controlled cultivation of certain crops; • Cover cropping and crop rotations that can efficiently utilize irrigation systems and prevent runoff; • Water conservation and/or efficiency outcomes of grower use of soil moisture monitoring, on-farm water storage, and improved irrigation uniformity; • Benefits of habitat restoration in large-scale agricultural systems. • Methods or inputs to increase winter chill quantity and quality.	• University of California • Ag Associations & Commodity Groups • UC ANR • USDA Natural Resource Conservation Service (NRCS) • Xerces Society • Audubon California • Resource Conservation Districts	Secondary	Long	High
Crop Breeding: Coordinate with key partners to promote research on: • Crop heat and cold tolerance; • Low chill varieties; • Self-fertile varieties of almonds and other pollinator-dependent crops; • Maintain public crop breeding programs (e.g., secure funding for maintenance of germplasm information).	• University of California • Plant Breeding Companies • Growers • USDA	Tertiary	Long	High
Improve Honeybee Health Identify new methods and products to improve honeybee health, in terms of: • Disease • Breeding • Pesticides • Nutrition	• University of California and California State University • Ag Associations & Commodity Groups • UC ANR Cooperative Extension • USDA	Tertiary	Long	High

Recommendation	Key Partners	Level of Priority	Timeframe	Potential Cost to CDFA
Study Impacts of Saltwater Intrusion Study saltwater intrusion on agricultural lands, asking the following questions: • Where are the greatest threats? • Will sea level rise add to the problem - in coastal areas or elsewhere? • What are the adaptation solutions available to growers?	• Coastal Conservancy • Army Corps of Engineers • Resource Conservation Districts • California Department of Water Resources (DWR) • University of California and California State University Researchers	Tertiary		
Pest Forecasting CDFA and other agencies should develop and adopt pest forecasting tools that account for the effects of climate change	• USDA Animal and Plant Health Inspection Service (APHIS) • University of California • National Aeronautics and Space Administration (NASA)	Tertiary	Medium/Long	Medium/High
Augmentative Biological control Study opportunities in augmentative biological control, the release of large numbers of native natural enemies, for emerging pest threats (e.g., assess the ability of California's beneficial generalist species to provide control for new invasives).	• University of California • Other Universities	Tertiary	Long	High
Crop Fertility Research to describe and determine the effects of climate change on fertilization and pollination of California crops.	• University of California • Other Universities	Tertiary	Medium	Low

Recommendation	Key Partners	Level of Priority	Timeframe	Potential Cost to CDFA
Technology and Innovation				
Weather Information CDFA should compile a list for NOAA of grower needs for weather data and forecast products for up to 21 day forecasts including improved: • Accuracy and spatial resolution; • Grower-specific data products such as heat- or chill-hours, fog presence, soil moisture, evapotranspiration (ET), drought and flood prediction indicators; • Access to data (the historical record) through accessible data interfaces and/or list of providers of relevant data products; • Warning systems.	• National Aeronautics and Space Administration (NASA) • National Oceanic and Atmospheric Administration (NOAA) • National Weather Service • Ag Associations &Commodity Groups • Agriculture Coalitions • California State University • University of California • Cal Emergency Management Agency	Secondary	Long	High
Field Level Monitoring Tools CDFA should develop a list specific to grower needs for vegetation and pest information from new/emerging technologies (e.g., remote sensing, mobile sensors) for field level monitoring of environmental variables and farm management.	• National Aeronautics and Space Administration (NASA) • Private Companies • California State University • University of California • Ag Associations &Commodity Groups • Agriculture Coalitions	Tertiary	Medium/Long	Medium/High

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Attachment 4

help specialty crop growers plan for future impacts

Posted on August 2, 2012 by Office of Public Affairs

California's specialty crops account for more than half of the nation's fruits, vegetables, and nuts as well as nearly $7 billion dollars of exports worldwide. California's production of diverse specialty crops is threatened by potential climate-related phenomena, including reduced water supplies, increased plant heat stress, decreased chill hours, shifts in pollinator lifecycles and increased influx of invasive species. Addressing these risks to ensure agricultural adaptation to climate change will require a concerted effort and is an objective of California Agricultural Vision: Strategies for Sustainability.

Climate change and its impacts are frequently discussed in the agricultural community, but there is a need for a strategic evaluation of these risks as well as a compilation of potential solutions. To address this need, CDFA Secretary Karen Ross is announcing the establishment of a consortium of growers, educators, and technical experts in California to study and make recommendations on strategies for climate change adaptation.

The consortium will consist of:
• Four members from different agricultural associations and commodity groups in California
• One grower of each of the following specialty food crops; grapes, strawberries, almonds, tomatoes, walnuts, lettuce, citrus, pistachios, broccoli, and tree fruits.
• One scientist from the University of California system
• One extension specialist from the University of California Cooperative Agriculture
• One scientist from the California State University system
• One member that is a licensed Pest Control Adviser/Crop Control Adviser
• One member that is an Agricultural Commissioner
• One member from the California Resource Conservation Districts

Four two-day workshops are planned: Modesto (November, 2012), Tulare (January, 2013), Napa (March, 2013), and San Diego (May, 2013). At each session, the consortium members will hear about recent scientific findings, consider information shared by stakeholders, and compile specific practical solutions for the adaptation of California's specialty crops to climate change. Recommendations made by the consortium will be made available to the secretary of CDFA and distributed to stakeholders with the goal of helping growers adapt to climate change impacts.

Attendance at these workshops by consortium members is mandatory. Travel expenses for the consortium members to attend the two-day sessions will be reimbursed.

Individuals interested in being considered for the consortium are encouraged to send a brief resume by September 5, 2012 to the California Department of Food and Agriculture, 1220 N Street, Room 315, Sacramento, CA 95814, Attn: Carolyn Cook or via email carolyn.cook@cdfa.ca.gov.

The intended outcome of this consortium's work is to help growers prepare for future impacts from climate change through practical, strategic solutions.

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This entry was posted in AG Vision, Agricultural Education, Climate Change, Environment, Specialty Crops, Uncategorized and tagged Ag Vision, climate change, environment, Specialty Crops. Bookmark the permalink.

Attachment 5

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CDFA Home > Environmental Stewardship > Climate Change Adaptation Consortium for Specialty Crops

CLIMATE CHANGE ADAPTATION CONSORTIUM FOR SPECIALTY CROPS

California's specialty crops account for more than half of the nation's fruits, vegetables, and nuts as well as nearly $7 billion dollars of exports worldwide. California's production of diverse specialty crops is threatened by potential climate-related events, including reduced water supplies, increased plant heat stress, decreased chill hours, shifts in pollinator lifecycles and increased influx of invasive species. Ensuring agricultural adaptation to climate change events will require a concerted effort and is an objective of California Agricultural Vision: Strategies for Sustainability.

Climate change and its impacts are frequently discussed in the agricultural community, but there is a need for a strategic evaluation of the potential impacts as well as a compilation of practical solutions. To address this need, in August of 2012, CDFA Secretary Karen Ross announced the establishment of a consortium of growers, educators, and technical experts in California to study and make recommendations on strategies for climate change adaptation.

The consortium consists of

- **Four members from different agricultural associations and commodity groups in California**
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- **One scientist from the University of California system**
- **One extension specialist from the University of California Cooperative Agriculture**
- **Two scientists from the California State University system**
- **One member that is a licensed Pest Control Adviser/Crop Control Adviser**
- **One member that is an Agricultural Commissioner**
- **One member from the California Resource Conservation Districts**

At each session, the consortium members will hear about recent scientific findings, consider information shared by stakeholders, and compile specific practical solutions for the adaptation of California's specialty crops to climate change. Recommendations made by the consortium will be made available to the secretary of CDFA and distributed to stakeholders with the goal of helping growers adapt to climate change impacts. The strategies prepared by the consortium will be posted here in fall of 2013.

For more information about CDFA's climate change adaptation consortium for specialty crops contact Carolyn Cook, Environmental Scientist and CDFA Liaison to the Climate Change Consortium (Carolyn.Cook@cdfa.ca.gov)

RESOURCES

- Fertilizer Research & Education
- Western Plant Health Association
- FREP/WPHA Conference Proceedings

- Western Plant Health Association
- California Climate Change Portal
- CA Air Resources Board
- CA Energy Commission
- California & 2012 Farm Bill
- Planting Seeds: The CDFA Blog
- California Agricultural Vision 2030
- Invasive Pests & Diseases

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

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FOOD SAFETY GUIDELINES

PATHOGENS

1. What disease organisms may be found in the field or packing shed?
   A. Salmonella
   B. Foot and mouth disease
   C. E. Coli 0157:H7
   D. A and C
   E. B and C

2. What primary pathways are used for pathogens to enter the field or packing shed?
   A. Contaminated water
   B. Poor worker hygiene
   C. Un-sanitized vehicles and tools
   D. A and B
   E. A, B, and C

PRIOR TO PLANTING

3. What is true about untreated manure?
   A. It should always be stored with a buffer between it and the production area.
   B. It should be applied only after final harvest when crops are fallow.
   C. It should be treated with chlorine before used.
   D. It should never be used.
   E. A and B

4. It is impossible to keep all animals out of a field that is soon to be harvested, so time is better spent on other food safety issues.
   True_____ False_____

5. You do not have to take corrective actions if property next to your farm or packing area has issues concerning food safety and is not under your control.
   True_____ False_____

DURING THE GROWING SEASON

6. Where should sanitation and hand washing facilities be?
   A. They must be accessible within 100 feet of work.
   B. They may be placed within the area being harvested if that area has already been picked.
   C. They are to be placed in an area outside the field.

7. Eating, smoking, and storage of personal items are restricted to designated location(s) outside of growing/processing areas.
   True_____ False_____

8. Standing water is common on a farm and there is not a way to reduce food safety issues related to it.
   True_____ False_____

9. If irrigation water is from a ditch, it needs to be tested more often during the season than well water.
   True_____ False_____

10. Irrigation water from a well is not required to be tested.
    True_____ False_____

11. Drip irrigation, sprinklers, or furrow irrigation are equally safe.
    True_____ False_____

HARVEST

12. How often should harvest equipment be cleaned and sanitized?
    A. Weekly or more often if needed.
    B. Daily or more often if needed.
    C. Before the beginning of the day and after work breaks or more often as needed.
    D. Only if they look dirty.

13. What should you do if you detect signs of animal intrusion?
    A. Thoroughly wash product harvested near intrusion.
    B. Thoroughly wash product harvested near intrusion with chlorinated water.
    C. Remove or prevent harvest of potentially contaminated product.

POST HARVEST PROCESSING AND STORAGE

14. How often should packing facilities, equipment, and food contact surfaces be disinfected?
    A. At least weekly or more often as needed.
    B. Prior to the season or more often if needed.
    C. Once a day during use or more often if needed.
    D. Whenever a different product is to be packed.

15. Refrigeration equipment should have temperatures checked and recorded at least once per week.
    True_____ False_____

FOOD SAFETY GUIDELINES

TRANSPORTATION

16. What is true when transporting product to the market?
    A. Transport vehicle must be clean and sanitary.
    B. Driver shall have a copy of the manifest.
    C. Each package can be traced to date and field that product was packed.
    D. A and C
    E. B and C

ADDITIONAL INFORMATION – RECORD KEEPING

17. What additional record keeping documentation in regard to food safety is important?
    A. Sale price and destination of product
    B. Employee training
    C. Equipment maintenance
    D. B and C
    E. A, B, and C

HYGIENE

18. Employees should wash their hands for a minimum of 60 seconds after taking a work break.
    True_____ False_____ (20 seconds)

WATER TESTING

1. The official minimum standard for water used to produce and process crops, is the "recreational water standard."
   True_____ False_____

2. Untreated manure, if used, should be applied and incorporated into the soil at least two weeks before planting and 120 days before harvest.
   True_____ False_____

FLEISHMANHILLARD

The power of true

May 2013

CA Grown Qualitative Interviews

Summary of findings

Methodology

Conducted a total of 19 interviews with key stakeholders.

- Interviews conducted over the telephone.
- Interviews were conducted between April 16 – May 2, 2013.
- Interviews lasted, on average, 15 minutes in length.
- Interviews were conducted with six different audiences:
  1. *Specialty crop/agricultural organization (n=6)*
  2. *Retailer (n=5)*
  3. *Trade organization (n=4)*
  4. *Retail organization (n=2)*
  5. *Licensee (n=1)*
  6. *Specialty crop grower (n=1)*

Methodology *(cont.)*

- FleishmanHillard was provided a list of 51 organizations, associations and companies by CA Grown that were to serve as possible interview candidates.
- CA Grown prioritized the list, reducing it to 37 priority contacts. An email was sent to each informing them of the research and urging them to participate in an interview.
- FleishmanHillard contacted all members on the priority list. It is from this priority list that all 19 interviews were completed.
- Each person had to be familiar with CA Grown to participate in the interview.

List of Participants

Name	Type	Member	Location	Interview Date
Harris Ranch	Licensee	No	California	April 16
California Grape and Tree Fruit League	Specialty crop/agricultural organization	No	California	April 17
Grocery Manufacturer's Association	Retail organization	N/A	Washington, D.C.	April 19
California Olive Committee	Specialty crop/agricultural organization	No	California	April 22
Raley’s	Retailer	N/A	California	April 22
Roll Global	Specialty crop/agricultural organization	No	California	April 23
California Strawberry Commission	Specialty crop/agricultural organization	No	California	April 24
California Walnut Commission	Specialty crop/agricultural organization	No	California	April 24
Western Growers	Trade organization	No	California	April 24
Dole	Specialty crop grower	No	California	April 24
California Avocado Commission	Specialty crop/agricultural organization	Yes	California	April 25
Go Texan	Trade organization	N/A	Texas	April 26
California Citrus Mutual	Trade organization	No	California	April 26
The Wine Institute	Trade organization	No	California	April 26
Sierra Nevada	Branded product	N/A	California	April 26
California Restaurant Association	Retail organization	N/A	California	April 26
Pacific Coast Farmer's Market	Retailer	N/A	California	April 29
Save Mart	Retailer	N/A	California	May 2
Safeway	Retailer	N/A	California	May 2

Summary of Qualitative Research

Key Findings

Key Findings and Recommendations

- Members want to be shown that there is value in becoming or remaining a member. Conveying the benefits of membership is key to possibly stemming the exodus of current members.
- Locally-grown is very important in the state, especially to consumers. Some retailers will advertise locally grown over California grown. Trying to incorporate "locally grown" into the messaging along side the CA Grown brand may help increase awareness, preference and consumption of CA Grown products.
- The CA Grown brand is thought to be non existent in the minds of non-Californians. It has low awareness and many other states have similar programs, which will make it hard to compete for consumers in those states knowing that consumers in general prefer food that is locally grown. Focus on the consumers in California and strengthen the brand there before considering expansion or a national campaign
- Some of the organizations felt they did not get their "fair share" of the benefits relative to the size of their contribution. Being transparent on where and how membership contributions are being spent may provide piece of mind to these organizations.

Executive Summary

Awareness and Perception of CA Grown

- Overall perception of CA Grown is positive.
- Close to 90% of interviewees do think statewide marketing campaigns, similar to CA Grown, are effective in promoting locally grown agricultural products.
- Almost 90% of interviewees rated the CA Grown program somewhat successful.
- The CA Grown logo is appears to be widely used, recognized and memorable.
- Despite funding issues that have limited promotions, most have seen some form of advertising about CA Grown, and most have seen multiple forms of advertising.

Executive Summary *(cont.)*

Is this right? Is this what they are members of?

Value of CA Grown

- Even though most everyone who was interviewed is not a current member of the Buy California Marketing Agreement (BCMA), non-members do feel membership in BCMA can provide value to organizations.
- Three-fourths (75%) of those asked believe that CA Grown can command a premium price.
    - ➢ Several respondents noted that the premium price would need to be small for consumers to be willing to pay it, and that for certain products, they do not feel consumers will pay a premium.
- Respondents believe that the CA Grown brand does mean something to consumers in California, such as quality, freshness, pride, safety and locally grown, among others.

Executive Summary *(cont.)*

Effectiveness of CA Grown

- More than half (58%) agree that the CA Grown campaign HAS succeeded in increasing awareness of CA Grown agricultural products.
- Respondents are more likely to believe the campaign has increased awareness than they are to believe it has increased consumption of CA Grown agricultural products.
- One-third (32%) agree that the CA Grown campaign HAS succeeded in increasing consumption of CA Grown agricultural products.
  - Almost half (47%) don't know if the campaign has actually led to an increase in consumption.

Executive Summary *(cont.)*

Effectiveness of CA Grown

- A majority of respondents believe that the CA Grown program has provided a positive economic impact.

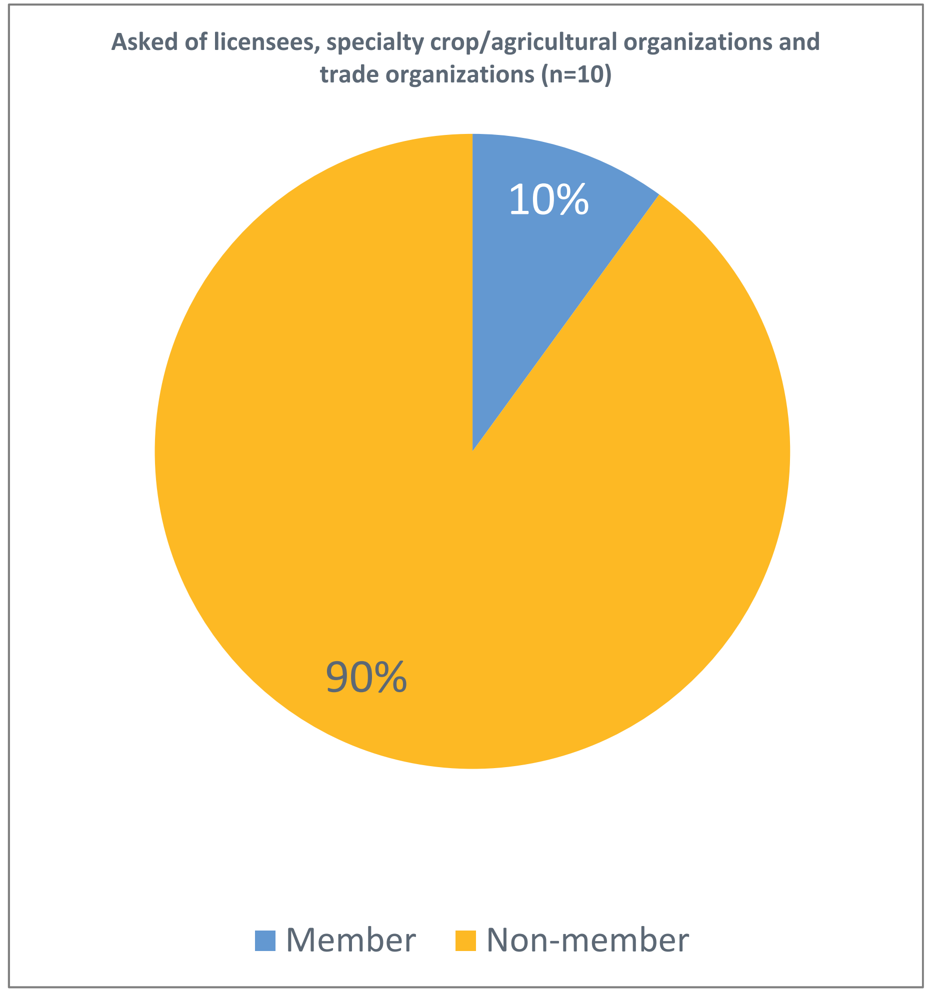
The CA Grown program….	Strongly agree/Agree
Provides positive economic impact to the state	69%
Enables products to expand their presence to new retailers and other states	64%
Is helping the California economy	63%
Is increasing revenue to growers and retailers	43%

Qualitative Research Results

Detailed Findings

CA Grown Membership

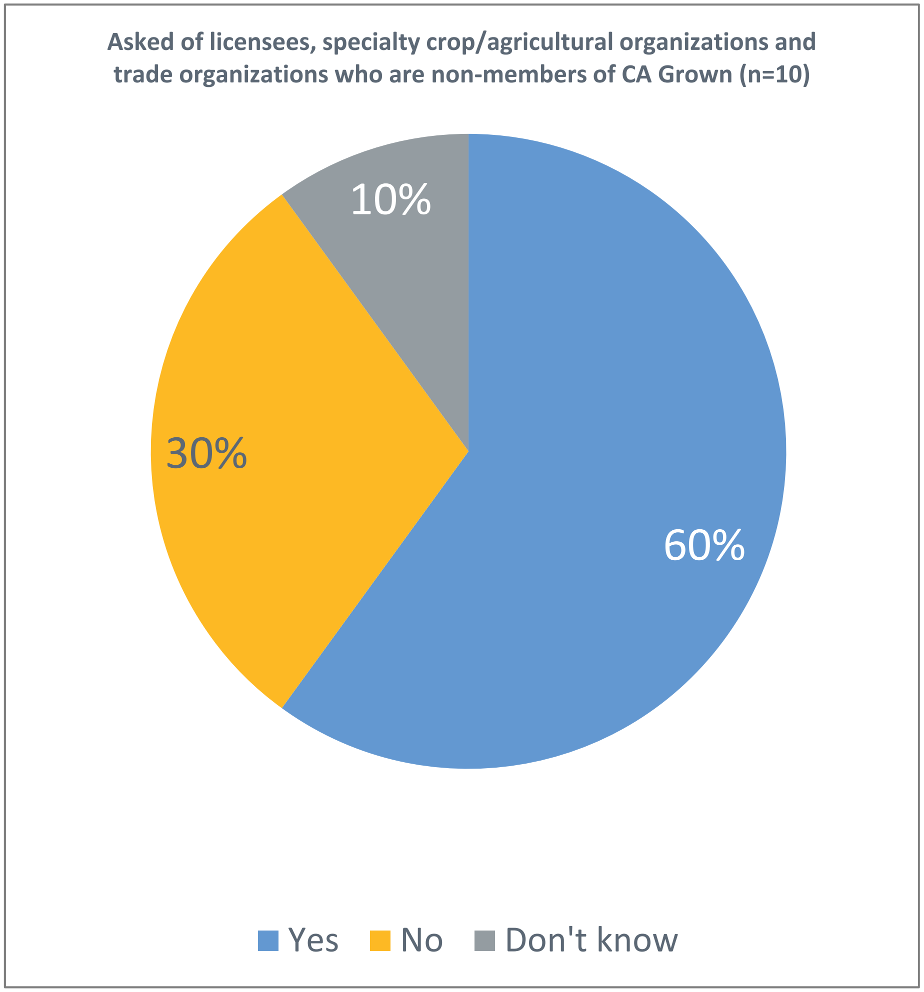
- Just one interviewee, of the 10 that were asked, is a current member.



Are you a member of the CA Grown program?

Perceived Value in CA Grown Membership

- A majority of non-members think there is value in becoming a member of CA Grown.
- Specific comments as why they feel the way they do are on the next few slides.



Do you think there is value in being a member of the CA Grown program?

Perceived Value in CA Grown Membership *(cont.)*

YES there is value

- *"Yes. It's ideal that you could brand your product as a product from California and appeal to folks looking for locally grown products. Has tremendous appeal. Something we struggle with here as well with some asking why go through the actual program vs. putting some statement on the package ourselves. It's because it's a professional marketed campaign. You can be associated with a successful program that goes across different industries."*
- *"Yes. From a licensee standpoint we use it in our literature, our brochures and even on our 50 branded trucks."*
- *"Yes there is value. California is a brand, and one way to create that brand that was going to have that ripple effects was the CA Grown campaign. The value is the branding of California products. The synergy which could have been built within industry members. We need to join together as much as we can on things. I felt one of the ways to ensure that everybody was really talking about the things that mattered and building synergy around certain things and utilizing something in a good way CA Grown."*
- *"Yes, though not for us because we're not a branded crop. We are primarily a policy organization, not a marketing organization. I think there is value, benefit, and an upside to promoting sustainable food."*
- *"Inherently yes. I do think the brand has positive connotations around the world and other states."*
- *"Only be of value if more agriculture participates, so yes. I thought it was a good idea to begin with. This type of approach can be positive if it has sufficient industry support. The problem is agriculture. There are too many free riders, too few to sustain it. There has to be a methodology that ensures a sustained level of support by a broad section of agriculture."*

Do you think there is value in being a member of the CA Grown program?

Perceived Value in CA Grown Membership *(cont.*

NO there is not value

- *"The value would have to be determined by the individual commodity groups. I don't think we see value in being a member because of the diversity of agriculture we represent."*
- *"No. Our board of directors determined that there was limited value to being a member. It was a sense that it was diluting our industry marketing efforts, rather than enhancing."*
- *"For my organization, no. Brands in our industry take care of their own business. Their brand or label, even a private label, is more important than the CA Grown logo. We thought for the amount of money we were asked to commit that we'd get that much value from the program. We were wrong. You have to have your packers supporting the program for it to work. If they think their brand is better than the CA Grown one, they won't use it. We gave it the old college try. It wasn't a mistake. It was worth taking a chance. But it didn't work out.*

DON'T KNOW if there is value

- *"I don't know. We don't leverage it. Right now to us there is not value. CA Grown is not meaningful to the people I sell to today. There is less value in it because I don't see a way to leverage where I'm from to help me sell my products."*

Do you think there is value in being a member of the CA Grown program?

Perceived Benefits of CA Grown Membership

The non-member respondents listed a number of benefits they believe CA Grown can provide an organization if they were a member. These include:

- Make the general public more cognizant of the size, scope and value of California agriculture. Places a renewed focus on the benefits that California agriculture brings to the state .
- Be a vehicle to that addresses consumer concerns in a variety of areas.
- Be able to frame debate around what farmers and ranchers really do. Through education it can leverage that positive image of farmers.
- Provides brand recognition and pride in supporting California fruits, vegetables and proteins.
- Provide additional marketing. If we're known as a California product and CA Grown is already out there it will compliment what we're already doing and heighten that much more; build more awareness and credibility.
- Provide visibility for small organization’s, grower’s and handling operation’s products and brands.
- Provide access to an organized program to promote California. It's an organized source to focus on the benefits and mindset of positives of California .
- Can tackle sensitive issues you don't want to take on your own. Operating under the CA Grown umbrella makes sense because it shelters you from exposure to the issue.
- Can help market minimally branded produce commodities that don’t have a lot of out-of-country competition.
- Can help create consumer loyalty and open doors to retailers.

What benefits do you think membership provides an organization/association like yours?

Perceptions of the CA Grown Brand

- The overall perception of CA Grown is positive.
- However, some respondents note that the organization has struggled the last few years due primarily to low membership and a lack of funds. The lack of funds in turn appears to be negatively effecting the organization by:
  - Limiting its effectiveness to promote and market it's member's products
  - Causing members to leave
  - Making it harder for organizations to see the value in joining CA Grown
- Comments are located on the next few slides, grouped by the tone of the perception (positive, negative, etc.).

What are your perceptions of the CA Grown brand?

Perceptions of the CA Grown Brand *(cont.)*

POSITIVE COMMENTS

- *"It's a great addition to our localization of products acquisition for our consumers. It's doing what it needs to do. We receive a lot of customer comments. But it's doing what it needs to do because of the number of comments we receive, based on consumers wanting to have products that are locally grown. Our consumers want to know that their products are basically from their backdoor, or at least from down the street. And this gives us the opportunity to easily convey that message and appease our consumers in that regard."*
- *"It seems like a good idea to me. We grow a lot of products in California. It's worthwhile to inform people of all the great products that comes from the state."*
- *"It's supporting the state. It's like it's made in the USA but for California. Made in or grown in the state."*
- *"I think it's very professional. Seems to be clear what it is based on the name. I feel like it provides a useful tool for consumers to find products directly from California."*
- *"I think its good, especially for out of state purchases (you know if comes from California when you purchase in-state). There is a lot of safety involved, denotes the product is safe. Good for economy."*

What are your perceptions of the CA Grown brand?

Perceptions of the CA Grown Brand *(cont.)*

SOMEWHAT POSITIVE COMMENTS

- *"It's a good program but it needs more support in the way of advertising (radio and TV ads) and PR. When it was being promoted and advertised it was doing well."*
- *"It's a positive program that has lost some of its momentum over the years. I recall the logo and license plate and remember more discussion of promoting California agriculture in the past than now. I'm not sure why lost they momentum. Maybe it's a marketing focus. The perception I've seen is that various entities that were involved originally have fallen off because they didn't get value out of it."*
- *"Good, but not enough. Good from the standpoint of the brand and what it stands for is highly marketable in the restaurant space. Not enough in the sense that you don't see it marketed in the food service settings as much as I would like. The logo and brand are underused by our industry."*
- *"Real strong and great opportunity but it's regretful that not enough in the agricultural industry participates in it. Some of it is turf but for the most part it's because they are sourcing products from other states and countries and it's not feasible for them to comply and keep products separate."*

What are your perceptions of the CA Grown brand?

Perceptions of the CA Grown Brand *(cont.)*

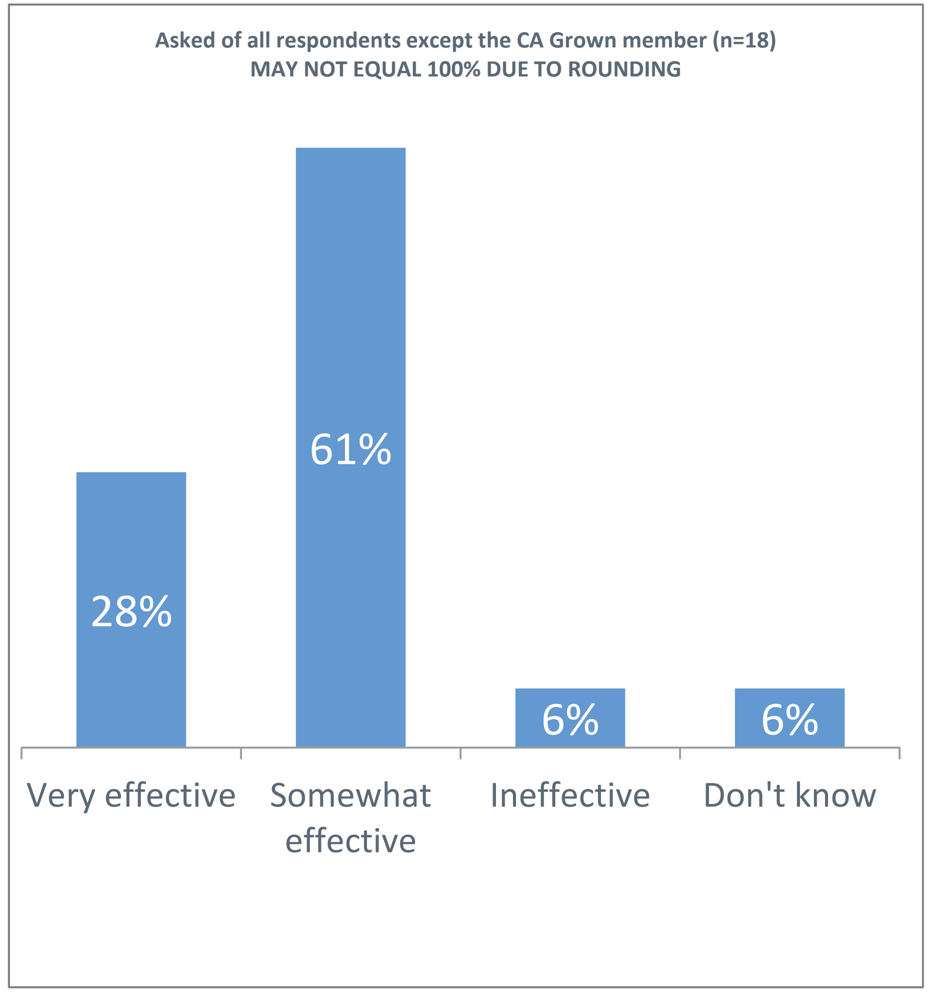
NEGATIVE COMMENTS

- *“Its underlying message is good; reinforces California agriculture. But I don't think it has significant critical mass in terms of the dollars it needs to take it to the next level and have the influence that it needs to be. I think California is an inherit brand to a lot of consumers. I don't think the dollars are currently sufficient, nor have they been in the past, to make an overall impact.”*
- *“It has been reduced in size significantly from where it was 6-7 years ago. It's not highly visible. I don't see high visibility in supermarkets or within the state.”*
- *“Trying to make other things fit didn't work. In produce, you have minimal branding. There are stickers on the pears, etc. But there's no real signage or brand staring at you, as with in dry grocery. To get political support, they had to include everything from redwood at Lowes to salmon at the fish counter, lamb, walnuts, etc.. You had a mix of products that were not very homogeneous. It was hard to promote. You're promoting to different buyers, managers.”*
- *“The purpose is to try and drive agricultural products grown here. I don't think it has a broad reach. I don't see activity for CA Grown from a consumer standpoint in the markets we operate. CA Grown's activities are much smaller than the commodity boards that represent their products. They have a strong marketing and trade presence. CA Grown doesn't have the same reach or relevance.”*

What are your perceptions of the CA Grown brand?

Effectiveness of State-Wide Marketing Campaigns

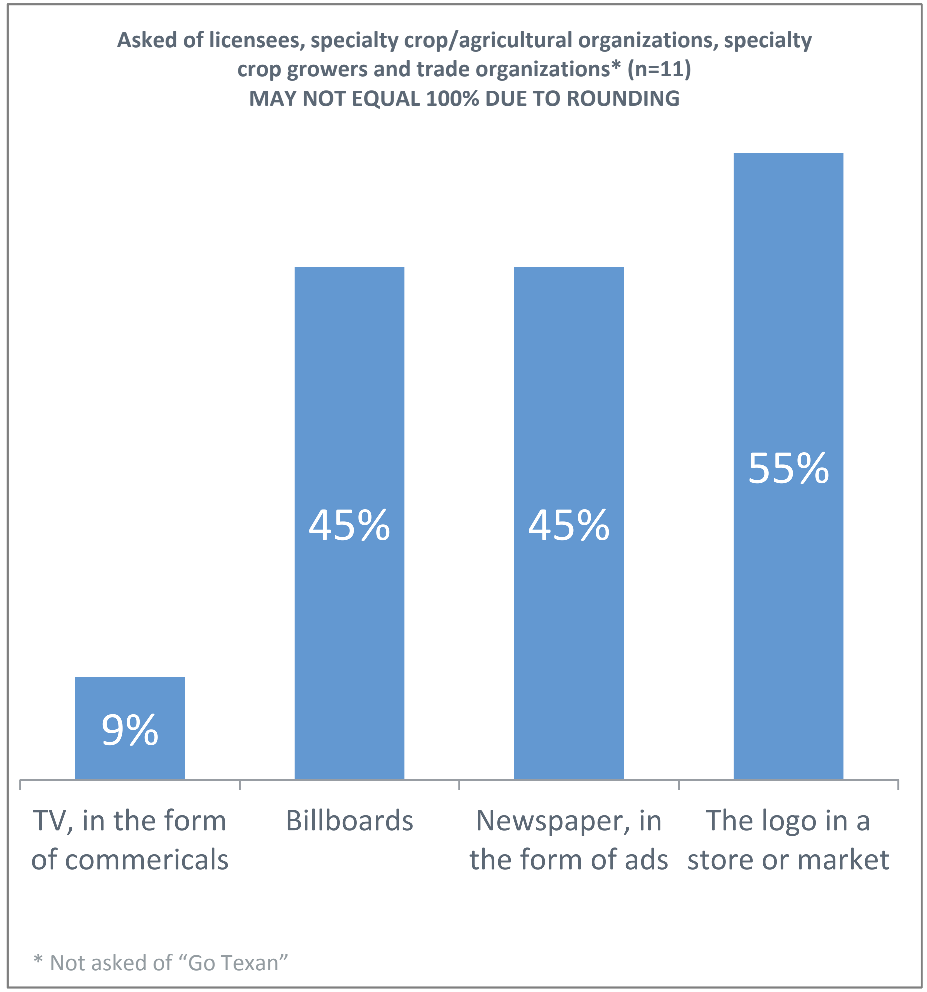
- Almost all of those who were interviewed consider programs similar to CA Grown to be effective.
- Though a majority just consider them somewhat effective.



How effective do you think state-wide marketing campaigns are in promoting locally grown agricultural products?

Seen CA Grown Advertising

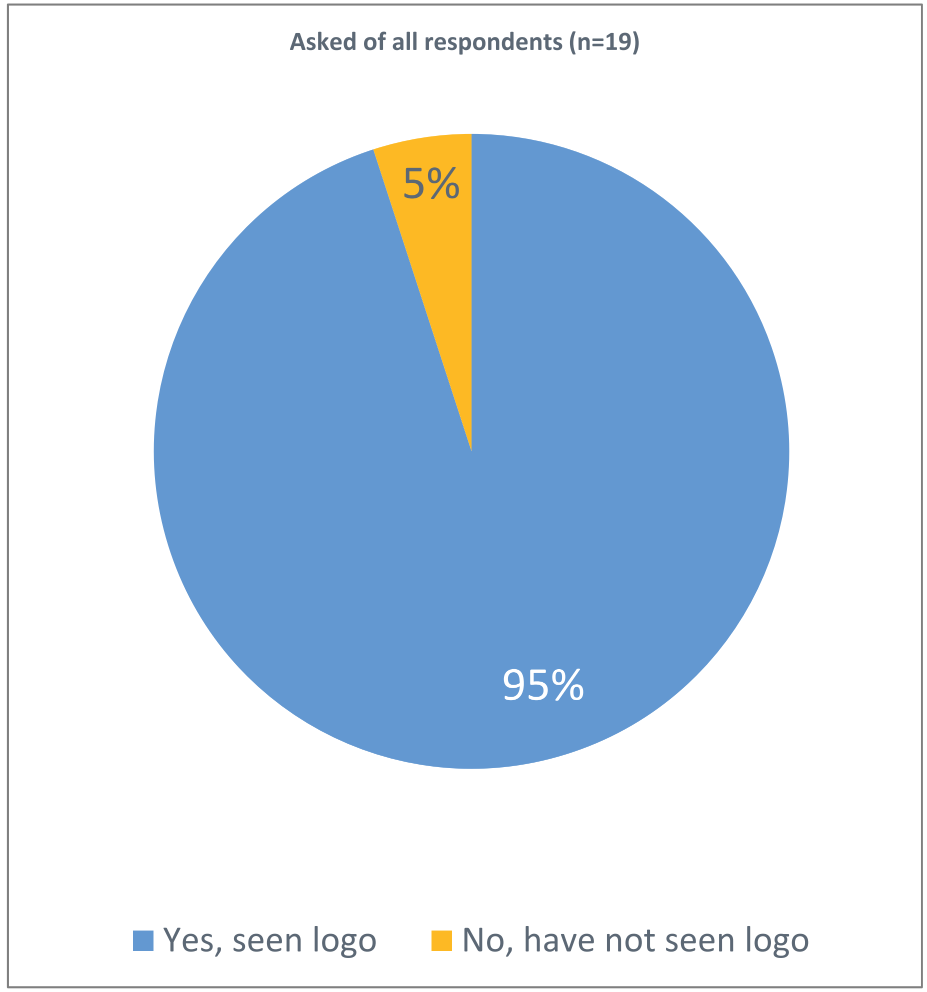
- Three of the 11 (27%) individuals who were asked this question replied they had <u>not seen any</u> CA Grown advertising.
- Most of the others had seen multiple forms of CA Grown advertising.
- One individual noted he had seen CA Grown advertising in a magazine.



Have you seen CA Grown advertising on or at any of the following locations?

Aware of CA Grown Logo

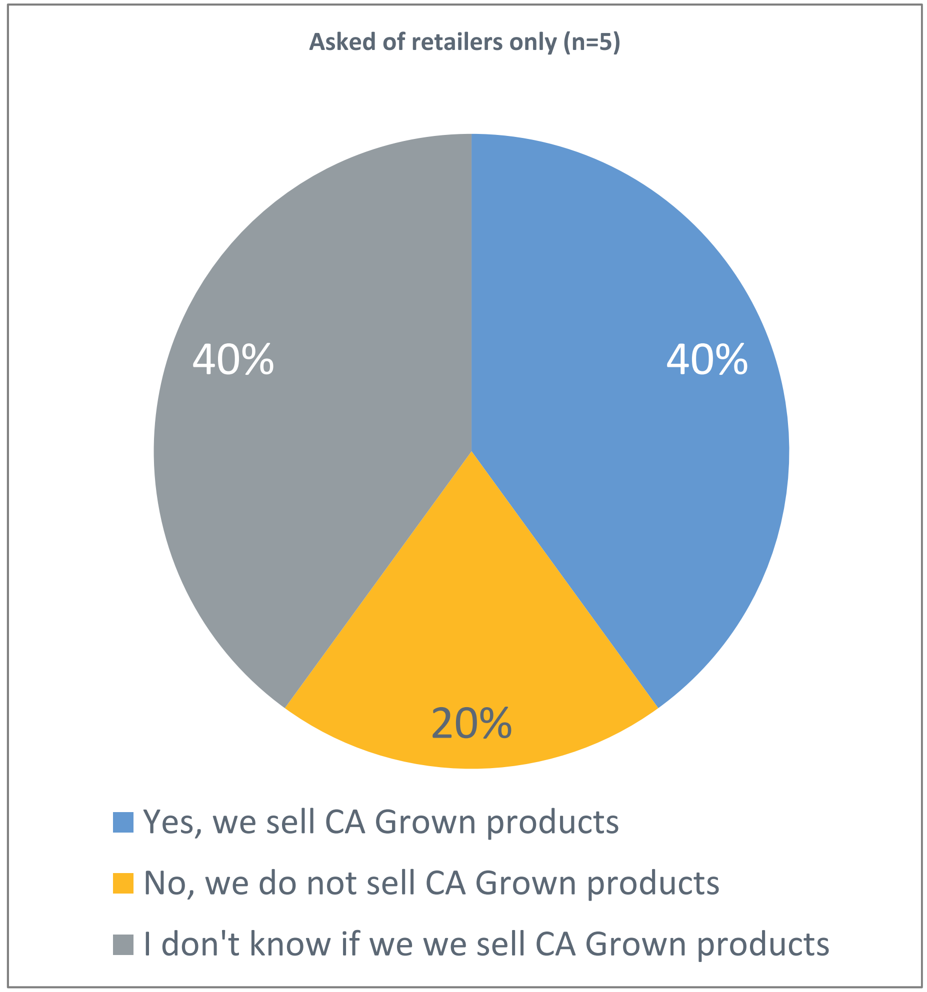
- Virtually all of the individuals who were interviewed have seen the CA Grown logo before.
- This indicates that the logo is widely used and recognized.



Have you seen the CA Grown logo before?

Selling CA Grown Products

- Of the two interviewees that do sell CA Grown branded products, one person did not know if their stores have seen an increase in store revenue as a result of offering CA Grown products. The other person replied that they have seen no change in revenue as a result of selling CA Grown products.
- The one individual who states they do NOT sell CA Grown products, stated that the reason why is because:
- *"We try to push local grown rather than California grown only because it resonates with the consumers in the local areas. Usually we'll say locally grown."*



Does your store or stores sell CA Grown products?

Preference for Selling U.S.-Grown Products

- All five retailers that were asked this question replied that they DO prefer to sell U.S.-grown products when feasible.
    - *"Prefer U.S., but we won't even accept stuff from outside the state. It's because of the **quality**, the overall **taste**."*
    - *"Whenever possible, absolutely. But at end of day we need to provide customers what they want and if its not in season we have to get it and typically that means it's not in this country. For the most part it's **responding to the wants and concerns of customers** but they have great confidence in our country's food supply."*
    - *"U.S. grown is a priority. We're in the salad bowl. The interesting thing about us, we've been in business 61 years and a lot of the agreements we have with producer-suppliers in our operating area, those agreements have been in place 60 years. So we have the long-standing tradition of giving preferential treatment to California grown suppliers. And we only buy products out of other areas only when it's necessary because of seasonality. That's always been **our preference** and always will be."*
    - *"We always try to support first and foremost locally for **the environment**, the carbon footprint. It's a lot easier to get product here than go elsewhere. Whenever possible we try to buy locally, as much as possible."*
    - *"Yes. The **trust** factor. I trust it. It's better **quality** and you're keeping the money in the U.S."*

Do you prefer to offer U.S.-grown products over products grown outside the U.S., or does it not matter?

Preference for Selling California-Grown Products

- All five retailers that were asked this question were adamant that California-grown products are a priority to their business.
  - *“Yes. It's part of our original goal when we started 25 years ago to offer locally-grown food. So I want to stick to local, grown in the state. It's **sustainable** and keeps the **money flowing in state**.”*
  - *“Absolutely. **Customers really want local**. In California, customers are used to having fruit stands and farmers markets everywhere where they can access locally-grown fruit and vegetables.”*
  - *“Yes. Because it's grown in California. The **standards** set on California products. They are **better quality** products because of the system we have set up in the state. The checks and balances. California is **more stringent** on the use of chemicals, pesticides and herbicides on food products.”*

Two retailers addressed this question in the previous question about preferring U.S.-grown over products grown outside the U.S.

Do you prefer to offer California-grown products over products grown in other states, or does it not matter?

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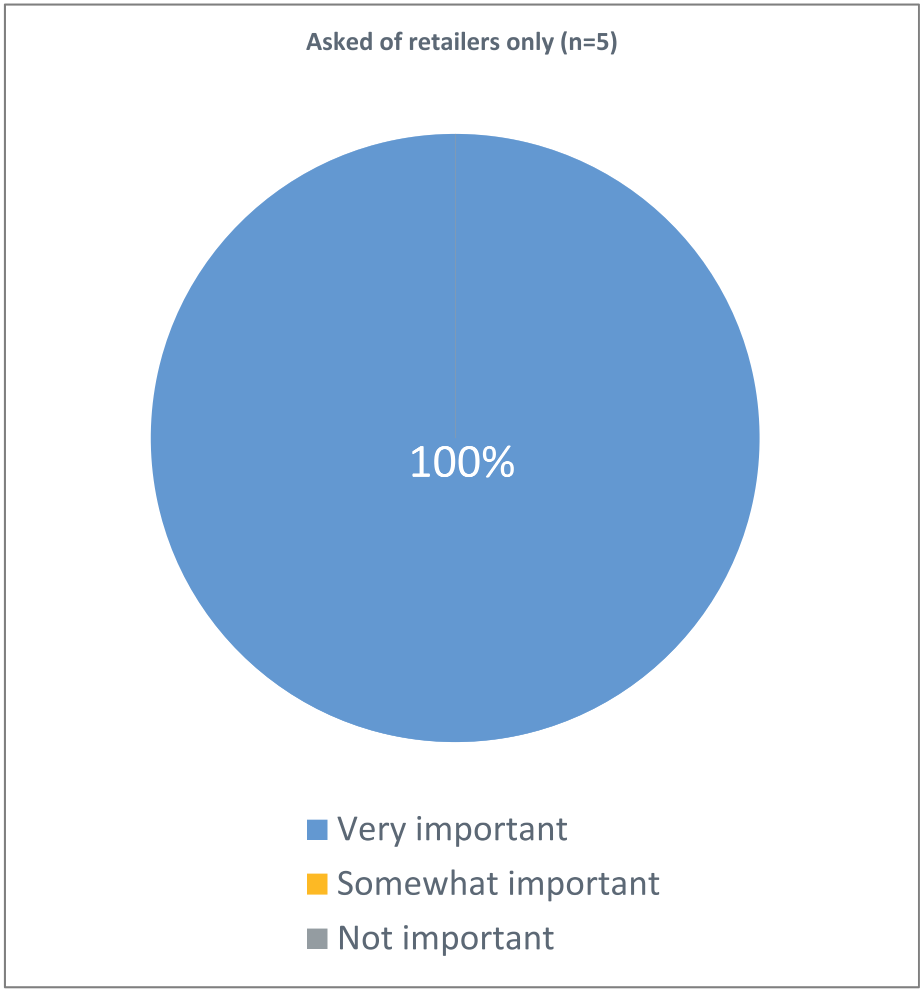
Importance of Locally-Grown Products to Business

- Locally-grown products are very important to all the retailers we interviewed.
- Reasons why locally-grown products are so important to the retailers include:
  - Satisfies our consumers needs/customers want it/resonates with customer
  - Provides jobs
  - Environmental and societal benefits
  - Higher quality product
  - Less transportation miles
  - Keeps the money local
  - Supporting small local family farms



How important are locally-grown products to your business?

Benefits of Selling California-Grown Products

- Retailers and retail organizations cite numerous benefits of selling California-grown products, but primary appears to be that Californians want and seek them out.

Retail Organizations

➢ *"**Driving customer traffic**. Helping to **promote the locally grown and fresh concept** in the food service space."*

➢ *"I imagine it would **appeal to individuals** who prescribe that local is better. Connotes **freshness** and **quality**."*

Retailers

➢ *"I don't know if it affects us but I can see affecting places in our community. I image the benefits being **consumers swaying towards locally grown**. You know where it's coming from and what processes were used. It feels a lot **safer**."*

➢ *Being able to provide our customers the **highest quality** products. We'd much rather sell California products than anything else.*

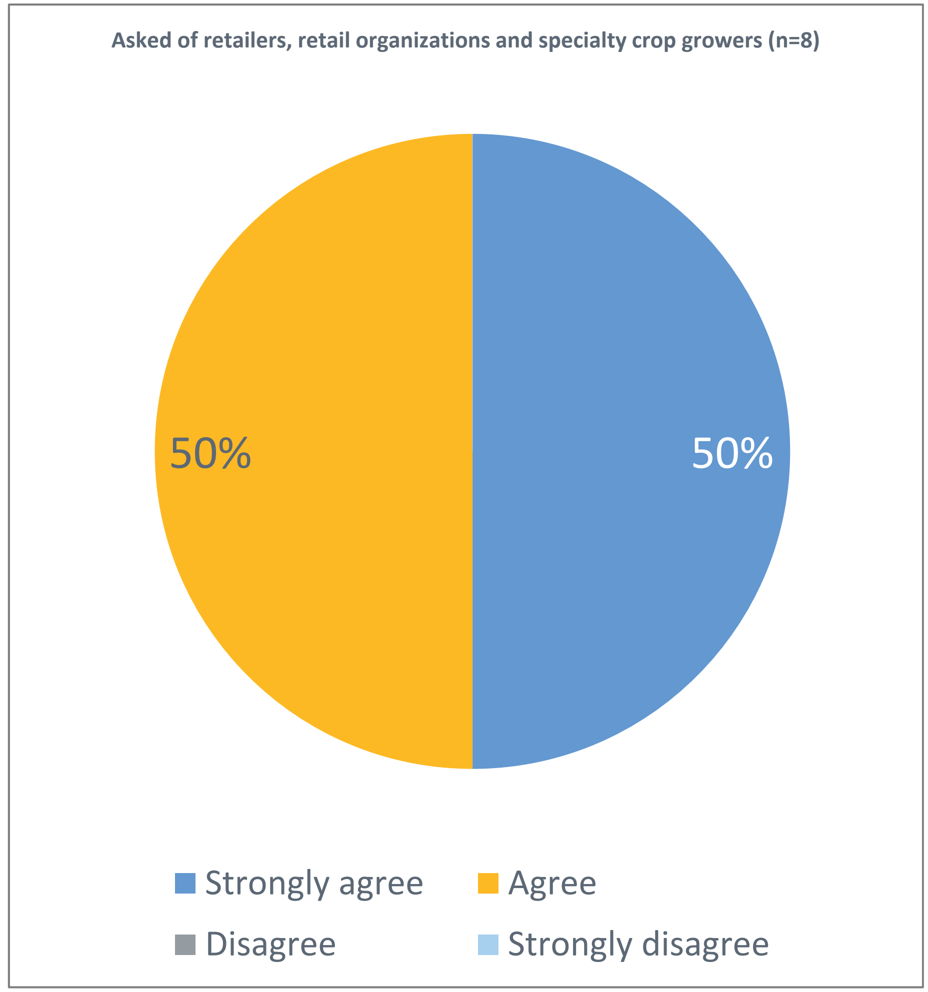
➢ *"**Customers want it**. Community involvement. We're **giving back to our neighbors**, to our community members. It allows us to keep a full circle of revenue within our marketing area. And it's just really **good business**."*

➢ *"**Better quality** products."*

What are the benefits, if any, of selling California-grown products?

Agreement or Disagreement with Statement Regarding Benefits of the CA Grown Program

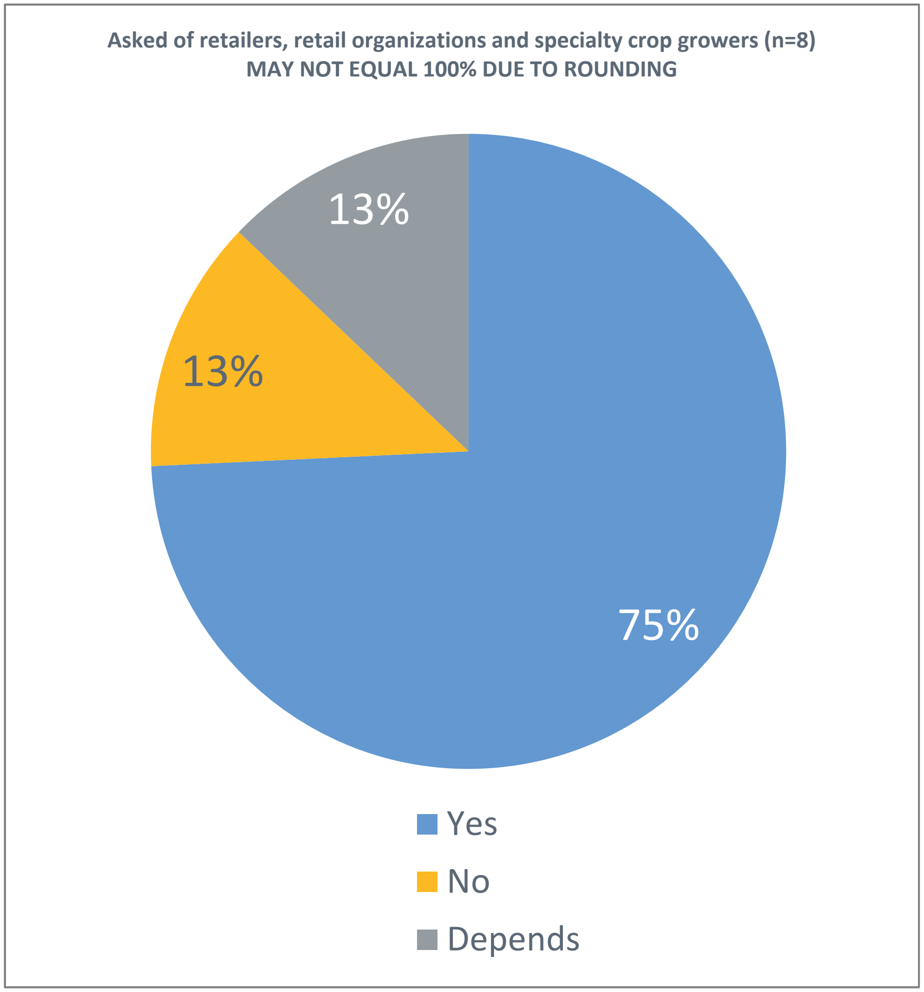
- **Statement**:
  - *"The CA Grown program can increase the effectiveness of sales when supplemented with existing individual marketing strategies."*
- All individuals agree with this statement regarding increasing sales as a benefit of the CA Grown program.



How much do you agree or disagree with the statement?

CA Grown Products Commanding a Premium Price

- Three-fourths (75%) of those asked believe that CA Grown branded products can command a premium price.



Do you believe that CA Grown products can command a premium price?

Reasons Why CA Grown Products Can or Cannot Command a Premium Price

NO, cannot command a premium price

- *Based on the **current economy** and price volatility. **Consumers are price sensitive** so they may not want to pay higher for CA Grown dish or product.*

YES, can command a premium price

- *"It conveys **freshness** and **quality** that **appeal to shoppers** who are looking for things that are grown in the U.S. and grown locally that haven't spent weeks in transit. It's about quality control; an assurance that you don't get if it's grown overseas, that may not be regulated. It's the perception that it's better, fresher and of higher quality."*
- *"It can command a premium price to some extent, but just a little bit higher. I feel like the **benefits outweigh the price**. It benefits yourself and it's **keeping jobs in California**."*
- *"Yes, but it needs more support from the agriculture and retail industry for that to happened. It stands for quality. The **California name is synonymous around the world**. We've seen it with the wine industry. There's great variety."*
- *"That's tricky, especially in this market. I would say yes but it's more market specific. Some stores can sell for a premium others not so much."*
- *"Because it's California. I'm an immigrant myself. When I go back to Canada I can see the fresh fruits and vegetables look better. The are super consistent and super good."*
- *"Because of the **positive association with California agriculture**. Not a huge premium price. I think people are more inclined to paying more for CA Grown products than products grown outside the U.S., but not necessarily other states."*

Why do you feel that way?

What the CA Grown Brand Means to Consumers in California

- Two individuals noted that the CA Grown brand doesn't mean as much to consumers as it should. They feel the brand hasn't done enough to educate consumers on the importance of agriculture in the state and the role farmers and ranchers play .
- Overall though, respondents associate CA Grown with positive words and phrases.
- CA Grown is most associated with the state or being locally grown. Words indicating what the brand means to consumers are illustrated below.

ECONOMY

- Supporting the California economy; it's good for the state
- And they're keeping their dollars in California
- The program and the products is a way for consumers to support them in the state

LOCALLY GROWN

- Local
- Grown locally here
- Homegrown
- Buying a local product
- Telling them it's from California. A stamp of origin
- Identification. Locally grown product
- Equate to local
- It tells them where the product came from
- Grown in California
- Instill local ownership
- The produce is grown in California

QUALITY

- Best quality
- Highest quality
- Quality
- Higher quality

FRESHNESS

- Fresh
- Signifies fresh
- Fresher

SAFETY

- That it is not going to be handled in unhealthy way
- Safe
- Provides food security
- Integrity

PRIDE

- Instills a sense of pride
- Instill local pride
- Instills a sense of pride

OTHER

- Imply sustainability. Environmental awareness/positive environmental impact
- Instills a sense of loyalty

FARMERS/RANCHERS

- CA Grown projects a positive image of farmers and ranchers
- Supporting local farmers, agricultural workers
- Family farms

What do you think the CA Grown brand means to consumers in California?

What the CA Grown Brand Means to Consumers Nationally, Outside the State of California

- Respondents are more likely to feel that the CA Grown brand does not mean as much to consumers outside the state of California as it does to consumers within the state.
- However, a few respondents do feel it means more to consumers outside California than to consumers inside the state, or at least means the same to both.
- Regardless, almost all respondents believe that California-grown products do mean much the same to consumers outside the state is they do to consumers inside the state, with the exception of “locally grown.” They believe that consumers outside California would associate many of the same attributes to California-grown products as California consumers do to the CA Grown brand – quality, fresh, safe, etc.
- See the next slide for sample comments from respondents.

What do you think the CA Grown brand means to consumers nationally, outside the state of California?

What the CA Grown Brand Means to Consumers Nationally, Outside the State of California *(cont.)*

Means more

- *"Probably has more value to consumers outside the state because it's communicating that its domestic. I do think there is value there because it shows that the product is not from Mexico and elsewhere."*
- *"Identification for them. When I was in Texas 5-6 years ago it was big, huge. When you go to other states it's a big deal. California is written on everything. It's a lot bigger than we realize. They are not going to put that on in Texas if their consumers aren't attracted to that."*

Means the same

- *"Some of the same as my last response, but not the locally grown part. I think compared to choices from other countries for particular products, California is preferred."*
- *"Same as to California consumers but to a lesser extent. Depending where you are in the country, the freshness argument may not hold for example. Also depends on the product. There is lesser value if there are competing commodities in the area."*

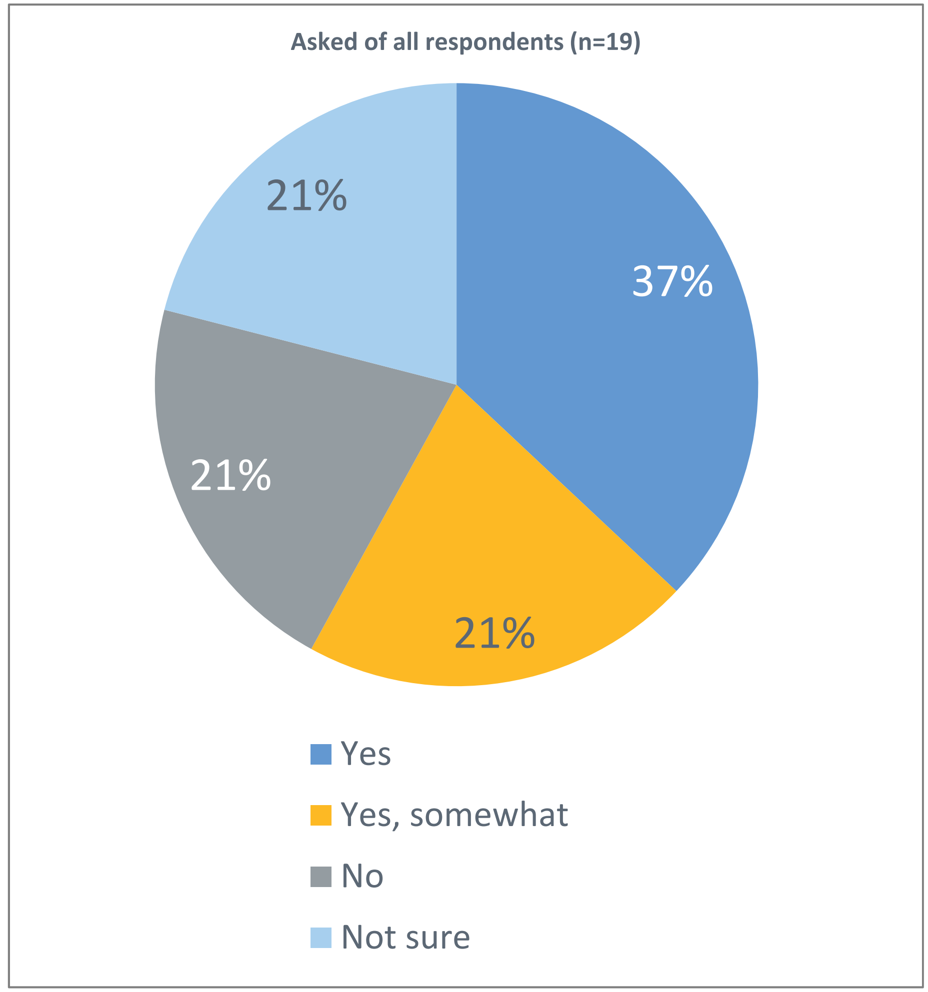
Means less

- *"It means a lot less. It's more about grown in the USA as opposed to grown in California. In some of the border states, Nevada is ok with it, it resonates with them. But the states not bordering they don't care."*
- *It doesn't mean as much. Each state has their own program, such as Colorado Proud, Texas Grown, Northwest Grown, etc. Most of the states are just like California. It's resonating within their state. They're going to buy locally."*
- *"Ambiguous. The landscape is pretty crowded. There are multiple states with their own program. It's from California, so what. CA Grown doesn't differentiate it enough from the others."*
- *"I don't think it means anything because I don't think they have promoted outside the state of California."*
- *"Our retail partners in other states tell us not to put the CA Grown logo on our products we send them. They say it does not carry a lot of weight. We hear from our major food service providers out East that the CA Grown logo and name is not going to be a draw to consumers."*
- *"California agriculture is well thought of by consumers in the U.S., but the CA Grown brand does not always register to consumers because it's limited in scope."*

What do you think the CA Grown brand means to consumers nationally, outside the state of California?

CA Grown Campaign Increasing Awareness of CA Grown Agricultural Products

- Over half (58%) the respondents feel the CA Grown campaign has succeeded in increasing awareness of CA Grown agricultural products.
- Reasons why the respondents feel they way they do is depicted on the next two slides.



Do you think this campaign has succeeded in increasing awareness of CA Grown agricultural products?

CA Grown Campaign Increasing Awareness of CA Grown Agricultural Products *(cont.)*

YES, has Increased Awareness

- *"Yes. I'm familiar with the early data from the program. When consumers were made aware of the program they responded quite favorably to it."*
- *"Yes. But depending on where you're at, it may make more sense to put CA Grown vs. locally grown, and vice versa."*
- *"Yes. If people see it they will recognize it and have a good feeling about the state. Putting it in front of people reminds them they want to look for that product."*
- *"Yes. I think people are much more aware where their food is coming from and California has a positive image and positive association with agriculture. So consumers seeing food grown in California is a positive."*
- *"I believe it did when CA Grown ran TV ads. They did measurement of it, documented increased awareness."*
- *"I would bet it did. Some of the early research showed some recognition. "*
- *"Yes. A lot of people were identifying with the license plate and you still see it on things now."*

YES, TO A DEGREE has Increased Awareness

- *"Somewhat. I don't know if it has created a high level buzz or recognition of think California first. It doesn't drive behaviors of I'm going to buy California first."*
- *"Minimally. It's moved the bar a little bit. The issue of generic vs. branded advertising has been a difficult one."*
- *"I think it's been somewhat limited. The overall goal is good, but I can't measure the effectiveness. I don't see or hear the activity. I don't know how much they're doing, beyond licensing a CA Grown logo."*
- *"Not as well known as it should be. When I'm in the store its there but people don't realize the importance of it. They need to do a better job educating the consumer."*

Do you think this campaign has succeeded in increasing awareness of CA Grown agricultural products?

CA Grown Campaign Increasing Awareness of CA Grown Agricultural Products *(cont.)*

NO, has not Increased Awareness

- *"No. It's a tad too generic."*
- *"It's lacking. I can't point to a single ad I've seen in the past two years."*
- *"No. It's just been resource challenged."*
- *"No. Consumers I talk to in focus groups and custom research and customers I talk to in general don't seem to have a better awareness about CA produce this year from last and from last year to the previous year. The industry understands but consumers don't see it."*

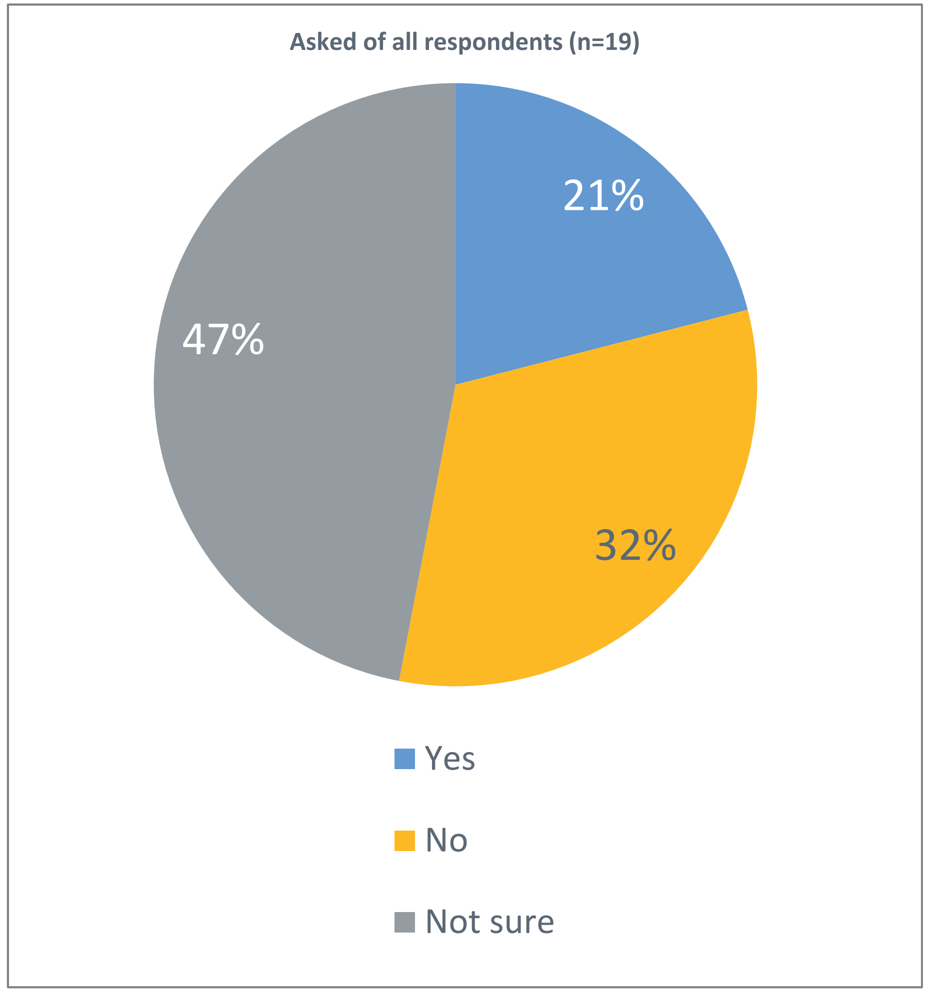
NOT SURE if Increased Awareness

- *"From a consumer standpoint, not certain it has. I think it registered early on when the funding commitment was greater. They made some gains in increasing awareness then but not sure they are doing that now adequately."*
- *"Can't say with certainty of the impact of CA Grown."*
- *"I know it can, but not sure there are metrics to prove it."*
- *"Not sure."*

Do you think this campaign has succeeded in increasing <u>awareness</u> of CA Grown agricultural products?

CA Grown Campaign Increasing Consumption of CA Grown Agricultural Products

- Respondents are less sure if the CA Grown campaign has succeeded in increasing consumption of CA Grown agricultural products than they were about increasing awareness.
- Respondents are more likely to respond that they do not know if consumption increased or reply no, it did not increase.
- Reasons why the respondents feel they way they do is depicted on the next two slides.



Do you think this campaign has succeeded in increasing consumption of CA Grown agricultural products?

CA Grown Campaign Increasing Consumption of CA Grown Agricultural Products *(cont.)*

YES, has Increased Consumption

- *"Yes. I think so because I'm seeing it more and more in more stores."*
- *"Yes, to a degree. [Retailer] tells us that their shoppers gravitate toward CA Grown products."*
- *"Yes. If people are made aware of it and given the opportunity and it's a similar price, they would purchase the CA Grown product."*
- *"I think it would if consumer actually recognizes what is CA Grown versus others."*

Do you think this campaign has succeeded in increasing consumption of CA Grown agricultural products?

CA Grown Campaign Increasing Consumption of CA Grown Agricultural Products *(cont.)*

NO, has not Increased Consumption

- *"Probably not."*
- *"No. It doesn't drive behaviors of 'I'm going to buy California first'."*
- *"No. The only way to connect consumption to an unbranded campaign is through awareness and I can't see how you can connect to consumption with no increase in awareness."*
- *"In a large perspective, I'd say not. Consumption is growing, but products from California are losing market share in U.S."*
- *"No. If you talk to a wide spectrum of members from the first two years, it was more sizzle than steak. Everybody was enthused until the results weren't there."*
- *No. California agriculture is big. We're family farmers. The size and scope we have to move product has to be moved out our state to generate the necessary revenues to offset our costs. There is no way a commodity in this state is going to make sufficient revenue by only selling to California citizens should. That is not a model for success."*

NOT SURE if Increased Consumption

- *"Don't know."*
- *"Not sure. I don't have a lot of awareness of the campaign, but I expect it to be successful."*
- *"Not sure."*
- *"Not sure."*
- *"Can't say with certainty of the impact of CA Grown."*
- *"Not sure."*
- *"Hard to say. We certainly have the program and it's working in concert with marketing efforts of the various other organizations like ours. I think collectively those things have had an impact on consumption. I'm not sure the CA Grown program by itself has made a dent in consumption."*
- *"Yes and no. That is market specific."*
- *"This is harder to measure. I don't have knowledge if a component of the measurement included consumption, but I don't believe it was."*

Do you think this campaign has succeeded in increasing consumption of CA Grown agricultural products?

Agreement with Statements About CA Grown Having a Positive Economic Impact

- Respondents agree with the statements that the CA Grown program provides positive economic impact the state, growers and retailers

The CA Grown program….	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Provides positive economic impact to the state	11%	58%	21%	11%	0%
Enables products to expand their presence to new retailers and other states	11%	53%	5%	26%	5%
Is helping the California economy	5%	58%	21%	11%	5%
Is increasing revenue to growers and retailers	11%	32%	32%	16%	11%

May not equal 100% due to rounding. Asked of all respondents (n=19)

How much do you agree or disagree with the following statements?

Reasons for Consider Using or Increasing the Use of CA Grown Products

- There are four primary reasons respondents cited for possibly using or increasing use of CA Grown products. Those four reasons are:
    1. The program was promoted/had an updated marketing/advertising/branding campaign
    2. If CA Grown can demonstrate the value/benefits/impact of the program
    3. If there was consumer support for it/if it was requested
    4. If the program could be rebuilt
- Also mentioned in some comments was the lack of funds to promote the program.
- Specific sample comments are located on the next slide.

Complete the sentence: I would consider using or increasing the use of CA Grown products if.......

Reasons for Consider Using or Increasing the Use of CA Grown Products *(cont.)*

The program was promoted/had an updated marketing/advertising/ branding campaign

- ‘If there was a stronger financial commitment to promote the program, from both the industry and members.”
- “It was tied to a significant marketing campaign that really delivered on the benefits being CA Grown.”
- “If the branding was updated.”

If CA Grown can demonstrate the value/benefits/impact of the program

- “If it could be demonstrated it improves the bottom line.”
- “If I felt that the program was creating value for the grower base.”
- “If I had a better sense of the metrics and impact of the program.”

If there was consumer support for it/if it was requested

- “I'd use it more often if there was more support to reach the consumer public.”
- “If my retail partners requested it.”
- “If it resonates with the consumer in a broad sense utilizing the marketing campaign.”

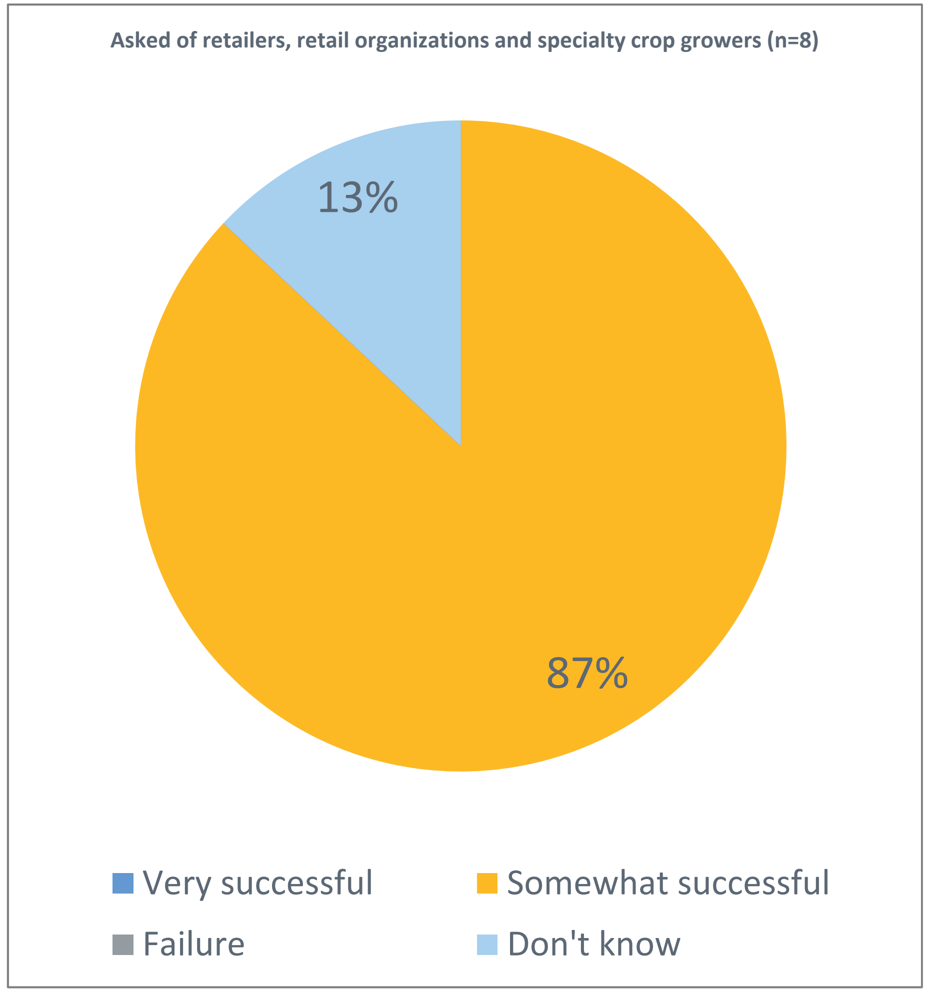
If the program could be rebuilt

- “If we could build it to what it needs to be. Something that the industry gets behind, utilizes, identifies with, and not viewed as another thing they have to do.”
- “I wish we could turn the clock back and build it right.”

Complete the sentence: I would consider using or increasing the use of CA Grown products if.......

Rating the CA Grown Program

- Most of those who responded to this question believe the CA Grown program is somewhat successful.



Overall, how would you rate the program?

What the CA Grown Program Means to Organizations

Comments from respondents include:

- *“An opportunity that can be leveraged. By leveraged I mean by all parties coming together to support it, really expanding the efforts to promote it and really resonate with the public.”*
- *“We're buying products we know come from the state and we're supporting the local economy.”*
- *“Increased opportunity for increasing locally grown demand statewide.”*
- *“It means that you're supporting the one state. CA Grown will try to utilize that for those stores in California as much as possible.”*
- *“Compliments our message we are doing here. Our theme is "hand grown in California." Matches up nicely to that. Getting a little more mileage out of the messaging.”*
- *“It provides us an opportunity to effectively communicate product localization to our consumers.”*
- *“It doesn't help me a whole lot. It goes hand in hand with us. We promote the same things. They are like a co-promoter.”*
- *“On an advocacy front, the CA Grown brand would support our advocacy efforts in terms of contributions to the U.S. economy, employment, assurance of quality from a food safety perspective, understanding it's regulated by U.S. agencies. I don't think it would have a significant impact here. I don't know that there is a role or home for it. I don't think it has great significance inside the organization.”*

What does the CA Grown brand mean to you or your organization?

Qualitative Research Results: CA Grown Member

Specific Questions and Results from the interview with a CA Grown Member

Value as a CA Grown Member

What, if any, value is there to you as a member?

- *"The connection with other agricultural organizations; the opportunity to work with them toward the common goal of promoting California agriculture."*

How could CA Grown add additional value?

- *"I've been told there has been some dialog with the California Tourism Department, for example, to try and get some synergy there and link communications about California and California products together to benefit the California economy. We support that kind of thinking and idea."*

Member Needs

What, if anything, does your organization want or need from CA Grown that you are not already receiving as a member?

- *"It's a difficult one. We certainly would like to see more activities aimed at building awareness and increasing demand of California products. But we also know that without long term funding commitments, that to do at a higher level, the program won't be effective to us and our growers. We want to see some increased activities. I know that goes back to us and other participants and stepping up funding. It's kind of a Catch 22. You're not going to do that unless you think the program is working for you, and if the program is not working for you you're inclined to funnel funding into your own activities. I don't know what the answer is to that and whether there is even an answer. It probably resides in the plans for future activities if they could be funded. The investment by us may be greater if we understood if those activities would indeed benefit our growers. If at some point the dollars aren't there, everyone has to admit it's just not working for us."*

Qualitative Research Results: Specialty Crop Grower

Specific Questions and Results from the interview with a Specialty Crop Grower

What the CA Grown Brand Means to Growers

What do you think the CA Grown brand means to growers in California?

- *It's a source of pride knowing California is the preeminent agricultural place in the world. I don’t know if they feel it gives them a premium price but they have to feel good that their products are being promoted.”*

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May 2013

CA Grown Quantitative Survey Results

Summary of findings

Methodology

- Online surveys with consumers.
  - National survey (n=1,000)
  - California survey (n=1,002)
- Consumers must be 18 years of age or older.
- Consumers must be the primary grocery shopper for the household, or at least have shared responsibility.
- Survey responses from 50 states and the District of Columbia.
- Survey fielded May 5-8, 2013.
- Use of the Research Now online consumer panel.

Summary of Quantitative Research

Key Findings

Executive Summary

There are clear differences in many instances between California consumers and national consumers, not only in awareness of "CA Grown" but in opinions related to locally grown and American grown. Even within the state of California, clear distinction are made between groups that appear to be based largely by proximity to and experience with California's "bread basket."

Preference for Agricultural Products Based on Geography

- Both California and national consumers report that they prefer locally grown products to products grown elsewhere. The preference is stronger among Californians at a 2:1 ratio.
- Additionally, three-fourths of the consumers from the California and national studies report they prefer U.S. grown agricultural products over products grown in and then imported from other countries.

Locally Grown

- California and national consumers couldn't be any further apart on this issue. Eighty-four percent (84%) of Californians and just 24% of national consumers consider products grown in California to be locally grown.

Executive Summary (cont.)

Locally Grown (cont.)

- The primary reason why consumers in the national study feel this way is because of how “locally grown” is defined by most consumers, including those in California. Locally grown implies a certain distance from the consumer, whether it’s a specific distance in miles or within a particular geographic area, such as town, county or even state. Since most of the national consumers completing the survey live outside California it’s easy to see why they feel this way.

Purchasing California Agricultural Products

- Given California’s role in producing so much food in the U.S. it’s not surprising to see why almost everyone – in California and nationwide – have purchased food they knew or suspected was from the state.
  - ➢ This indicates that American consumers know that California plays a key role in supplying food to consumers.

Executive Summary (cont.)

Purchasing California Agricultural Products (cont.)

- Though most consumers know they are purchasing products grown in California, only Californians appear to specifically seek out these products because they are from the state. Over half (59%) of California consumers purchase agricultural products specifically because they are from the state, compared to just 22% of consumers nationally.

Awareness of “CA Grown”

- Noteworthy is that the percentage of California consumers and national consumers who purchase agricultural products specifically because they are from California, matches the awareness level of “CA Grown.”
  - ➢ Perhaps awareness of “CA Grown” drives preference for agricultural products grown in California.
- Over half (59%) of California consumers have seen, read or heard about “CA Grown” before, compared to 24% of consumers nationally.

Executive Summary (cont.)

Awareness of "CA Grown" (cont.)

- A majority (60%) of the California consumers as well as national consumers (54%) referenced some form of advertising or signage to explain what they saw, read or heard about "CA Grown."

Awareness of the "CA Grown" Logo

- Consumers overall are not as familiar with the log than they are of the "CA Grown" campaign. Fifty-two percent (52%) of Californians have seen the logo before, compared to 59% who have seen, read or heard about "CA Grown" before. Among the national consumer study, 15% have seen the logo before compared to 24% who have seen, read or heard about "CA Grown" before.

Perception of "CA Grown" Brand

- Overall, consumers have a positive perception of the brand. Besides general positive comments about "CA Grown," consumer perception of the brand is that it's locally grown/grown in California.

Executive Summary (cont.)

Perception of "CA Grown" Brand (cont.)

- When asked to explain what "CA Grown" means , virtually all consumers connected the brand with an origin association (e.g., products grown in California).

"CA Grown" = American Grown

- National consumers were three times more likely than California consumers to think "CA Grown" means the same as American grown.
- It appears that the further away respondents are from California the more likely they are to think "CA Grown" means the same as American grown.
- This is also the case within the state of California. The further away consumers are from the San Joaquin Valley, the more likely they were to associate "CA Grown" with American grown.
- These findings are opposite of the results asking about locally grown.

Executive Summary (cont.)

Purchasing “CA Grown” Products is Supporting the U.S.

- Virtually every California consumer (99%) and national consumer (97%) agree that purchasing “CA Grown” products is supporting the U.S. economy.
- Fifty-nine percent (59%) of California consumers and half (50%) of national consumers “strongly agree” with the statement.

Select “CA Grown” Products Over Other Products

- Almost two-thirds (63%) of California consumers report they are “very likely” to purchase a “CA Grown” product over another seemingly identical product if they are priced the same.
- Less than one-third (31%) of the national consumers feel the same way as the California consumers.

Executive Summary (cont.)

Pay a Premium for "CA Grown" Products

- Consumers are willing to pay a premium for a product with the "CA Grown" brand name on the package versus the same product where you don't know from where it came. However, consumers are mainly "somewhat willing" and not "very willing" to do so.
- Overall, 51% of national consumers are willing and 42% are unwilling to pay a premium.
- Among California consumers, 69% are willing and 26% are unwilling to pay a premium.
- This is an indication that consumer behavior is still driven largely by price.

Rating "CA Grown" Characteristics

- California and national consumers rated "CA Grown" products very similarly, though California consumers tended to rate the products slightly higher.

Executive Summary (cont.)

Rating “CA Grown” Characteristics (cont.)

- Consumers rate “CA Grown” products highest for freshness and quality and lowest on price.

Does “CA Grown” Matter?

- Eighty-six percent (86%) of California consumers and 54% of national consumers report that “CA Grown” products matter to them.
- In the state of California, “CA Grown” products appear to matter more to women, consumers age 35 or older and to consumers who are close to where the bulk of the agricultural products are grown.
- About nine out of ten (89%) national consumers report it’s important that a similar program like “CA Grown” exists in their state.

Comparing Key Figures from the National and California Studies

	California	National
Does “CA Grown” products matter to you	86%	54%
Willing to pay more for a “CA Grown” brand product	69%	51%
Likelihood of buying “CA Grown” product over identical one if same price	91%	79%
Agree that purchasing “CA Grown” products is supporting U.S. economy	99%	97%
“CA Grown” means the same as American grown	21%	64%
“CA Grown” means the same as locally grown	84%	24%
Seen the “CA Grown” logo before	52%	15%
See, read or heard about “CA Grown” before	59%	24%
Ever purchase agricultural products specifically because they are from California	59%	22%
Ever purchases agricultural products that were grown in California	95%	87%
Preference for U.S. grown agricultural products	77%	75%
Preference for locally grown agricultural products to products grown elsewhere	63%	57%

Quantitative Research Results

Detailed Findings

Preference for Locally Grown Agricultural Products

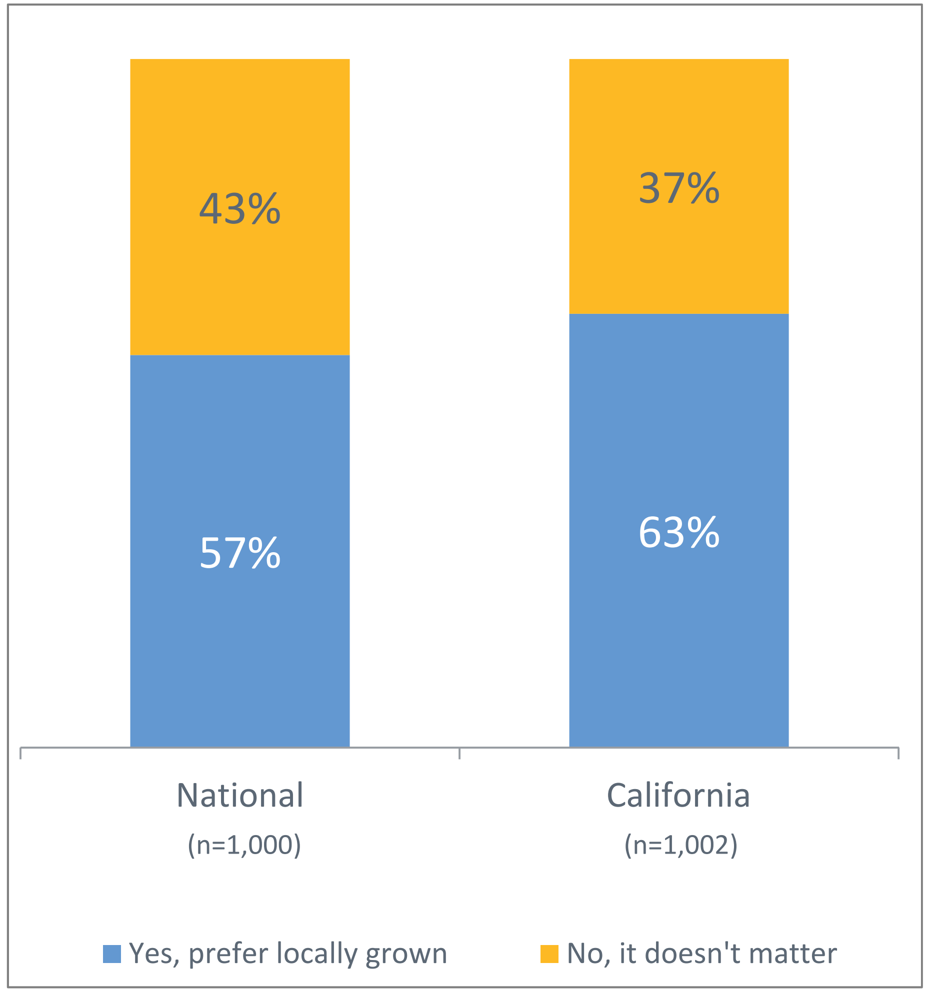
California

- California residents in the central part of the state are most interested in locally grown (68%) while those in the southern part of the state are least interested in locally grown products (60%).
- Women are significantly* more likely than men to prefer locally grown products (68% vs. 55%).

National

- Women are significantly* more likely than men to prefer locally grown products (63% vs. 50%).
- Locally grown is most important to residents of the Northeast (61%) and least important to residents of Texas (48%).

* Difference is statistically significant at 95%



Q.1 Do you prefer “locally grown” agricultural products to products grown elsewhere?

Preference for U.S. Grown Agricultural Products

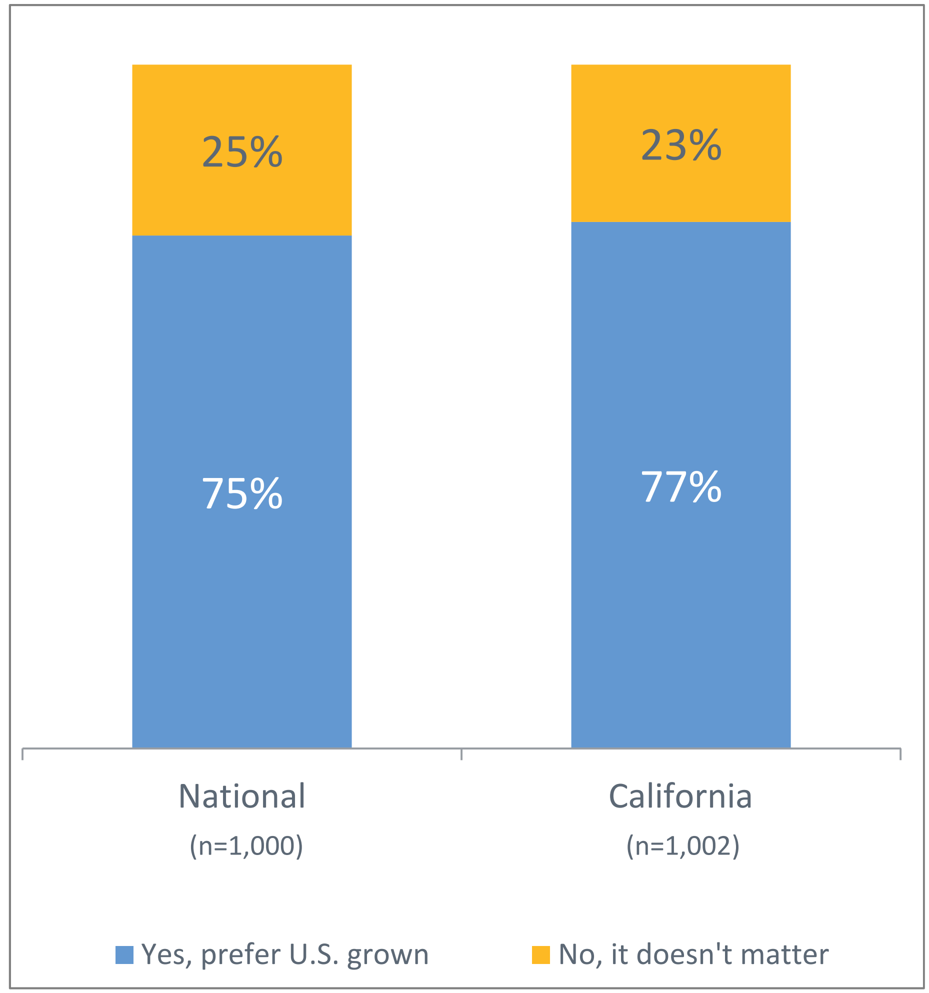
California

- Residents in San Joaquin Valley are the most likely to have a preference for U.S. grown products (86%) while those in San Diego are the least likely to have a preference for U.S. products (72%).

National

- As consumers age they are more likely to prefer that their agricultural products are grown in the U.S.

18-24	25-34	35-44	45-54	55+
67%	70%	72%	76%	82%



Q.2 Do you prefer agricultural products grown in the United States to products grown in and then imported from other countries?

FLEISHMANHILLARD

What Locally Grown Means to Consumers

- Respondents in the California survey and the national survey responded very similarly to this question.
- Virtually everyone has an explanation or definition of what “locally grown” means to them.
- The most common response was that if it was grown nearby.
- One quarter (24%) of respondents were specific in their location/distance, replying that if they were grown within a certain distance (25 miles, 50, miles, 100 miles, etc.) they are “locally grown.”
- Very few consumers used a large geographic area (e.g., U.S., surrounding states) or long distance (e.g., 700 miles) to mean locally grown
- For coded responses see the next slide.

BASE: All respondents

Q.3 What does “locally grown” mean to you?

What "Locally Grown" Means to Consumers

Coded responses to an open-ended question (Multiple responses allowed. Total can exceed 100%)	California	National
Grown within my state	32%	28%
Grown in my local area, near where I live/grown by farmers in my community/region	30%	31%
Grown within a specific distance	24%	21%
Within 25 miles	*1%*	*2%*
Within 50 miles	*7%*	*7%*
Within 100 miles	*12%*	*9%*
Within 200 miles	*3%*	*2%*
Within 700 miles	*1%*	*1%*
Grown in my county/around my county	9%	5%
Grown within the U.S.	6%	8%
Grown in my city/around my city	5%	4%
Close enough to be delivered in a short time frame/delivered same day	5%	4%
Farmer's market produce/from farmer's markets/farm stands	3%	2%
If it's fresh	3%	3%
If it's organic/free of pesticides/chemicals/hormones	2%	2%
Nearby state/surrounding states	2%	7%
Grown locally (general)	1%	2%
Backyard/home grown	1%	1%

Q.3 What does "locally grown" mean to you?

Product Grown in California Equals "Locally Grown"

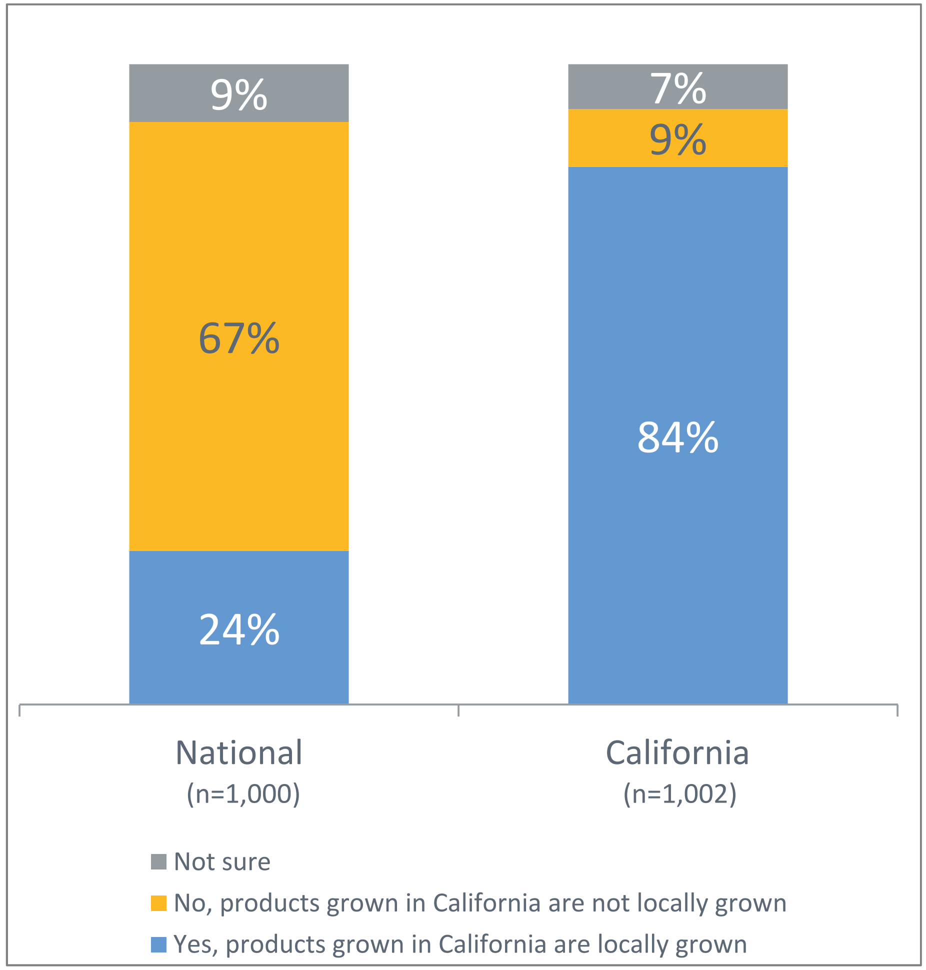
California

- The regions differ on whether California grown products are "locally grown."

Southern	Central	Northern
86%	83%	77%

National

- 78% of the residents from California in the national survey replied yes, followed by 38% from the three adjoining states of Arizona, Nevada and Oregon and 23% from Texas residents.
- 18-24 year olds were the most likely age group to think product grown in California equals locally grown (36%).



Q.4 Do you consider products grown in California to be "locally grown"?

Why “CA Grown” Means the Same as “Locally Grown”

Coded responses to an open-ended question **(Multiple responses allowed. Total can exceed 100%)**	**California** (n=839)	**National** (n=239)
I live in California/not produced/imported from elsewhere	54%	22%
Grown in California/California is local (non-specific)	18%	15%
Grown nearby/near me/close	11%	10%
Shipping time/distance/doesn’t take long to transport/not stored for long periods	10%	5%
Anything in the U.S. is local to me/grown in U.S./not from a foreign country	7%	40%
Not necessarily the same/depends where it is grown in California	6%	2%
Same thing (general)	5%	5%
Fresh products	2%	2%
Isn’t imported	*	1%
Other	2%	4%

* Less than 0.5%

BASE: Respondents who replied that “yes” they consider products grown in California to be “locally grown.”

Q.12A Why do you consider “CA Grown” to mean the same as locally grown?

Why “CA Grown” Does <u>Not</u> Means the Same as “Locally Grown”

Coded responses to an open-ended question **(Multiple responses allowed. Total can exceed 100%)**	**California** (n=92)	**National** (n=674)
California is a large state/northern and southern California are not local to each other	53%	1%
Local means close to me/is my community	49%	20%
Do not live in California/live in a different state	--	33%
I live across the country/live on the East Coast/is thousands of miles away	--	25%
Local mean it needs to be closer than 200 miles	8%	7%
California is not local/not local for me (general)	7%	8%
Shipping time/distance/takes a long time to transport/is stored for long periods	7%	8%
Local means my states	--	5%
Other	2%	1%

BASE: Respondents who replied that “no” they do not consider products grown in California to be “locally grown.”

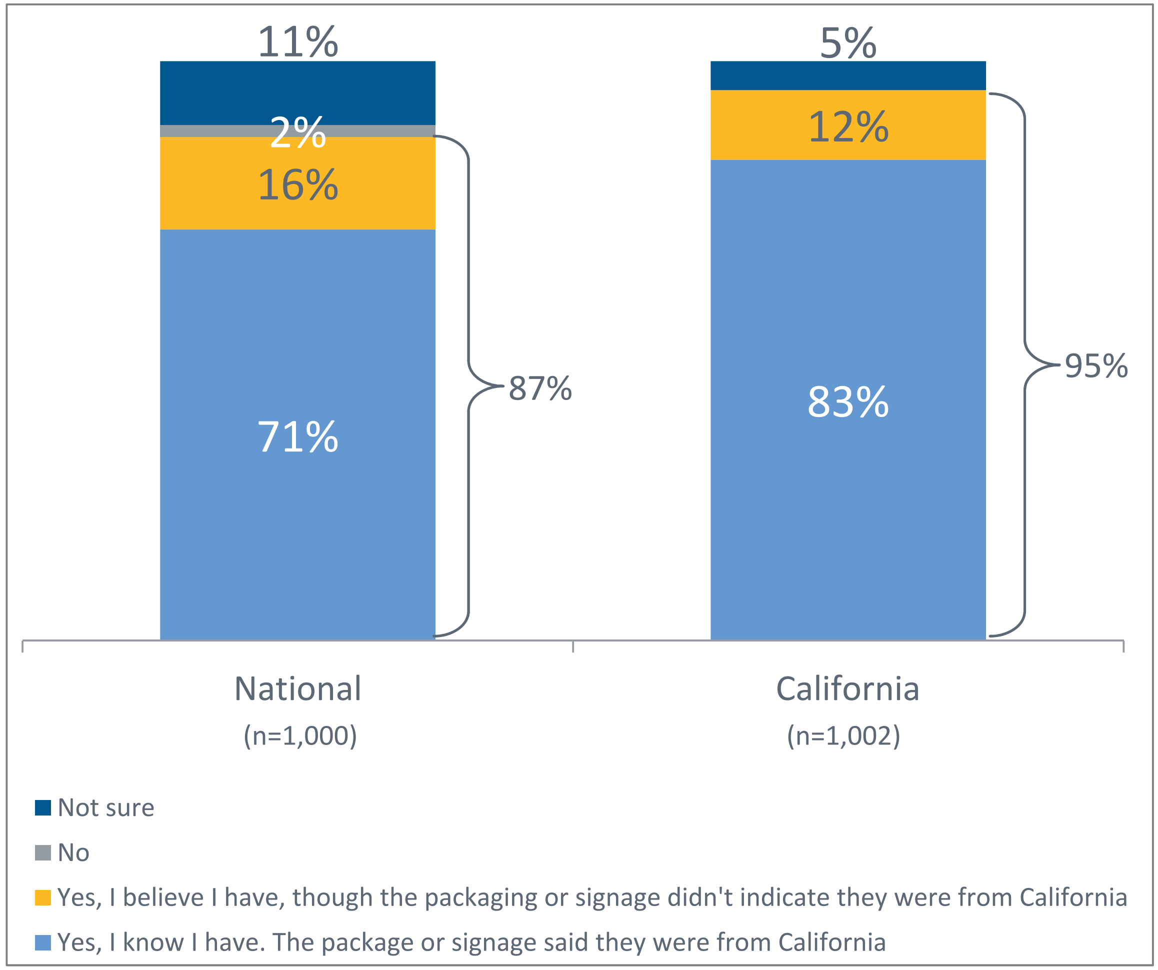
Q.12B Why don’t you consider “CA Grown” to mean the same as locally grown?

FLEISHMANHILLARD

Purchasing Agricultural Products Grown in California

California

- Los Angeles (76%) and Inland California (78%) have the lowest incidence of residents saying they've seen packaging or signage saying products were from California. Residents in the San Joaquin Valley had the highest incidence at 92%.



Q.5 As far as you know, have you ever purchased agricultural products that were grown in California?

Purchasing Agricultural Products Specifically Because They are From California

California

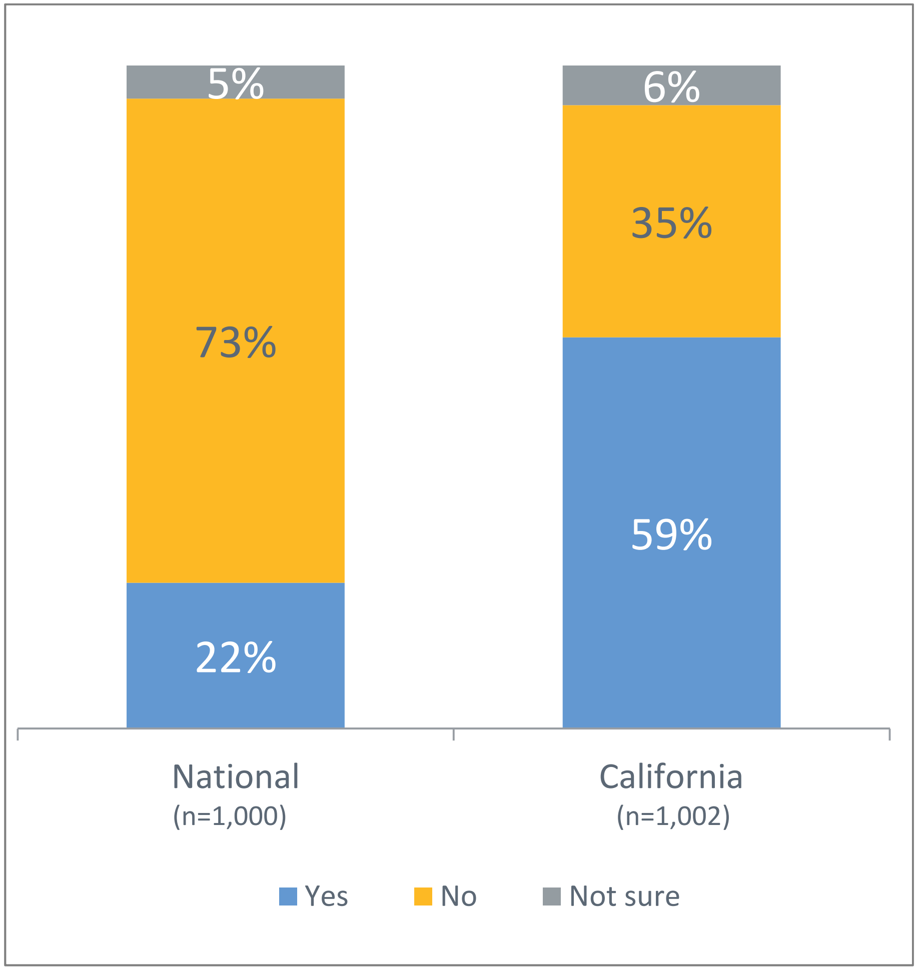
- Women are significantly* more likely than men to seek out agricultural products because they are from California (62% vs. 54%).
- Residents of Southern California are the least likely to seek out products because they are from the state (54%), compared to 63% of residents in Central California and 66% of residents of Northern California.
- The older the consumer in the state, the more likely they are to seek out products specifically because they are from the state.

18-24	25-34	35-44	45-54	55+
34%	57%	58%	62%	62%

National

- 18-24 year olds were the most likely age group to think product grown in California equals locally grown (36%), AND they are the most likely age group to seek out products from California for purchase (30%).

* Difference is statistically significant at 95%



Q.6 Do you ever purchase agricultural products specifically because they are from California?

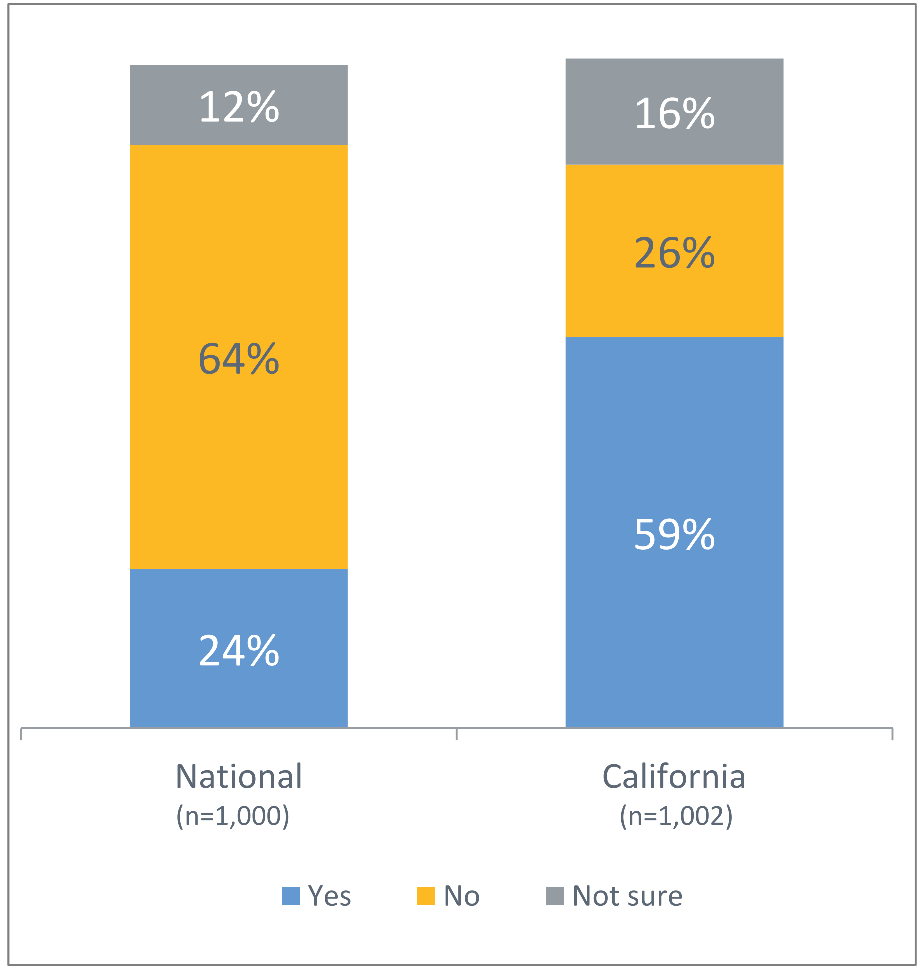
Seen, Read or Heard About “CA Grown” Before

California

- Highest incidence of being aware of “CA Grown” include:
  - Residents of N. California (70%)
  - Residents of San Joaquin Valley (69%)
  - Residents of Sacramento area (68%)
  - 35-44 year olds (64%)
  - Women under age 45 (63%)
- Lowest incidence are among residents of Los Angeles and San Diego (53%).

National

- 50% of the residents from California in the national survey reported they are aware of “CA Grown,” as did 50% from the Pacific states of Hawaii and Alaska (small sample).
- Interestingly, just 29% of residents from the adjoining states of Arizona, Nevada and Oregon are familiar with “CA Grown.”
- Take away California, the Pacific states and adjoining states, just 16% of the rest of the nation has seen, read or heard about “CA Grown” before.



Q.7 Prior to taking this survey, had you seen, read or heard of “CA Grown” of the CA Grown campaign?

What Saw, Read or Heard About CA Grown Before

California

- Sixty percent 60% who have seen, read or heard something about “CA Grown” before mentioned the sources they saw, read or heard about it. The most common source mentioned was TV commercials/ads (27%).
- Overall, nine different sources were mentioned. Besides television, other sources mentioned include on labels/packaging (16%); in-store advertising (12%); billboards (5%); print ads (non-specific)(5%); Farmer’s market (4%); radio (4%); magazine (2%) and Internet (2%).
- One in five (21%) mentioned a specific product/product association as the source for seeing, reading or hearing about “CA Grown” before. The most common product mentioned was avocados (7%).

BASE: Those that have seen, read or heard about “CA Grown” before (n=588)

Q.8 What have you seen, read or heard about “CA Grown?”

What Saw, Read or Heard About CA Grown Before (cont.)

National

- Of the 24% of the national audience who report they have seen, read or heard something about "CA Grown,"54% mentioned the sources they saw, read or heard about it. The most common source mentioned was TV commercials/ads (30%).
- Noteworthy is that fairly high percentages of residents in the South (45%), Northeast (33%), Texas (23%)* and Midwest (21%) say they have seen TV commercials/ads before.
- One in four (23%)* residents of Texas who say they saw, read or heard something about "CA Grown" before report seeing in-store advertising before.
- One in four (23%) mentioned a specific product/product association as the source for seeing, reading or hearing about "CA Grown" before. The most common type of product mentioned was fruit (5%) and vegetables (5%).

* Small sample

BASE: Those who have seen, read or heard about "CA Grown" before (n=235)

Q.8 What have you seen, read or heard about "CA Grown?"

Seen the "CA Grown" Logo Before

California

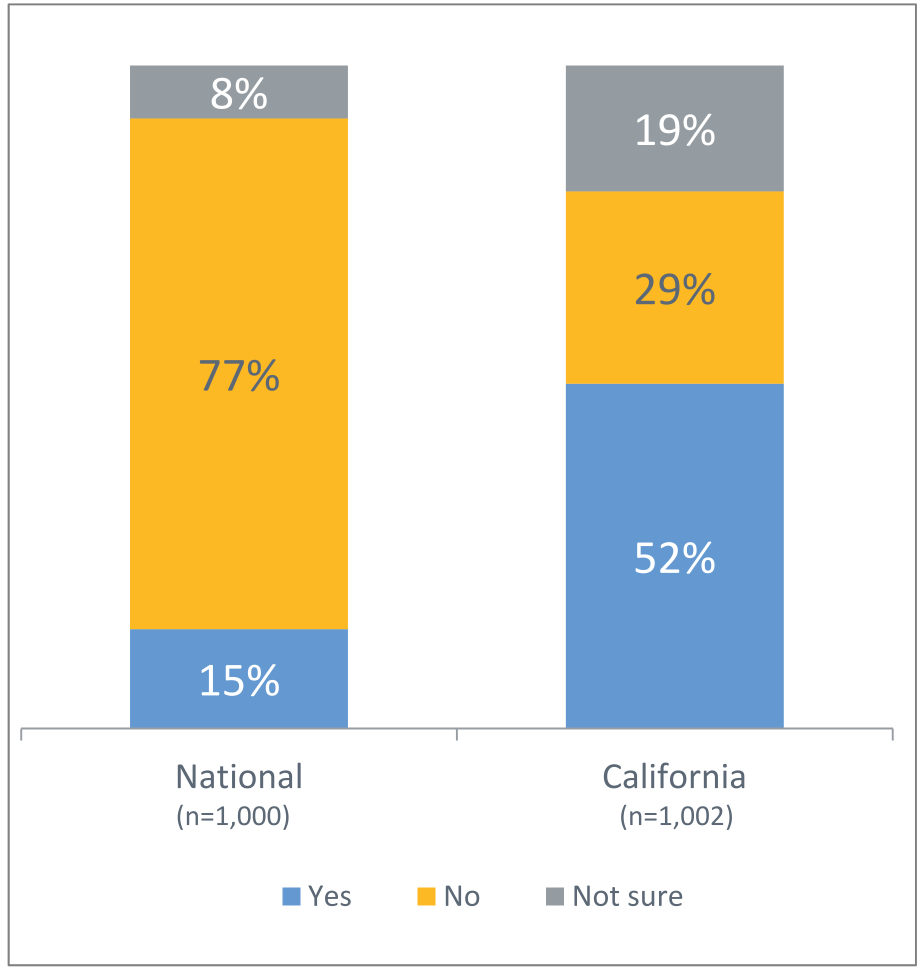
- The younger the consumer the more likely they are to recall seeing the logo.

18-24	25-34	35-44	45-54	55+
64%	62%	63%	50%	41%

- Residents of Northern California (61%) are the most likely to recall seeing the logo, followed by Central California (56%) and then Southern California (46%).

National

- 52% of the residents from California in the national survey reported they have seen the "CA Grown logo," as did 50% from the Pacific states of Hawaii and Alaska (small sample).
- Noteworthy is that just 18% of residents from the adjoining states of Arizona, Nevada and Oregon have seen the "CA Grown" logo.



Q.9 Have you seen this logo before?

FLEISHMANHILLARD

What is Perception of the CA Grown brand

Coded responses to an open-ended question **(Multiple responses allowed. Total can exceed 100%)**	**California** (n=521)	**National** (n=149)
Locally grown/products grown in California/made in the U.S.A	32%	29%
Favorable/good brand/positive (general)	31%	29%
Fresh/fresher products	11%	8%
Quality products	9%	9%
Supports California agriculture/supports local farmers	5%	1%
Less transportation/shipping	5%	2%
Supports the local economy (non-specific)	4%	3%
Healthy products	3%	2%
Safer products	2%	2%
Average/OK/neutral (general)	2%	4%
Organic products	2%	1%
Marketing campaign/advertising)	2%	3%
Helping environment/environmentally friendly	1%	2%

BASE: Respondents who have seen the “CA Grown” logo before

Q.10 What is your perception of the “CA Grown” brand?

What CA Grown Means

Most respondents connect "CA Grown" with an origin association.

California **(n=481)**

- Almost all (94%) respondents stated that "CA Grown" means that the products were grown/harvested in the state.
- An additional 3% said "CA Grown" mean local/locally grown.
- Just 2% mentioned product attributes such as quality/quality products (1%) or fresh/fresher products (1%).

National **(n=851)**

- Almost all (92%) respondents stated that "CA Grown" means that the products were grown/harvested in the state.
- An additional 1% said "CA Grown" mean local/locally grown and 1% said it means they are grown in the U.S.
- Just 2% mentioned product attributes such as quality/quality products (1%) or fresh/fresher products (1%).

BASE: Those who have NOT seen, read or heard about "CA Grown" before

Q.11 What do you think "CA Grown" means?

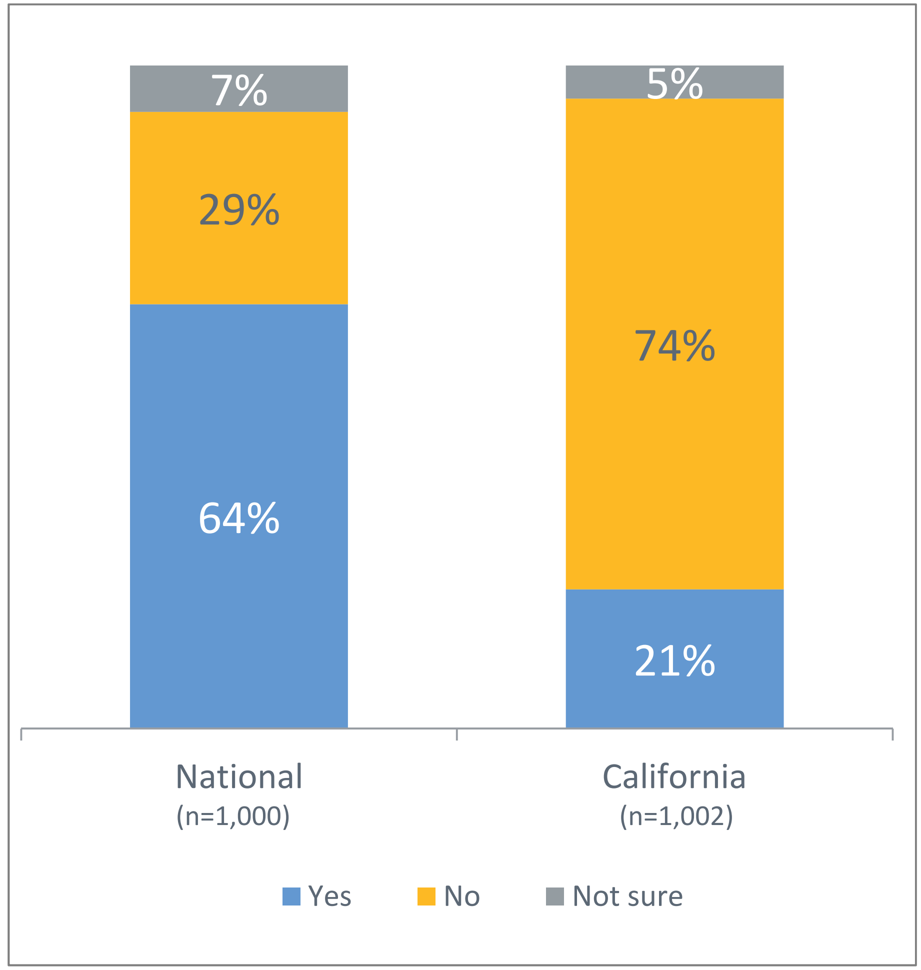
“CA Grown” Meaning the Same as American Grown

California

- Noteworthy is that residents of Southern California are the least likely to be familiar with the “CA Grown” brand and logo and are the most likely to believe “CA Grown” means the same as American grown.
  - San Diego 25%
  - Los Angeles 25%
  - Inland 24%
  - Central Coast 23%
  - Sacramento 18%
  - Bay area 16%
  - San Joaquin Valley 11%

National

- The further away respondents are from California the more likely they are to think “CA Grown” means the same as American grown.



Q.13 In your opinion, does “CA Grown” mean the same as American Grown?

Why CA Grown Means the Same as American Grown

Most respondents consider "CA Grown" to be American grown because California is a state/state in the union.

California **(n=207)**

- Most (88%) respondents stated that "CA Grown" means the same as American grown because the products are grown in the U.S./California is in the U.S.
- An additional 3% said "CA Grown" means the same as American grown because it's not grown locally but grown in the U.S.

National **(n=643)**

- Most (90%) respondents stated that "CA Grown" means the same as American grown because the products are grown in the U.S./California is in the U.S.
- An additional 3% said "CA Grown" means the same as American grown because it's not grown in their state/not locally but grown in the U.S.

BASE: Those who consider "CA Grown" to mean the same as American grown.

Q.14A Why do you consider "CA Grown" to mean the same as American Grown?

Why CA Grown Does Not Mean the Same as American Grown

Coded responses to an open-ended question **(Multiple responses allowed. Total can exceed 100%)**	**California** (n=740)	**National** (n=290)
American grown can mean anywhere in the U.S./grown in any state	52%	48%
CA Grown is specific to California/means grown in California	38%	47%
Shipping time/distance/products may be traveling a long distance	15%	3%
American grown means nationally not locally grown (California is local)	12%	5%
America is a large country/big place/bigger than California	5%	4%
Not as fresh/would need preservatives/CA Grown is fresher	4%	3%
Laws/regulations are different from state to state/not the same across the U.S.	4%	3%
America includes North, South and Central America/not specific to North America	4%	9%
Lower quality/CA Grown means better produce/better taste	4%	4%
Is not the same thing (general)	1%	2%

BASE: Those who do NOT consider "CA Grown" to mean the same as American grown

Q.14B Why don't you consider "CA Grown" to mean the same as American grown?

Agreement That Purchasing CA Grown Products is Supporting the U.S. Economy

"CA Grown" is an initiative with a mission to educate consumers about the importance of choosing American Grown agricultural products from California. The goal is to increase the awareness, consumption and value of California agricultural products, helping the national and state economy in the process.

California

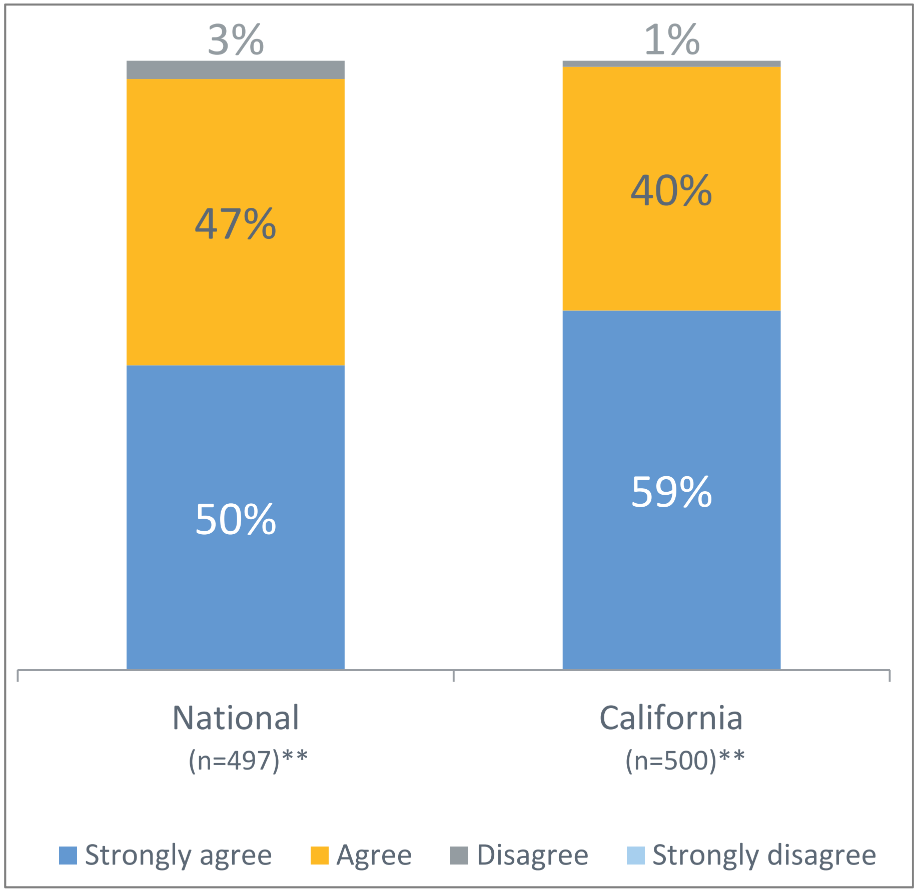
- The most likely California residents who "strongly agree" with this statement include:
  - Residents of San Joaquin Valley (69%)
  - Residents of Central Coast (68%)
  - Los Angeles residents (66%)
  - Men age 45 or older (65%)
  - Consumers age 55 or older (63%)

National

- The older the consumer the more likely they are to "strongly agree" to this statement.

18-24	25-34	35-44	45-54	55+
26%	46%	48%	54%	57%

** See appendix in back of presentation



Q.15 Based on the information provided, how much do you agree or disagree with the following statement? ***"Purchasing CA Grown products is supporting our U.S. economy"***

FLEISHMANHILLARD

Likelihood of Buying CA Grown Products Over Seemingly Identical Product Priced the Same

"CA Grown" is an initiative with a mission to educate consumers about the importance of choosing American Grown agricultural products from California. The goal is to increase the awareness, consumption and value of California agricultural products, helping the national and state economy in the process.

California

- Women are significantly* more likely than men to be "very likely" to buy a "CA Grown" product over a seemingly identical one if priced the same (67% vs. 57%).
- Most likely groups to be "very likely" to buy a "CA Grown" product over a seemingly identical one if priced the same include: Women, age 45+ (72%); consumers age 55+ (71%) and residents of Sacramento (70%).
- The older the consumer the more likely they are to be "very likely" to buy a "CA Grown" product over a seemingly identical one if priced the same.

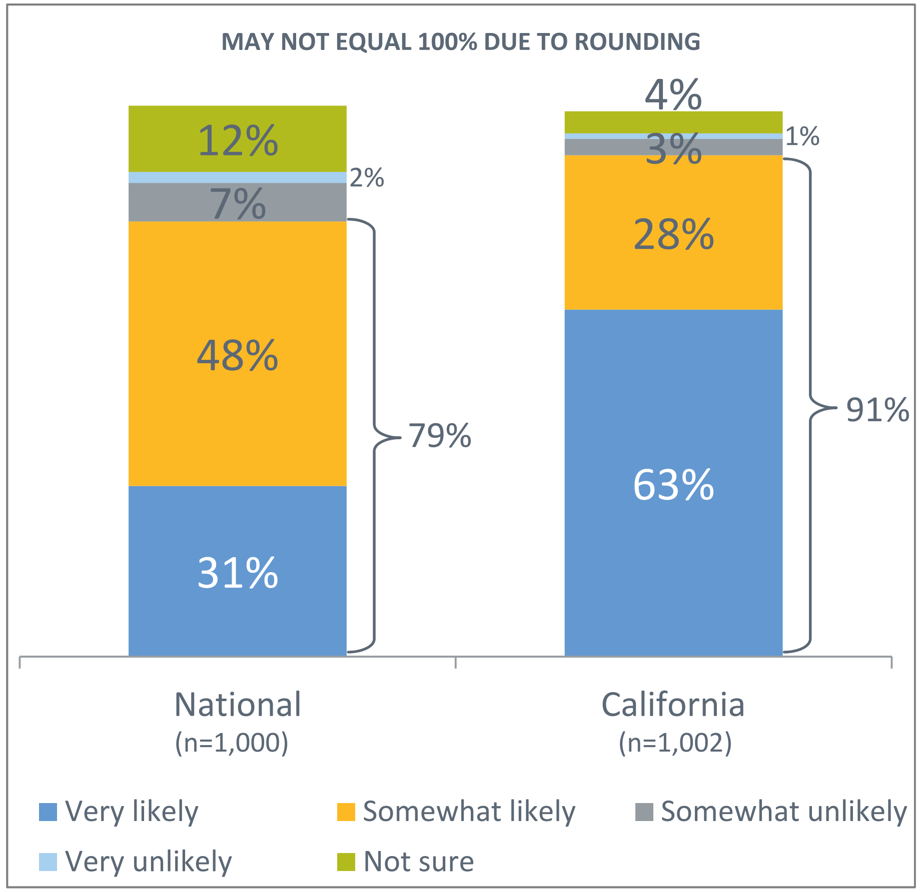
18-24	25-34	35-44	45-54	55+
42%	49%	62%	66%	71%

National

- Gender and age play a role in how likely consumers are to choose a "CA Grown" product over a seemingly identical one if priced the same.

"Very likely"	< 45	45 +
Men	21%	26%
Women	32%	40%

* Difference is statistically significant at 95%



Q.16 Based on the information provided, how likely are you to buy a "CA Grown" product versus a seemingly identical product without the CA Grown brand on it if the prices were the same?

Willingness to Pay More for Product With the CA Grown Brand Name on it

California

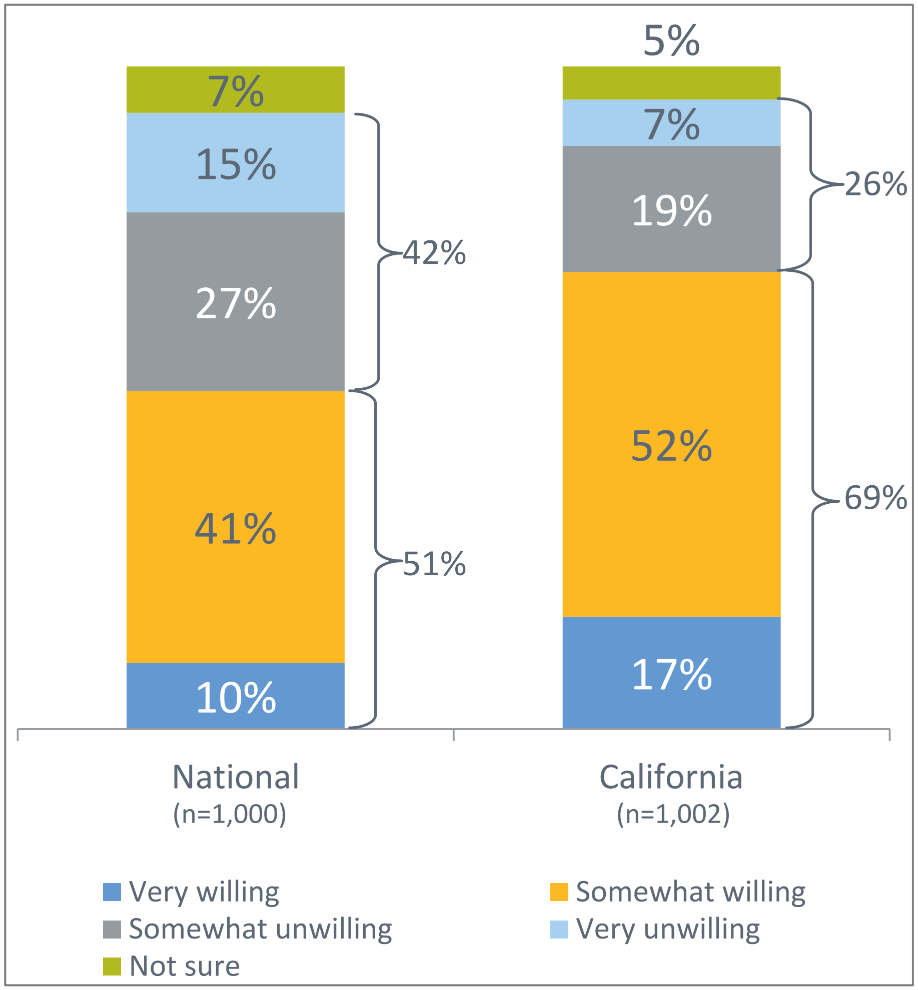
- Groups most likely to be willing o pay more for a product with the “CA Grown” brand name on it include:
  - Residents of Sacramento (79%)
  - Residents of N. California (78%)
  - Residents of San Joaquin Valley (76%)
  - Women, age 54 or older (75%)
  - Consumers age 35 or older (72%)
  - Women (72%)

National

- Women are significantly* more likely than men to be willing to pay more for a product with the “CA Grown” brand name on it (55% vs. 46%).
- The older the consumer, the more willing they are to pay more.

18-24	25-34	35-44	45-54	55+
39%	45%	46%	51%	63%

* Difference is statistically significant at 95%



Q.17 How willing would you be to pay more for a product with the “CA Grown” brand name on the package versus the same product where you don’t know from where it came?

FLEISHMANHILLARD

Rating CA Grown on Characteristics Exhibited: Cross Tabulation Data

California

- Women are more likely than men to rate “CA Grown” higher on each of the characteristics .
- Older consumers consistently rate “CA Grown” higher on the characteristics than younger consumers. The key break is between those age 35 or older and those under age 35.

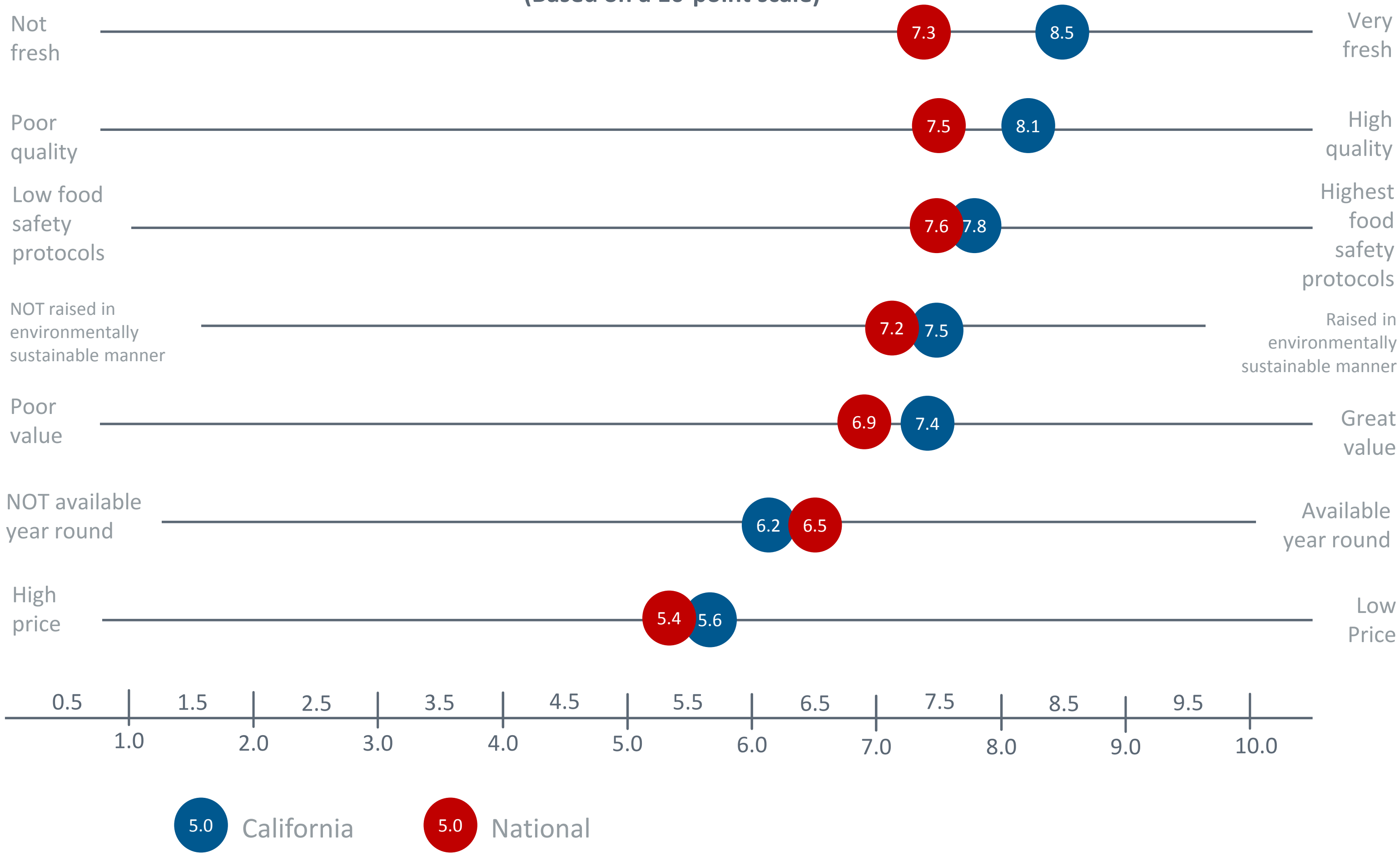
National

- Women are more likely than men to rate “CA Grown” higher on each of the characteristics .
- Residents in the state of California tend to rate “CA Grown” higher on the characteristics than residents of other areas of the U.S.

Q.18 How do you think “CA Grown” products would rate on several characteristics?

Rating CA Grown on Characteristics Exhibited

Mean ratings for each characteristic
(Based on a 10-point scale)



Q.18 How do you think "CA Grown" products would rate on several characteristics?

Does "CA Grown" Matter

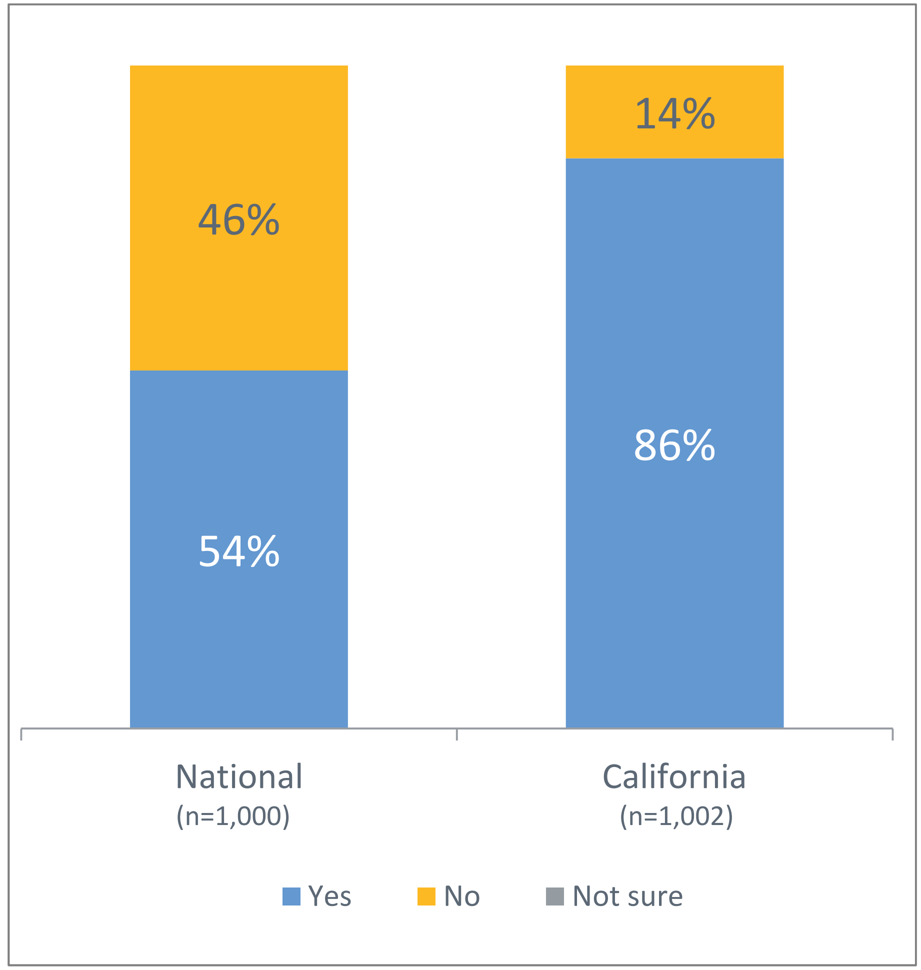
California

- "CA Grown" matters most to residents in the San Joaquin Valley (95%) and least to residents of San Diego (78%).
- "CA Grown" matters a lot more to consumers age 35 or older than consumer under age 35 (89% vs. 76%).

National

- 83% of California residents in the national survey replied "CA Grown" does matter to them.
- Women are significantly* more likely than men to report "CA Grown" matters to them (60% vs. 47%).

* Difference is statistically significant at 95%



Q.19 Do "CA Grown" products matter to you?

FLEISHMANHILLARD

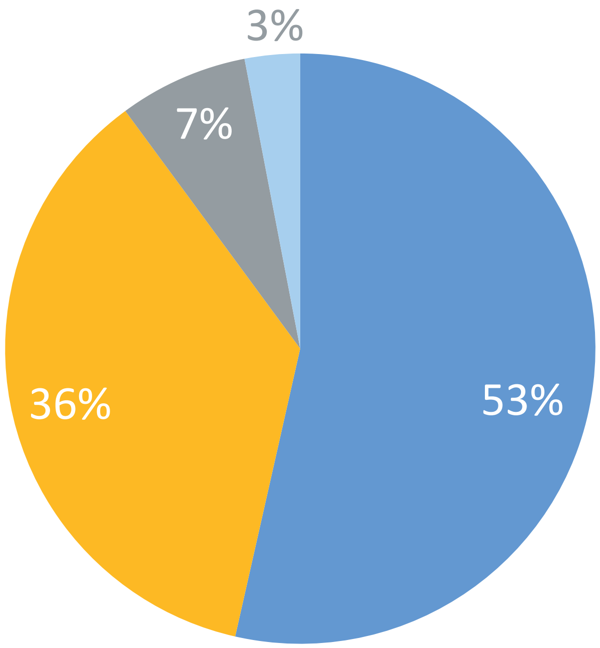
Similar Programs to CA Grown in Other States

National

- Women are significantly* more likely than men to report think a program like "CA Grown" in their state would be important (94% vs. 84%).
- There is universal agreement among the various regions that think this is important, as they range from a low of 88% to a high of 92%.

* Difference is statistically significant at 95%

MAY NOT EQUAL 100% DUE TO ROUNDING



BASE: National survey audience except those in California (n=885)

Very important
Somewhat important
Not important
Not sure

Q.20 If there was a similar program like "CA Grown" in your state, how important would that be?

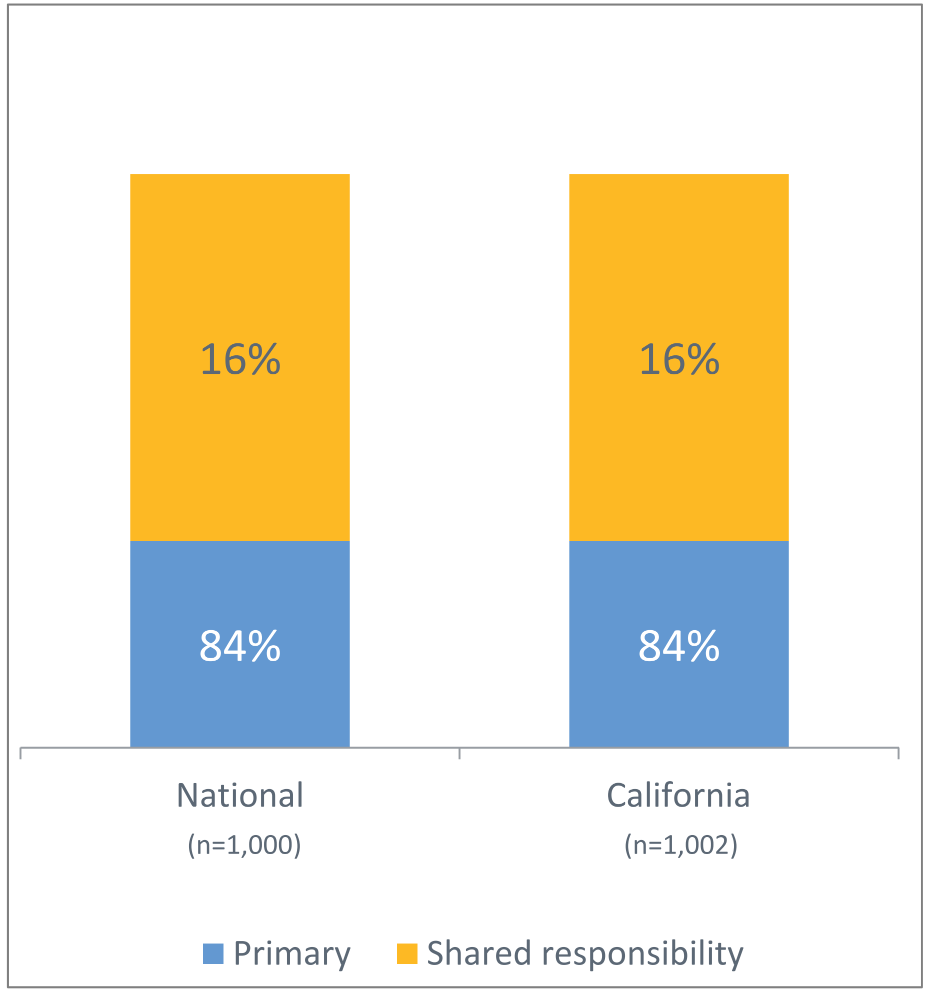
FLEISHMANHILLARD

Participant Profiles

Grocery Shopper

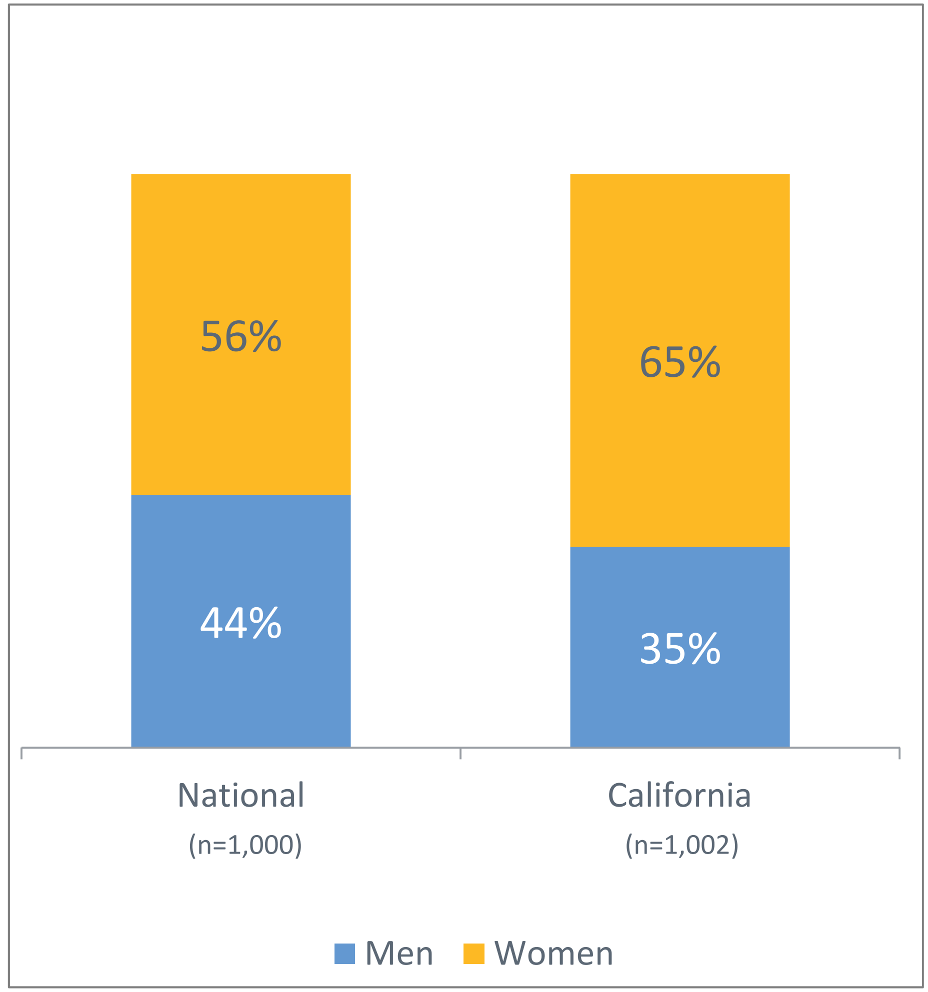
California

- One-fourth (23%) of men share grocery responsibility.



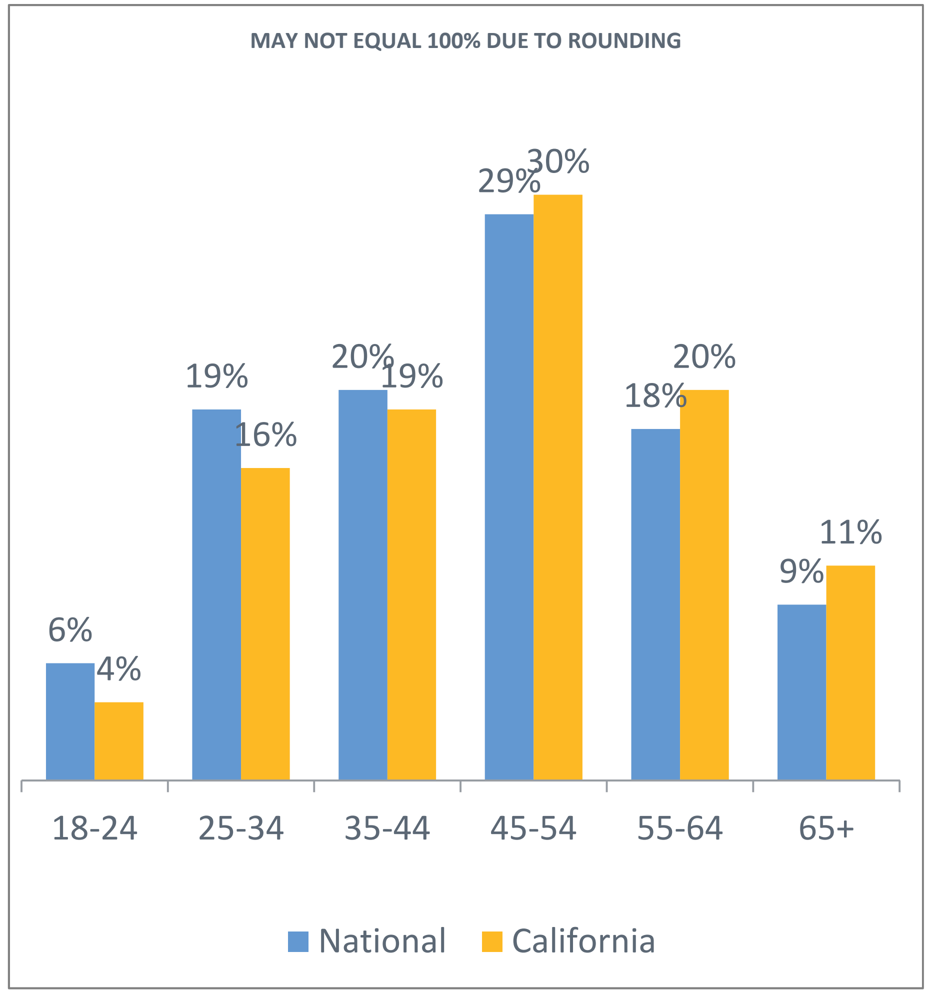
Gender

- The national sample tends to be more evenly split between men and women.



Age

- The California sample is slightly older than the national sample



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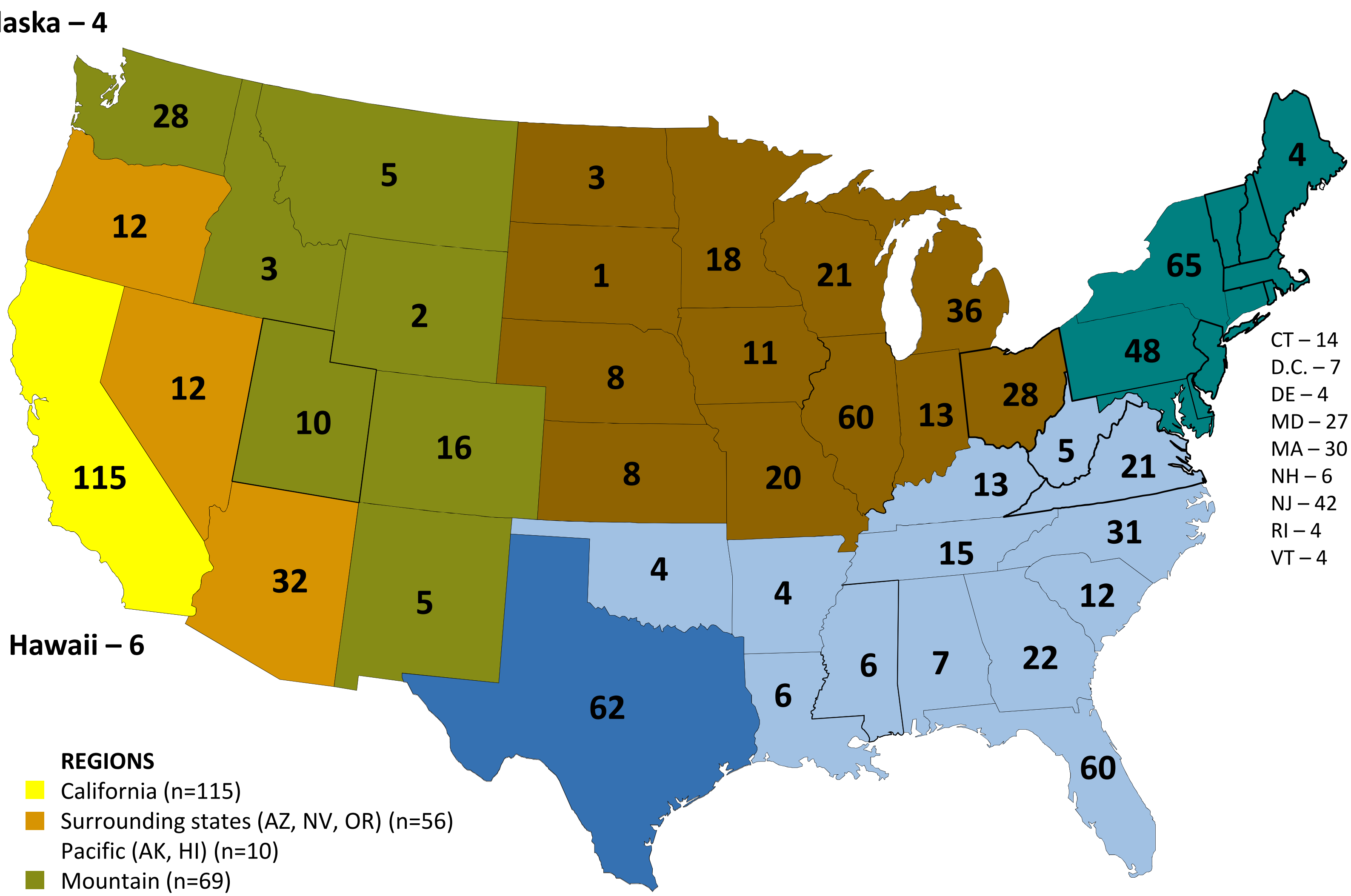
Geography: Number of completed surveys from each state

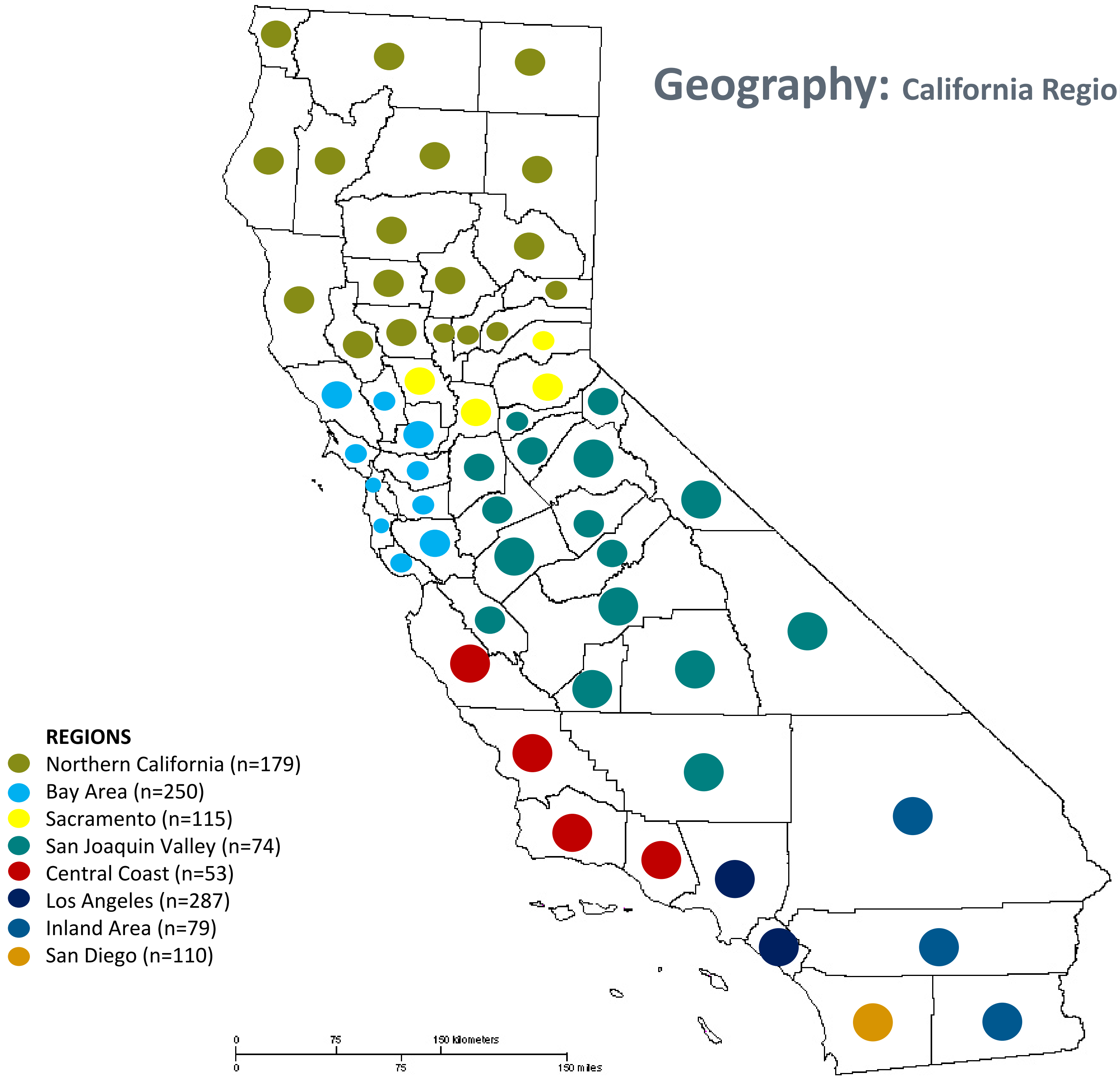


REGIONS

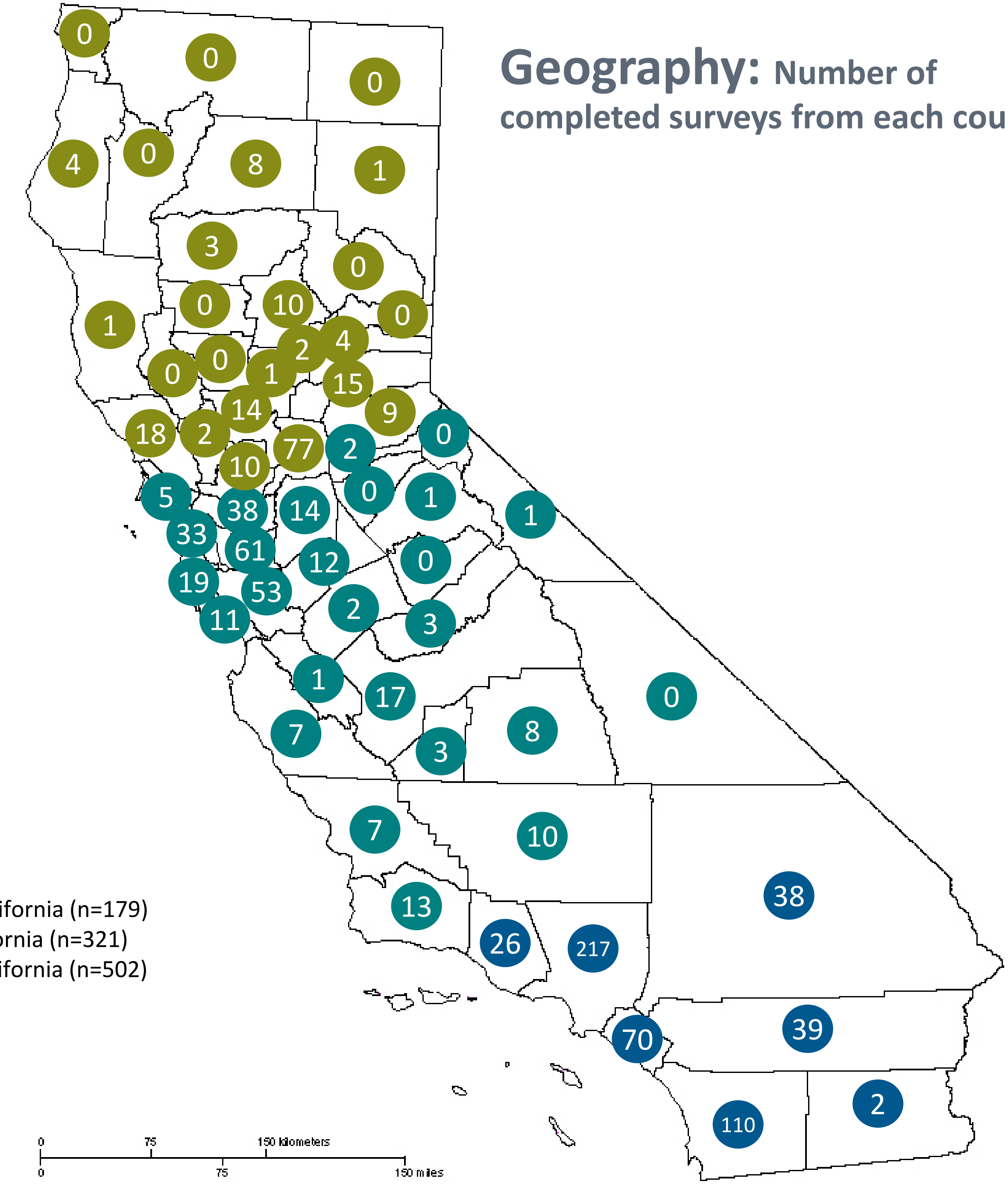
- California (n=115)
- Surrounding states (AZ, NV, OR) (n=56)
- Pacific (AK, HI) (n=10)
- Mountain (n=69)
- Midwest (n=227)
- Texas (n=62)
- South (n=206)
- Northeast (n=255)

FLEISHMANHILLARD

Geography: California Regions



Geography: Number of completed surveys from each county



REGIONS
- Northern California (n=179)
- Central California (n=321)
- Southern California (n=502)

Appendix

Variations in CA Grown Description Resulting in Different Results

- Prior to question 15, as illustrated on slide 32 and 33, a description of "CA Grown" was provided to the survey participants. Half of the participants were given one definition and the other half were given a slightly different description.
- Participants read the description and then referenced it in answering questions 15 and 16.
- The only difference between the two is that the first description did not have the words "American Grown" while the second description did. The description is as follows:

Description 1

"CA Grown" is an initiative with a mission to educate consumers about the importance of choosing agricultural products from California. The goal is to increase the awareness, consumption and value of California agricultural products, helping the national and state economy in the process.

Description 2

"CA Grown" is an initiative with a mission to educate consumers about the importance of choosing <u>American Grown</u> agricultural products from California. The goal is to increase the awareness, consumption and value of California agricultural products, helping the national and state economy in the process.

Variations in CA Grown Description Resulting in Different Results (cont.)

- Recipients who were given the second description with "American Grown" in it, were more likely to agree to the statement in question 15 but were less likely to report they would buy a "CA Grown" product in question 16.
- The results for questions 15 and 16 based on the two descriptions is below.

	Q.15 (Percent "strongly agree")		Q.16 (Percent "very likely")	
	Description 1	Description 2	Description 1	Description 2
California	55%	59%	64%	62%
National	46%	50%	32%	30%

- The differences in the results are not statistically significant.

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TO: Kasey Cronquist, Nick Matteis

FROM: FleishmanHillard

DATE: June 14, 2013

RE: Results from Two Focus Groups Conducted with California Consumers

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BACKGROUND

As part of the ongoing research into attitudes toward and perceptions of CA Grown, FleishmanHillard conducted focus groups with rural and urban consumers in California.

The focus groups were the fourth and final phase of qualitative and quantitative research that comprised the research plan submitted to the Buy California Marketing Agreement in February 2013.

FOCUS GROUP DETAILS

FleishmanHillard conducted two Web-based focus groups with a total of 16 consumers, eight urban consumers in the first group on Wednesday, June 5 and eight rural consumers on Thursday, June 6 (see table below).

Date: *Audience:*	**June 5, 2013** **Urban**	**June 6, 2013** **Rural**	**TOTAL**
Men	2	2	**4**
Women	6	6	**12**
TOTAL	**8**	**8**	**16**

A detailed profile of the participants is located in the appendix.

KEY FINDINGS AND RECOMMENDATIONS

- **Consumers have great respect for and want to support local farmers specifically, as well as agriculture in the state in general. They know that California produces a significant portion of the nation's food and is a major component of the state's economy. However, consumers don't understand how the brand helps local farmers. In fact, there is a misperception by some that CA Grown is only for the large, corporate producers.**
  - CA Grown needs to communicate to consumers how they are helping all famers and producers in the state and how that help translates into benefits for the local famer as well as agriculture in general in California.

- **Consumers have great faith in the food that is grown in the state, knowing it is of the highest quality and safety. They believe that consumers living outside the state have a positive perception of California-grown produce and that they seek it out. California consumers are proud of this.**
  - CA Grown should incorporate into their messaging the quality of locally produced products and the pride that all Californians should feel in supporting their local farmer and producer.

- **Any message about creating jobs and supporting the local and state economy resonated well with consumers. These words/phrases were consistently selected by consumers in the mission statement as being relevant or impactful to them. Overall,** this **is an important issue for Californians.**
  - CA Grown should also consider jobs and the economy as the central theme of their communication efforts.

- **Consumers are somewhat skeptical of the CA Grown brand because they are not that familiar with CA Grown, and they do not know what the benefits are to them as consumers. For some, CA Grown seems like marketing or PR.**
  - CA Grown should communicate to consumers what its purpose is as an organization, how the CA Grown campaign benefits farmers, producers and consumers, and that by getting the word out about the organization, they are actually helping those farmers and producers.

- **Consumers believe that there is a very distinct difference between locally produced food products and non-food products. They are open to paying a premium for locally produced food but not non-food products, such as flowers.**
  - If consumers are going to be open to paying a premium for non-edible products, such as flowers, they will need to be told why they should pay more; what the benefits are. CA Grown needs to communicate tangible differences between California-grown flowers and non-local flowers.

- **CA Grown products are not highly visible, particularly in grocery stores. Although most consumers stated they have seen some form of advertising or the logo, they also volunteered the products are hard to find. Consumers perceive CA Grown products to not be readily available. This appears to validate lack of visibility.**
    - One recommendation from a participant, which several others quickly stated they liked, is to have CA Grown sections in the grocery stores, similar to gluten-free or organic food sections. This could help raise visibility of CA Grown products.

- **There are some clear differences in thinking between the rural and urban consumers, particularly on motivations and barriers to purchasing more CA Grown products and why consumers in general should purchase CA Grown products.**
    - CA Grown needs to tailor their message to each audience for maximum effect.

DETAILED FINDINGS

Food Origin

Consumers say food origin is important to them, though it isn't important enough to affect the purchase decision for most. It is really only important when all of their other criteria have been met (price, quality, etc.), and it comes down to selecting the product grown locally or domestically over a seemingly identical product grown elsewhere. Freshness and quality are of greatest importance to most consumers.

Consumers say food origin is important primarily for safety reasons. The consumers believe that food produced in the state of California and in the United States has to meet more rigorous standards than food produced elsewhere and then imported. Members in each group brought up incidences of contaminated food imported into the U.S. as "evidence" that food grown outside the U.S. is not as safe as California-grown or domestically grown produce. Interestingly, one participant stated that if you properly wash your fresh produce and vegetables, it doesn't matter where they come from.

However, consumers expect to be able to purchase virtually any type of fruit or vegetable year round. Because of this expectation, consumers realize that if they want certain types of produce during the time of year they are out of season in California, they must purchase food that was grown outside the state and country (e.g., realistic accommodation). Overall, this realization does not weigh heavily on consumers' minds.

Locally Grown

Virtually all of the consumers in each group reported that they prefer locally grown food, though a few were indifferent because of very specific food needs.

> *"I feel strongly about supporting locally grown."* (Urban group)

> *"I would definitely buy local if we have a choice."* (Urban group)

When asked what constitutes "locally grown," many of the California participants replied that anything grown in the state of California is local. This is similar to the findings from the quantitative survey when almost one-third of Californians responded that locally grown means anything grown within their state.

Consumers in both groups do see a difference in what constitutes locally grown and domestically grown. Domestic is anywhere in the U.S., including California, but locally grown is specific to a smaller geographic region, which for many of these consumers is the state of California.

Consumers definitely understand, or at least perceive, there are real advantages to purchasing locally grown products. Among some of the benefits consumers mentioned are:

- Supports the local economy.
- Provides consumers with fresher/higher-quality products.
    - If grown farther away, produce may be picked ripe but by the time it arrives to consumers, it could be past its prime. Locally, it will be picked ripe and delivered ripe to consumers.
    - The quality of food produced elsewhere is questionable; assume locally grown is higher quality.
- Sustainability/smaller environmental impact/carbon footprint; less pollution from transporting products.

Consumers admit that it is difficult to know if the produce they purchase is grown locally, domestically or imported. Sometimes it is labeled but not always.

While consumers are concerned about the growing, handling and packaging standards in other countries, several participants pointed out that there have been e-coli issues with California-grown products. Although there is concern about these incidents, consumers appear to still trust locally grown food products more than products grown elsewhere, especially outside the United States.

Concerning flowers, consumers realize that some flowers cannot be grown locally, or even in the state, and so they have to be shipped in. However, consumers do not seem to care if the flowers they purchase are locally grown or not. The participants are not as concerned about flowers as they are about their food products being locally grown. The primary reason appears to be that the food products are edible; they are needed for sustenance, while flowers are not. They are something nice to have but are not needed for survival.

Premium Price

Consumers in both groups were about evenly split on whether they would pay more for locally grown products. Consumers who would pay more for a locally grown product over a seemingly similar product with a lower price, would do so because of the benefits they perceive to come with purchasing locally grown food (see Locally Grown section).

Some participants think that California products are better than other domestically grown food products. They point to the importance and history of agriculture in the state and the reputation of California products in general. One consumer noted that California legislation is tougher than other states regarding regulations and the use and sale of genetically modified products. This enhances the state's reputation of producing quality fresh food products. They are proud of their state and the role it has in providing food to the rest of the country and the world.

When asked if they would be willing to pay more for locally grown flowers, virtually none of the consumers volunteered that they would be willing to pay more. As one participant put it:

> *"Food benefits you. Flowers are an aesthetic. After a few days, you throw them out. What you put in your body is more important."* (Rural group)

Others would not pay more for local or California-grown products because it doesn't matter to them where it is grown.

CA Grown

In the urban group (June 5), five of the eight consumers indicated they have seen or heard of CA Grown or the CA Grown campaign. In the rural group (June 6), six of the eight consumers indicated they have seen or heard about the brand or campaign. Those who have seen or heard of the brand or campaign recalled seeing it in TV commercials about cheese, dairy and avocados, seeing stickers on products in-store and on billboards.

Most of the participants in the rural group did not know CA Grown was a brand or logo; they thought it was just a sticker signifying that the product was grown in the state. They believed this because of the name "CA Grown." They were surprised to find out it is a brand.

Hardly any of the consumers stated that they actively seek out CA Grown products. One participant in the urban group noted she does for salads, stating:

> *"I have bought into it hook, line and sinker."* (Urban group)

Another participant in the rural group also seeks out CA Grown products because when she lived outside the state, she craved California-grown produce. Now that she's back in the state, she seeks out products with the CA Grown label on it.

Consumers' perception of CA Grown also signifies the benefits the brand can provide:

- Better taste
- Reliability
- Consistency
- Freshness
- Highest quality
- Helping the local/California economy
- Reducing the carbon footprint
- Ensuring growers meet/follow certain standards

No one associated anything negative with the CA Grown brand. Most have positive perceptions. A few have neutral opinions because they are not as familiar with CA Grown, or they are more interested in organic products and do not care too much about CA Grown. Being CA Grown is a plus but not a requirement.

There was a perception among a few consumers that membership to CA Grown is only open to large producers and that it would actually hurt the small, local farmer. This notion was corrected by the moderator.

Overall, consumers were conflicted on whether they would pay a premium for food products that carry the CA Grown brand. Some of the consumers noted that if the perception of CA Grown products is true, they would pay more for CA Grown products. One participant stated:

> *"If the price wasn't that much bigger, I would probably go for the one with the (CA Grown) label because that tells me this grower has gone through the effort of making sure their standards are good enough to carry this sticker."* (Urban group)

However, another participant felt differently:

> *"I would almost avoid it. I wouldn't care one way or another, but sometimes looking at something from large brands deters me from buying it. When I think of small local farms, that's what I'm trying to support, so consciously I think I'm supporting them by buying the one without the brand."* (Urban group)

Overall, most consumers consider CA Grown to be locally grown. They believe that anything grown in the state is locally grown. The concept "locally grown" is very important to the consumers because it keeps money in the state and supports the economy. This was a major point that the consumers made repeatedly in the discussions.

The consumers equate CA Grown more with locally grown than American grown because it says California grown on the products and they feel locally grown is anything grown within the state.

Consumers are near unanimous that CA Grown is important to the state because it creates jobs, supports local farmers and keeps the money in the state. Though some consumers are less sure if CA Grown is as important to consumers as it is to the state.

Many consumers say they would be drawn to a CA Grown branded product over a non-CA Grown product because at least they know the product is from California, and they want to support the local farmer and the state economy. They can't be assured where the other product was grown or under what conditions. To them, CA Grown signifies trust.

> *"For me, it would be like a stamp on it. Just the fact it says it and the other product doesn't. I think it would make a difference to me. It's like knowing something is organic and one product having an organic stamp. It solidifies it a bit more."* (Rural group)

One participant said she would not select the CA Grown product; she would make her selection based on the price because:

> *"The CA Grown brand does not mean anything to me at this time. I don't know the difference between the brand and just California grown."* (Rural group)

A few consumers pointed out that CA Grown is "just a label." They questioned the purpose of it since the label is not inclusive of all California produce or farmers.

> *"I'm of the opinion it's only a label. It only carries the weight of what's behind it. What's the purpose? You can have something that is California grown and not labeled but it's still California grown. I'm a skeptic. Big deal, so what! Is it really going to make me buy the product? Maybe, maybe not."* (Urban group)

CA Grown Fan Club
When presented with the concept of a CA Grown fan club, most said they would not join, even if it was free. They need to know what the benefits of joining are. Several equated this with "junk mail." Several, however, said they would join if it was similar to joining on Facebook and "liking" the brand.

Again, several consumers think the brand CA Grown is for larger producers and supports only a few growers who can afford to participate. Since the consumers are more concerned about smaller growers, they are a little suspicious of the brand and the purpose of the fan club.

While some said they would pay more for products grown in California because they are at least getting a quality product for their money, they see the fan club just as a donation and they don't understand what the benefits of participating would be.

> *"I would need incentives, something significant, to be friends with anybody. Truth of the matter, with any big business I don't think we're given something better because a company is participating in an organization. I don't think buying something just because it has a stamp on it necessarily is offering something better."* (Rural group)

Logo
Between the rural and urban groups, more rural consumers reported seeing the CA Grown logo than urban consumers. Among the urban consumers, three of the eight participants reported

seeing the logo before. Among the rural consumers, six of the eight participants reported seeing the logo before, many on packaging in grocery stores.

Interestingly, when asked if they could describe the CA Grown logo, just one person from the rural focus group could accurately describe it. Most of the participants in the rural group inaccurately described the shape and colors of the logo, though once they were shown the logo, most remembered seeing it before. This indicates poor recall of the logo among the rural participants (question was not asked of the urban participants).

CA Grown Statement
The focus group participants were asked to read a brief statement about CA Grown and select words or phrases they felt are relevant or impactful to them as consumers. Among the words and phrases the consumers in each group selected as relevant and/or impactful include:

Urban Group	Rural Group
• "helping the U.S. and California economy" (2 people) • "choosing American-grown products from California" – *"Taking a stand against outsourcing which is very important."* • "increase awareness, consumption and value of American agricultural products from California"	• "helping the U.S. (and California) economy" • "helping the U.S. and California economy" • "helping the (U.S. and) California economy" (3 people) • "choosing American-grown products from California"

After reading the statement about CA Grown, the consumers were asked if they would be more inclined to seek out CA Grown products. Several stated that they would be more inclined:

> *"I would buy something with CA on it because I know I'd be helping the local economy, and it'd be fresher."* (Urban group)
>
> *"I might look for a new product based on this. See more (of) my options."* (Rural group)

Motivation and Barriers
The consumers in both groups were asked, one-by-one, to respond to a series of statements and questions related to reasons why they would purchase CA Grown or more CA Grown products. The first statement involved the consumers finishing the following sentence: "**I would buy more CA Grown products if….**"

Consumers from each group tended to focus on different criteria that would compel them to buy more CA Grown products. Consumers from the rural focus group tended to focus more on price, quality and availability, while consumers from the urban group focused more on standards and quality control. Participants in the groups responded the following ways.

Urban Group	Rural Group
• *"They **cost** the same or very close to non-CA grown products."* • *"They are **easily accessible**."* • *"I would remove the condition; I just would (buy it). I'd remove 'if.'"* • *"I would too. If it had the sticker and I knew the label meant that it had gone through certain **standards**, then I would just buy it too."* • *"If it also focused on GMOs, organic or trying to get rid of pesticides. If it was also an initiative for California products that had certain **quality control**."* • *"If I was assured of **quality** and **freshness**."* • *If it would help the **economy** and jobs and as long as California upholds the highest regulatory **standards** or policies."* • *"As long as the **price** was not excessively higher."*	• *"If they would tell me more **benefits**."* • *"If the **quality** was consistent."* • *"**Price** and **quality**."* • *"If it was better **quality** and **cheaper**."* • *"If it was **readily available** wherever I am shopping."* • *"If it's **right in front of me**. I walk right into the vegetable aisle and it's there."* • *"**Readily available** for me means it's in the store for me to purchase."* • *"If it looks **freshest**."*

Additionally, consumers were asked to complete another sentence. "**I would go out of my way to buy CA grown products if….**" Once again, consumers from each group tended to focus on different criteria that would induce them to go out of their way to buy CA Grown products. Rural consumers focused primarily on price, followed by quality and other attributes that consumers use to evaluate fresh food and ultimately make a purchase decision (taste, looks, etc.). These criteria are not too dissimilar from their responses to the last sentence. Urban consumers focused more on safety in the form of the produce coming from reputable farmers and from farms that follow regulatory guidelines. Participants in the groups responded the following ways.

Urban Group	Rural Group
• *"If I knew they were **reputable growers** that had a good track record."* • *"If they strictly **followed regulations** and guidelines."* • *"They both said it very well. I think that's my number one concern."* • *"I agree."* • *"If they didn't have to go out of their way to make a label for it. I'm just really hung up on the label."* • *"If I know it's also **supporting the smaller farms.**"*	• *"If it was a good **price**."* • *"In addition to being available to me, if it met whatever my criteria was for making a purchase. If it **looked appealing**, then I would absolutely choose that product first."* • *"If it's **reasonably priced**."* • *"**Price** and I would also say if I could clearly see this is the California stuff from this area. A lot of times it all blends together. If I knew this was the California stuff, it was priced good and was **available,** I would definitely go out of my way to go there.* • *"If I have already established that they have **better quality** than everybody else and its better **priced**."* • *"A clear mark or label on the produce that would make it very visible so you know for sure that it is. But everything will be based off of **price** and **quality**, with quality first."* • *"If it **tastes** better."* • *"If I knew they were **fresher** and **locally grown**."*

As the groups were winding down, the consumers were asked a few final questions that were meant to summarize their attitudes toward and perceptions of CA Grown. Consumers were asked why California consumers should care about CA Grown. The focus group participants responded by saying:

Urban Group	Rural Group
• *"Standards. If the standards are top notch."* • *"Structure and you're supporting the local economy. You're giving jobs to people you know, your neighbors, relatives of your neighbors, family. You're helping our community."* • *"I have to agree with supporting the local economy because it hasn't been great. If you're somebody who cares about that sort of thing, who cares about providing more jobs. That's hopefully what this initiative will create, then I think that's a great reason to do that."* • *"We have one of the highest unemployment rates in the country and the deficit is growing by the day, so anything we can do to help that will be beneficial of course."* • *"We have this California grown initiative but we have to make sure that they're pushing good quality. We're helping the economy but it has to be good quality. If we're putting California on there, the label, it's California pride then."*	• *"Quality."* • *"Taste."* • *"Freshness."* • *"Seasonal."* • *"Freshness."* • *"The fact that it supports our economy. The California economy."*

When asked what messages CA Grown should use to **drive preference and loyalty among consumers for CA Grown products**, rural consumers think that CA Grown should focus on raising awareness of the organization, informing consumers what the organization does and telling consumers what the benefits can be for them.

Urban consumers, on the other hand, think CA Grown messages should emphasize the effort and responsibility of the organization to ensure fair and socially conscious farming among its members.

Urban Group	Rural Group
• *"Focusing on fair wages for their workers. I think it is a really, really big thing. Make it more about social change and improve the actual job of the worker. I'd be more inclined to buy it."* • *"Support across the board (for all farms) regardless how big the farm is."* • *I'm buying something grown in California and it's good quality and I'm proud of it."* • *"Making it aware that they are going the extra mile (they are careful with the food in terms of regulations and guidelines). That's going to get my attention."*	• *"Safety."* • *"Freshness."* • *"More informative of what they are doing. More clear marketing and branding and expressing what they are doing and what the benefits are."* • *"(That) our products are not genetically modified."* • *"Overall awareness and what they do. I didn't know they were a brand because they are not out there promoting it."* • *"Who they are and what they can do for all of us."*

One participant made a passionate statement about CA Grown needing to connect to consumers emotionally if they hope to garner preference and loyalty.

> *"There has to be something emotional that ties me personally to, or sways me, or sells me on their label. Justify California. It somehow must emotionally connect me. It has to give me benefits. Why that product? What do they do to support California, California growers and the consumers?"* (Rural group)

Finally, consumers were asked what they thought was the most important thing that was discussed during the focus groups. Several consumers thought the knowledge they gained about CA Grown was the most important.

> *"Realizing that the logo is a brand."* (Rural group)

> *"The awareness of the brand. How little I knew about it."* (Rural group)

> *"Being aware of CA Grown products."* (Urban group)

Other consumers thought the economic benefit of agriculture and the jobs it brings to the state were the most important things discussed in the groups.

> *"The support we're trying to give to our local economy is important."* (Urban group)

> *"Jobs most important. Will resonate with consumers. Message we need to hear; hopeful message."* (Urban group)

> *"Supporting something that is of good quality. Something we can be proud of. It's fresher and gives people jobs, puts food on their plate. All around is a win-win situation for Californians."* (Urban group)

Though not grouped into any category, one participant made a particularly poignant statement about locally grown flowers.

> *"I never considered whether my flowers are grown locally or not; food yes. But I thought that was interesting you even brought that up because I've never considered whether or not flowers are local or not. I just assumed they were local. That was interesting to me. I will definitely be more aware of that."* (Rural group)

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Appendix

Profile of Focus Group Participants

URBAN Wednesday June 5, 7:00-8:30pm									
#	First Name	Gender	Age	Primary Shopper	Education	Marital Status	Employment	HHI	Ethnicity
1	Jan	F	65	Y	HS	Married	Fully retired	$61-80K	Caucasian
2	Michael	M	40	Y	GRAD DG	Married	Full time	Over $100K	Asian
3	Cristina	F	41	Y	GRAD DG	Married	Part time	$61-80K	Asian
4	Richard	M	33	Y	GRAD DG	Single	Full time	Over $100K	Asian
5	Jamie	F	27	Y	GRAD DG	Married	Full time	$81-100K	Caucasian
6	Sandra	F	22	Y	2 years college	Single	Part time	$80-100K	Caucasian
7	Jan	F	45	Y	GRAD DG	Married	Full time	Over $100K	Caucasian
8	Jayjay	F	38	Y	GRAD DG	Married	Full time	$81-100K	Asian

RURAL Thursday June 6, 7:00-8:30pm									
#	F Name	Gender	Age	Primary Shopper	Education	Marital Stat	Employment	HHI	Ethnicity
1	Arlene	F	70	Y	2 years college	Divorced	Part time	$25-40K	Caucasian
2	Hakima	F	34	Y	GRAD DG	Married	Full time	Over $100K	African-American
3	Pamela	F	24	Y	2 years college	Living w/partner	Part time	$25 - 40K	Hispanic
4	Vivian	F	56	Y	GRAD DG	Married	Part time	$81-100K	Caucasian
5	Katherine	F	32	Y	GRAD DG	Married	Full time	$81-100K	Asian
6	Rhonda	F	63	Y	GRAD DG	Married	Homemaker	Over $100K	Caucasian
7	Sultan	M	41	Y	GRAD DG	Single	Full time	$61-80K	African-American
8	Aris	M	38	Y	GRAD DG	Single	Full time	$25 - 40K	Asian

Figure 1. Regional Crop Map Base Case.

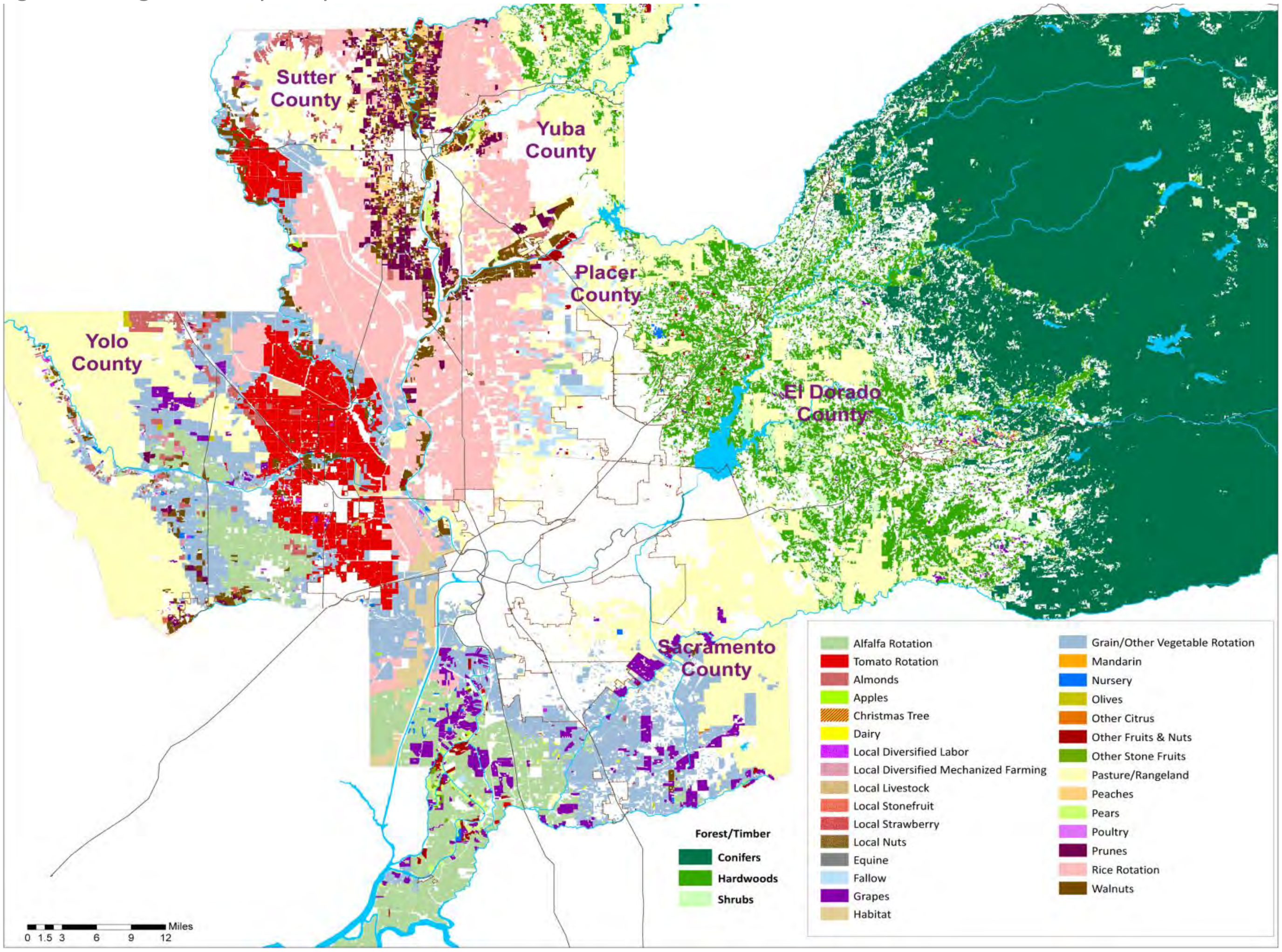


Table 1. Crop Rotation Blends.

	Blends		
Crop Type	Alfalfa Rotation	Grain/Other Vegetables Rotation	Tomato Rotation
Alfalfa	60%	45%	19%
Wheat	24%	27%	20%
Safflower	3%	13%	5%
Sunflower	7%	9%	7%
Corn	7%	5%	4%
Field Bean	0.2%	1%	0.5%
Processing Tomato			45%

Table 2. Source of Cost to Produce Studies.

Cost to Produce Study used as basis for Landscape Type

Landscape Type	**Cost Study**	**Year**	**Region**
Alfalfa	Alfalfa	2008	Sac Valley
Almonds	Almonds	2012	Sac Valley
Apples	Apples (Apple Hill)	2007	Apple Hill
Asparagus	Asparagus	2007	San J. Valley
Blueberries	Blueberries	2009	San J. Valley
Christmas Trees	Christmas Trees	2005	S.N. Foothills
Citrus	Oranges	2009	San J. Valley
Corn	Corn	2008	Sac Valley
Field Beans	Dry Beans	2008	Sac Valley
Leafy Greens	Vegetables Mixed	1994	Central Coast
Mandarins	Mandarins	2008	Placer/El Dorado
Night Shade	Fresh Market Tomato	2007	San J. Valley
Olive	Olives	2011	Sac Valley
Pears	Pears	2010	Sac Valley - Delta
Processing Tomatoes	Processing Tomatoes	2008	Sac Valley
Prunes	Prunes	2008	Sac Valley
Rice	Rice	2012	Sac Valley
Root Vegetables	Potatoes	2008	Intermountain
Safflower	Safflower	2011	Sac Valley
Stone Fruit	Peaches	2011	Sac Valley
Strawberry	Strawberry	2010	Monterey/Santa Cruz
Sunflower	Sunflower	2011	Sac Valley
Walnuts and Direct Nuts	Walnuts	2012	Sac Valley
Wheat	Wheat	2009	Sac Valley
Wine Grapes	Grapes /Wine	2012	San J. Valley

Figure 2.UrbanFootprint Screen Capture

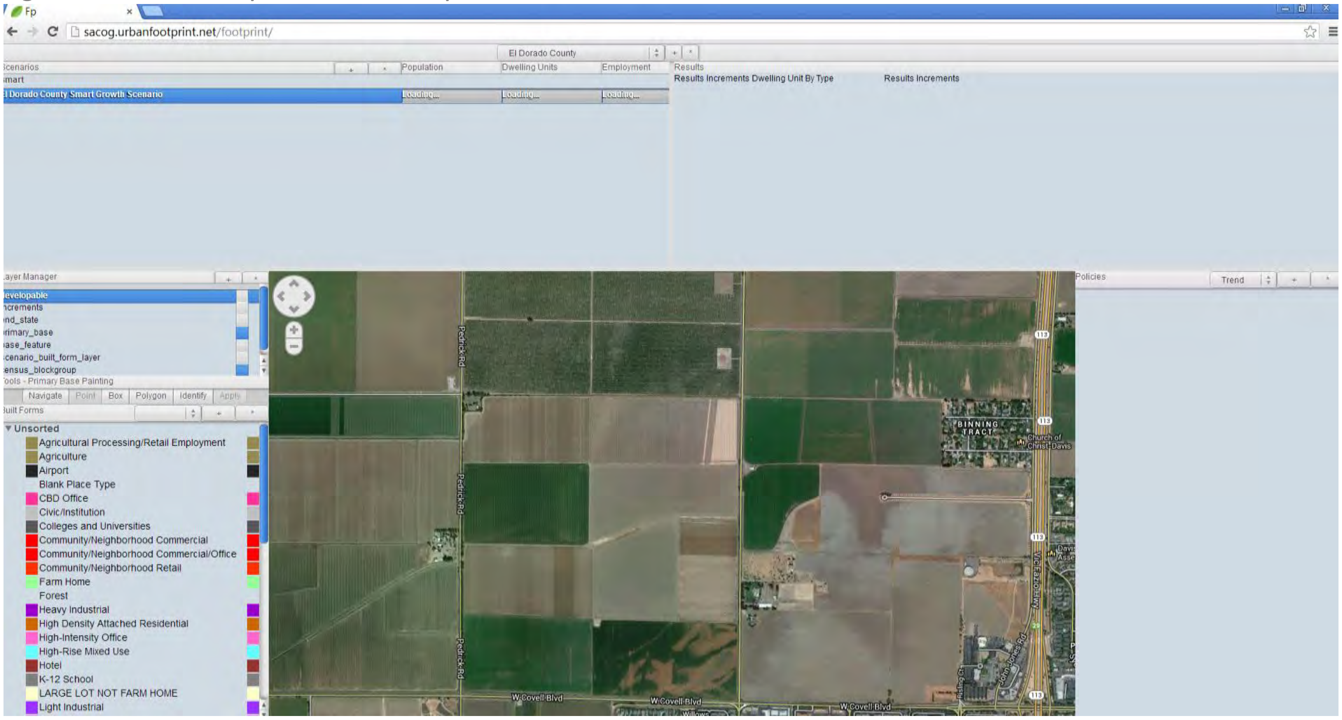


Figure 3.Yolo Base Case – UrbanFootprint.

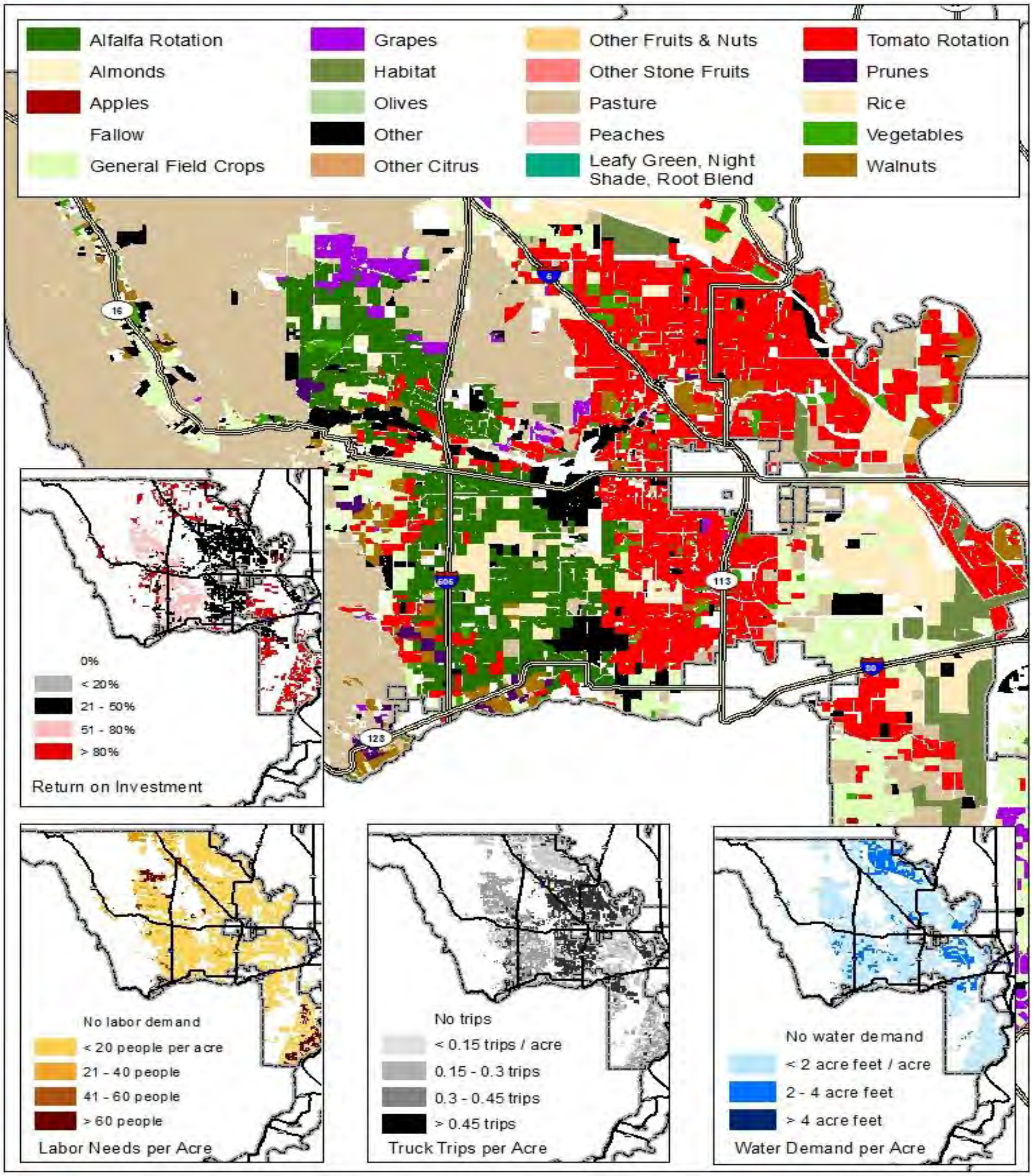


Table 3. Base Case Comparison of I-PLACE^{3}S and UrbanFootprint

	I-PLACE^{3}S ROI	UrbanFootprint ROI
ALFALFA	15.5%	15.42%
ALMONDS	15.2%	15.12%
APPLES	23.1%	22.98%
ASPARAGUS	-3.9%	-3.88%
CHRISTMAS TREES	18.7%	18.61%
CITRUS	0.9%	0.90%
DIRECT NUTS	59.0%	58.71%
DIRECT STONE FRUIT	14.1%	14.03%
FIELD BEANS	7.0%	6.9%
FIELD CORN	8.3%	8.2%
LEAFY GREENS	56.5%	56.2%
MANDARINS	25.7%	25.6%
NIGHT SHADE	34.7%	34.5%
OLIVE	9.7%	9.6%
PEARS	-15.5%	-15.4%
PROCESSING TOMATO	10.6%	10.5%
PRUNES	0.5%	0.5%
RICE	-21.0%	-20.9%
ROOT VEGETABLES	36.9%	36.7%
SAFFLOWER	-20.7%	-20.6%
STONE FRUIT	1.3%	1.3%
STRAWBERRY	11.6%	11.5%
SUNFLOWER	24.6%	24.5%
WALNUTS	27.6%	27.5%
WHEAT	5.4%	5.4%
WINE GRAPES	-0.4%	-0.4%

Table 4. RUCS Crop Type Indicators

	RETURN ON INVESTMENT (%)	GROSS RETURN ($)	LABOR (FTE/ACRE)	WATER (ACIN)
ALFALFA	15.5%	$1,453	0.001	42
ALMONDS	15.2%	$4,070	0.011	36
APPLES	23.1%	$16,160	0.163	74
ASPARAGUS	-3.9%	$5,500	0.015	12
BLUEBERRIES	0.0%	$31,250	0.973	36
CHRISTMAS TREES	18.7%	$5,517	0.074	7
CITRUS	0.9%	$6,360	0.013	32
DIRECT NUTS	59.0%	$7,500	0.052	24
DIRECT STONE FRUIT	14.1%	$12,735	0.255	44
FIELD BEANS	7.0%	$995	0.006	28
FIELD CORN	8.3%	$1,200	0.005	37
LEAFY GREENS	56.5%	$22,677	0.320	17
MANDARINS	25.7%	$19,910	0.378	105
NIGHT SHADE	34.7%	$29,320	0.605	42
OLIVE	9.7%	$11,960	0.017	24
PEARS	-15.5%	$5,004	0.018	30
PROCESSING TOMATO	10.6%	$2,711	0.013	30
PRUNES	0.5%	$5,020	0.021	30
RICE	-21.0%	$1,272	0.002	90
ROOT VEGETABLES	36.9%	$14,812	0.236	25
SAFFLOWER	-20.7%	$476	0.001	6
STONE FRUIT	1.3%	$6,777	0.104	36
STRAWBERRY	11.6%	$3,400	0.496	429
SUNFLOWER	24.6%	$1,360	0.002	29
WALNUTS	27.6%	$3,815	0.008	43
WHEAT	5.4%	$660	0.002	6
WINE GRAPES	-0.4%	$4,550	0.048	16

Table 4. Scenario Crop Blends

Low-water	Low-labor	Diversified Vegetable Production
80% General Field Crop	100% Alfalfa Rotation	33% Leafy Greens (small farm scale)
20% Wine Grape		33% Night Shade (small farm scale)
		33% Root Vegetables (small farm scale)

Table 5. Summary Scenario Metrics (Annual Totals)

	Return	Labor (hours)	Trucking (Trips)	Water (Ac-Ft)
Low-water	$451,781,426	10,473,837	69,891	597,049
Low-labor	$266,926,568	1,247,088	86,308	1,051,451
Diversified Veg	$484,641,285	263,530,406	1,707,362	1,450,956

Figure 4.Yolo Low Water Use – UrbanFootprint.

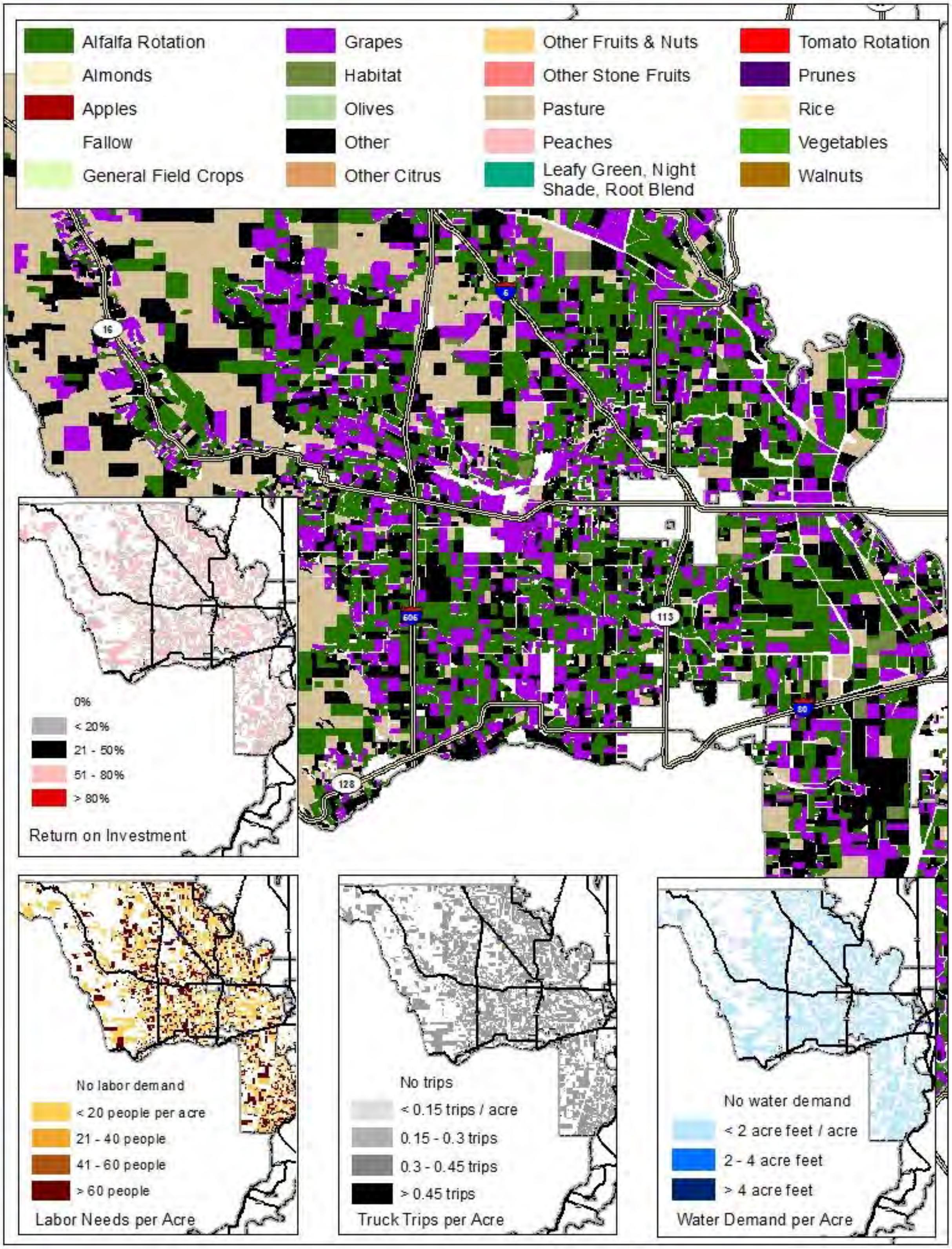


Figure 5.Yolo Low Labor Use – UrbanFootprint.

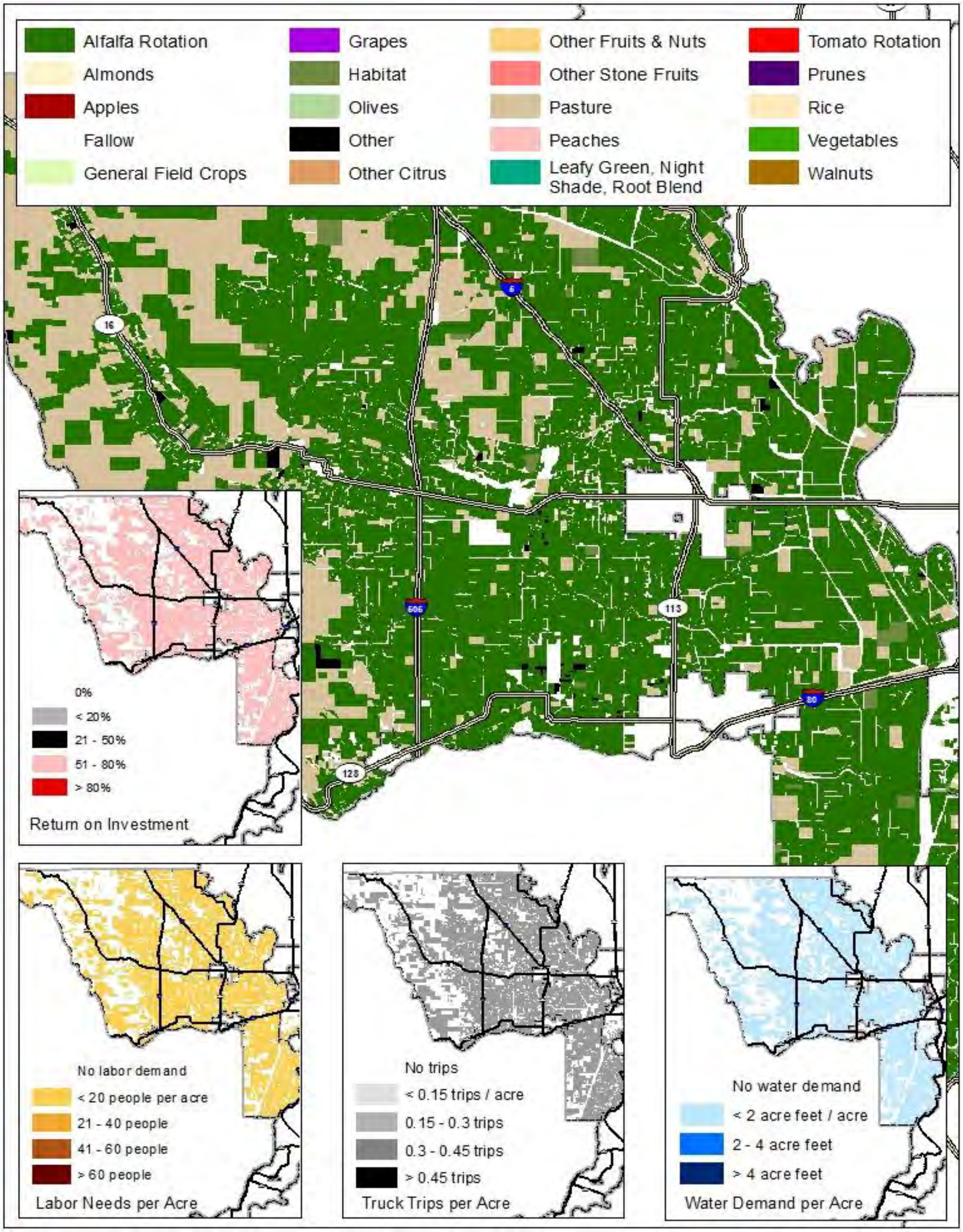
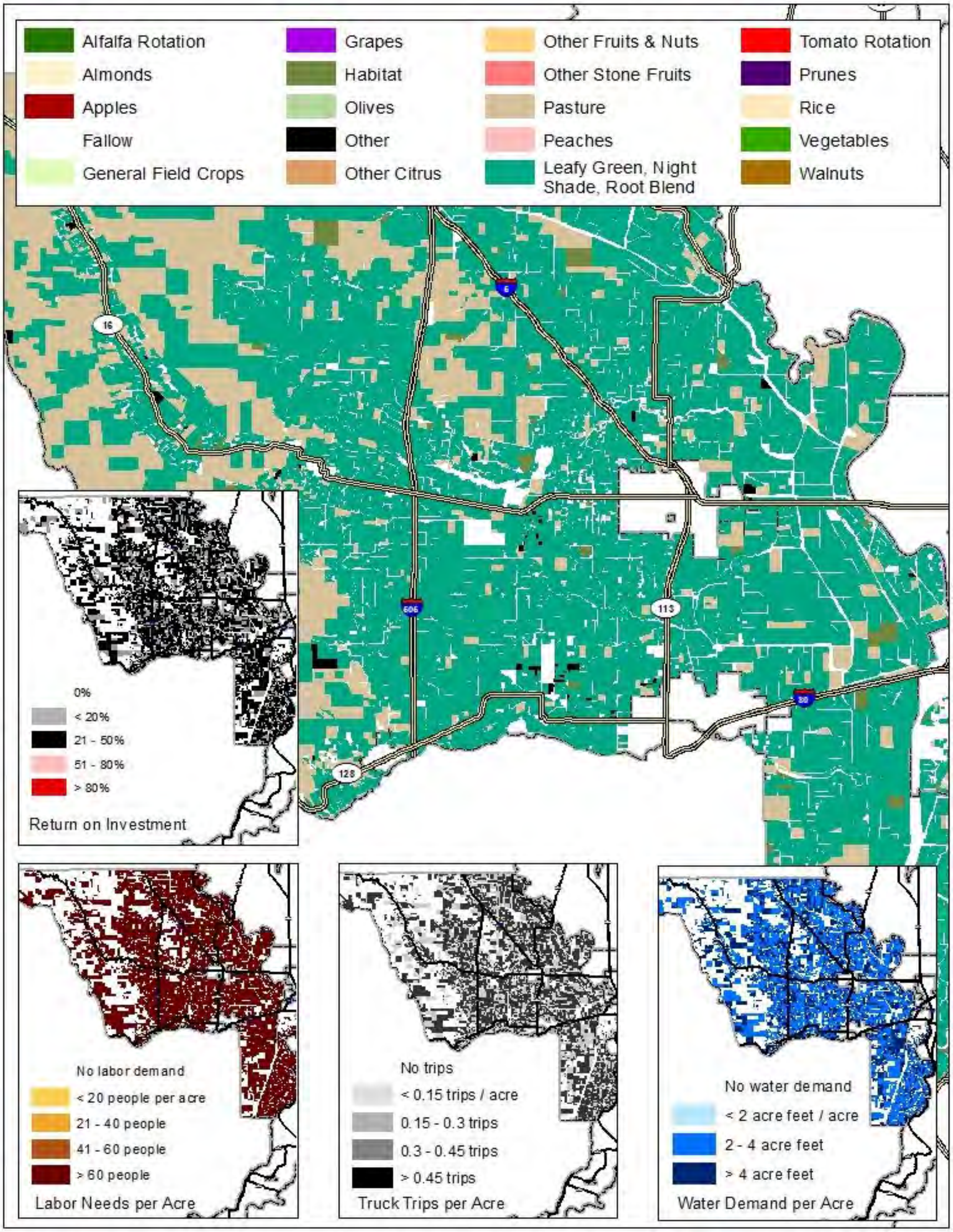
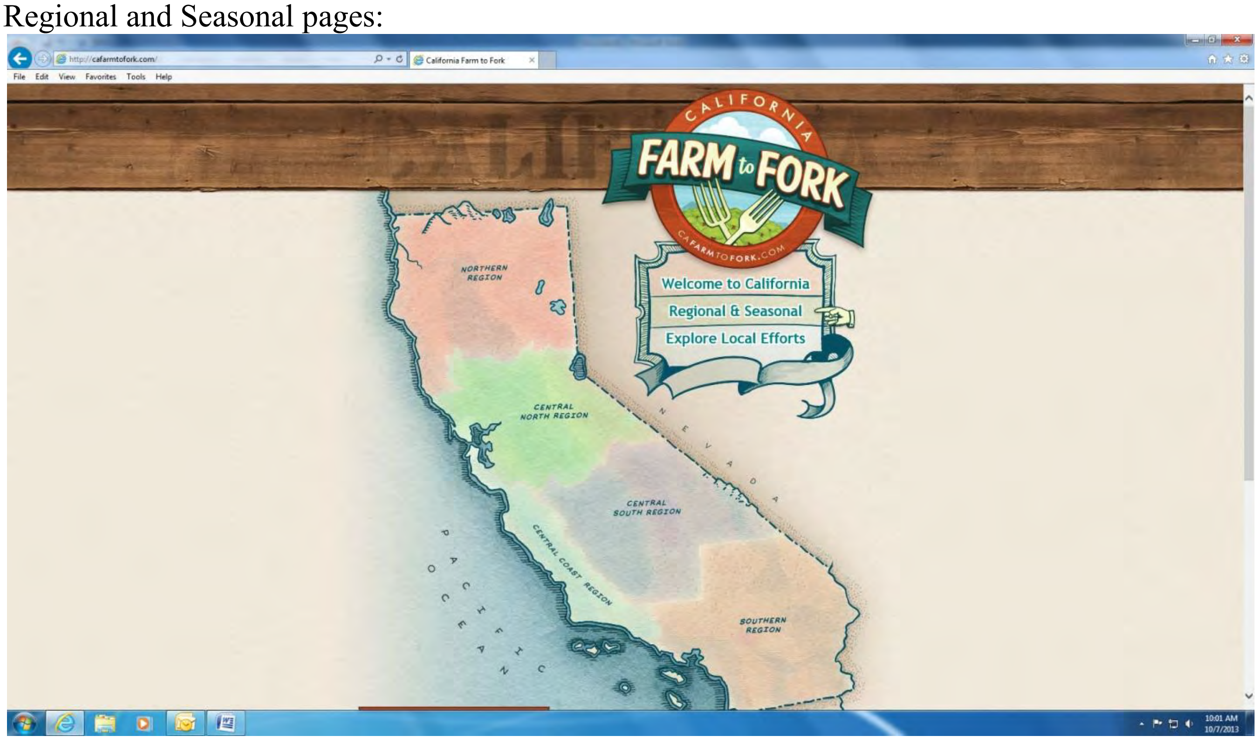


Figure 6.Yolo Increased Diversified Vegetable Production– UrbanFootprint.



Landing Page:

Regional and Seasonal pages:

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NORTHERN REGION
Welcome to California
Regional & Seasonal
Northern Region - October
This time of year the following fruits, vegetables, and nuts are generally grown in California's Northern Region, although growing seasons can vary from year to year. Choose a highlighted crop for tasty recipes.
Apples
Beans
Bell Peppers
Broccoli
Brussels Sprouts
Cauliflower
Celery
Chile Peppers
Cucumbers
Figs
Grapefruit
Green Corn
Kiwifruit
Limes
Mushrooms
Persimmons
Potatoes
Squash
Strawberries
Sweet Potatoes
Table Grapes
Tomatillos
Tomatoes
Walnuts
Close
SOUTHERN REGION
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10/7/2013


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Welcome to California
Regional & Seasonal
Central North Region - October
This time of year the following fruits, vegetables, and nuts are generally grown in California's Central North Region, although growing seasons can vary from year to year. Choose a highlighted crop for tasty recipes.
Apples
Beans
Bell Peppers
Broccoli
Brussels Sprouts
Carrots
Cauliflower
Celery
Chile Peppers
Figs
Grapefruit
Kiwifruit
Lettuce
Limes
Mushrooms
Persimmons
Romaine
Squash
Strawberries
Sweet Potatoes
Table Grapes
Tomatillos
Tomatoes
Walnuts
Close
SOUTHERN REGION
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Welcome to California
Regional & Seasonal
Central South Region - October
This time of year the following fruits, vegetables, and nuts are generally grown in California's Central South Region, although growing seasons can vary from year to year. Choose a highlighted crop for tasty recipes.
Apples
Beans
Bell Peppers
Broccoli
Brussels Sprouts
Cabbage
Cantaloupe
Carrots
Cauliflower
Celery
Figs
Grapefruit
Kiwifruit
Lettuce
Limes
Mushrooms
Persimmons
Romaine
Squash
Strawberries
Sweet Potatoes
Table Grapes
Walnuts
Close
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Regional & Seasonal
Central Coast Region- October
This time of year the following fruits, vegetables, and nuts are generally grown in California's Central Coast Region, although growing seasons can vary from year to year. Choose a highlighted crop for tasty recipes.
Apples
Beans
Bell Peppers
Broccoli
Brussels Sprouts
Cabbage
Carrots
Cauliflower
Celery
Chile Peppers
Figs
Grapefruit
Green Corn
Kiwifruit
Lettuce
Limes
Mushrooms
Onions
Persimmons
Potatoes
Romaine
Squash
Strawberries
Table Grapes
Walnuts
Close
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Explore Local Efforts
FoodCorps
FoodCorps is a nationwide team of leaders that connects kids to real food and helps them grow up healthy.
FOOD CORPS
FoodCorps places these leaders in limited-resource communities for a year of public service where they conduct hands-on food education, build and tend school gardens, and facilitate getting high-quality local food into public school cafeterias.
This year, FoodsCorps members are serving with the following California sites:
• Ventura Unified School District - Ventura, CA
• Oakland Unified School District - Oakland, CA
• North Coast CAFF - Santa Rosa, CA
• Center for Nutrition and Activity Promotion - Chico, CA
• Sierra Harvest- Grass Valley - CA
• North Coast Opportunities - Ukiah, CA
• San Diego Unified School District - San Diego, CA
• University of California Cooperative Extension - Central Sierra- San Andreas, CA
• Garden School Foundation - Los Angeles, CA
• Life Lab - Santa Cruz, CA
Close
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Explore Local Efforts
Noyo Food Forest
Noyo Food Forest empowers and educates local communities to eat locally grown fresh fruits and vegetables by promoting community gardens on the Mendocino coast.
NOYO FOOD FOREST
The Learning Garden at Fort Bragg High School
Noyo Food Forest works with the Fort Bragg Unified School District to educate students about the importance of eating fresh fruits and vegetables. By establishing The Learning Garden at Fort Bragg High School, Noyo Food Forest has helped students reconnect with their food and develop healthy eating habits. Students help tend the garden and eat what they grow in the meals served in Fort Bragg's school cafeterias.
Learn More
To learn more about Noyo Food Forest, please visit www.noyofoodforest.org.
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Explore Local Efforts
Terra Firma Farm
Terra Firma grows a wide variety of CCOF certified organic fruits, vegetables, and nuts that it sells directly to individual consumers and restaurants in Sacramento, Winters, Vacaville, and the San Francisco Bay Area.
Community Supported Agriculture
Terra Firma's Community Supported Agriculture (CSA) program provides fresh produce directly to individual households. CSA subscribers receive a weekly box of fresh, organic fruits and vegetables grown on Terra Firma's 200 acres in Winters, CA. Subscribers also receive weekly newsletters with news from the farm and a recipe using that week's produce. Households participating in Terra Firma's CSA get to learn about where their food comes from and eat fresh, organic, locally grown produce every week.
Learn More
To learn more about Terra Firma Farm and its CSA, visit www.terrafirmafarm.com.
Close
10:04 AM
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Explore Local Efforts
Solid Foundation Head Start
head start
Solid Foundation is a Head Start site in Sacramento that provides early learning education for low-income children.
Garden Based Education
As part of the "I am Moving, I am Learning" program, Solid Foundation Head Start incorporates garden-based learning into its curriculum. Children help tend their organic school garden, pick the produce, and eat it. Solid Foundation grows a range of different produce and introduces children to new vegetables as well as ones they are familiar with from home. As children become more familiar with the garden they become more willing to try new vegetables, planting the seeds for lifelong good eating habits.
Learn More
To learn more about HeadStart Sacramento, please visit headstart.seta.net.
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Explore Local Efforts
Pacific Coast Farmers' Market Association
The Pacific Coast Farmers' Market Association operates certified farmers' markets throughout the San Francisco Bay Area, making it possible for consumers to buy fruits and vegetables directly from the farmers that grow them.
PACIFIC COAST FARMERS' MARKET ASSOCIATION PCFMA
The Market Match Program: Improving Food Access
Through its Market Match program, the Pacific Coast Farmers' Market Association helps CalFresh participants stretch their food dollars a little further — an average of 30% further — and purchase more fresh fruits and vegetables. Any CalFresh participant spending $10 or more of their benefits at a PCFMA farmers' market receives an additional $5 to spend at the market on fresh fruits and vegetable. The program has greatly increased the use of CalFresh benefits at these farmers' markets and improved the diet of CalFresh participants.
Learn More
To learn more about the Pacific Coast Farmers' Market Association and its Market Match program, visit www.pcfma.com.
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Turlock Unified School District
Turlock Unified School District serves 13,800 students in Stanislaus County.
Real Fresh
Turlock Unified School District is encouraging students to eat healthier foods through its "Real Fresh" marketing campaign and efforts to include more fresh fruits and vegetables in the cafeteria and in the classroom. Turlock Unified encourages students to eat healthier foods by offering more fresh produce, sourcing from local farmers, redesigning fruit displays, and promoting nutritious school meals throughout the school. Schools gardens interest students in trying new fruits and vegetables and classroom activities teach them about nutrition.
real.fresh.
Turlock Unified School District - Real Fresh
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Explore Local Efforts
Share Our Strength
No child should grow up hungry in America, but one in five children struggles with hunger. Share Our Strength's No Kid Hungry® campaign is ending childhood hunger in America by ensuring all children get the healthy food they need, every day.
SHARE OUR STRENGTH'S COOKING MATTERS
Cooking Matters
Share Our Strength's Cooking Matters® empowers low-income families with the skills to stretch their food budgets so their children get healthy meals at home, as part of the No Kid Hungry® campaign to end childhood hunger in America. Cooking Matters serves families across the country through hands-on, six-week cooking courses; interactive grocery store tours; and mobile, online and educational tools. Participants learn to shop smarter, use nutrition information to make healthier choices, and cook delicious, affordable meals.
Cooking Matters also produces short videos to help consumers stretch their food budgets when buying groceries:
How to Save Money on Fruits and Vegetables / Spanish
How to Compare Unit Prices of Groceries / Spanish
How to Compare Fresh, Frozen and Canned Produce / Spanish
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Explore Local Efforts
California Association of Food Banks
The California Association of Food Banks provides a unified voice for its 41 member food banks from throughout the state to help build a well-nourished California.
California Association of Food Banks
Farm to Family
Operated by the California Association of Food Banks, the Farm to Family program connects California farmers with food banks around the state. Generous growers and packers provide fresh fruits, vegetables and other surplus farm products to food banks, which in turn provide them to low-income people in need of food assistance. The program creates a win-win by helping farmers to dispose of surplus product and by providing fresh produce to low-income people who often have little or no access to fresh fruits and vegetables that are essential for good health.
Growing California video series: Farm To Family
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Explore Local Efforts
UEPI/Farm to WIC
The Urban and Environmental Policy Institute (UEPI) at Occidental College works to eliminate disparities in food access and get more locally grown fruits and vegetables in the hands of all Californians through its Farm to WIC, Farm to Preschool, and the California Farm to School programs.
UEPI
Expanding Options for WIC
The Supplemental Nutrition Program for Women, Infants, and Children (WIC) helps mothers and young children access the nutritious foods they need, including fruits and vegetables. UEPI is working with retail stores and farmers' markets to increase the availability of fresh fruits and vegetables for WIC participants. As part of its Farm to WIC program, UEPI has helped WIC-approved stores carry more fresh fruits and vegetables by connecting them directly with growers. UEPI is also working on an initiative to make it easier to use WIC Fruit and Vegetable checks at Certified Farmers' Markets.
Learn More
To learn more about the Urban and Environmental and their projects, please visit www.uepi.oxy.edu.
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Explore Local Efforts
Los Angeles Food Policy Council
The Los Angeles Food Policy Council works with diverse stakeholders to bring healthy, affordable, fair, and sustainable food to all Los Angeles residents.
Healthy Neighborhood Market Network
LAFPC's Healthy Neighborhood Market Network is a capacity building platform for small neighborhood markets operating in LA's under-served neighborhoods to grow their skills as healthy food retailers. LAFPC's Healthy Neighborhood Market Network builds the capacity of neighborhood market owners, managers, and staff to grow their business as a healthy food retailer by connecting them to training, resources and networks of experts and community-based organizations. LAFPC has hosted four, multi-lingual business and leadership conferences featuring industry experts from Whole Foods, Yummy.com, Unified Grocers, Coosemans Shipping, Fresco Community Market and many others. The trainings also connect small stores to healthy food distributors, community lenders, government representatives and non-profits. A total of 350 stores across LA County have been reached through organizing and outreach efforts through the Healthy Neighborhood Market Network.
Learn More
To learn more about the LA Food Policy Council and its Healthy Neighborhood Market Network,
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Explore Local Efforts
Old Grove Orange
Old Grove Orange is a collaboration of 28 farmers in the Inland Empire. They grow a variety of fruits and vegetables, which they supply to local school districts and colleges.
Farm to School
By sharing resources – from picking teams to distribution – Old Grove Orange farmers work together to supply a variety of produce directly to farm to school programs. Old Grove Orange supplies local school districts and colleges with many kinds of fresh produce, including oranges, mandarins, strawberries, grapes, potatoes, and cucumbers, which the schools then feature in their Farm to School Programs. Collaborating helps the farmers in Old Grove Orange reduce costs and makes it easier for schools to connect with famers and serve a variety of fruits and vegetables in their cafeterias.
Learn More
To learn more about how schools incorporate Old Grove Orange produce into their meals, listen to Old Grove Orange's Bob Knight here:
Growing California video series: Salad Bar Supe...
Close
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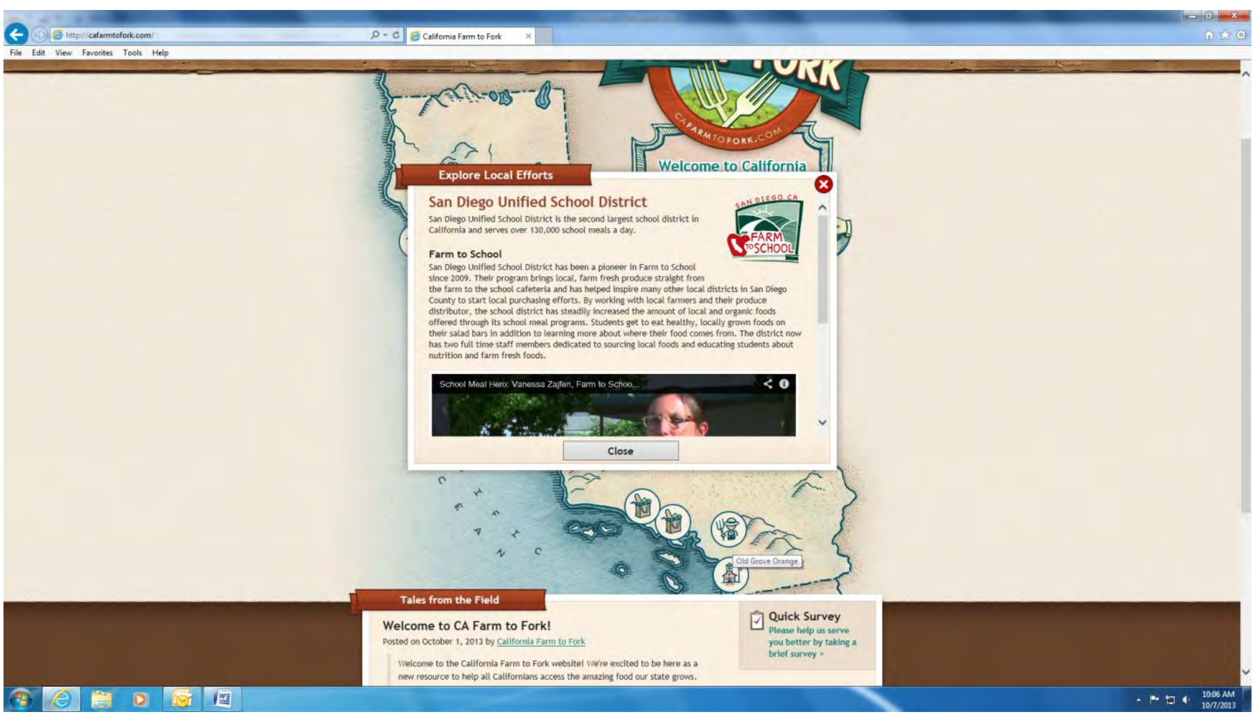
10/7/2013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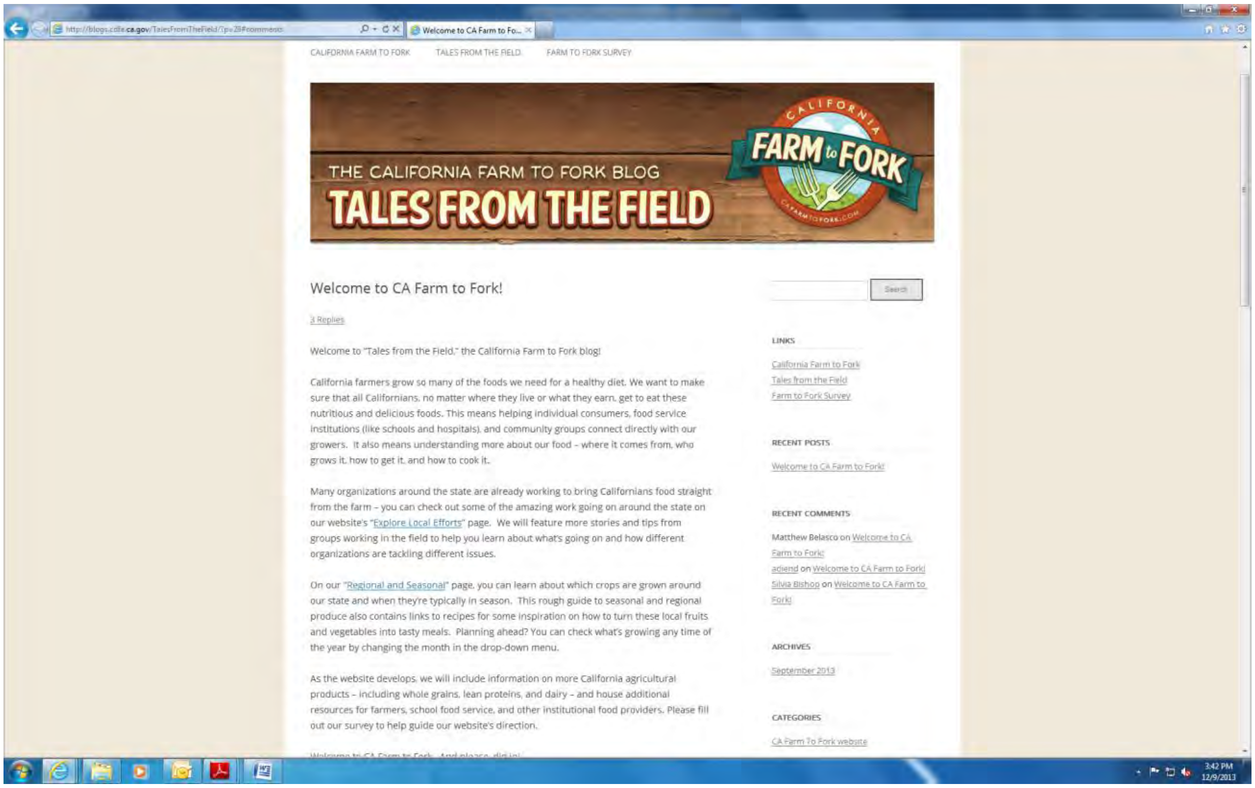
Explore Local Efforts
San Diego Unified School District
San Diego Unified School District is the second largest school district in California and serves over 130,000 school meals a day.
SAN DIEGO CA
FARM TO SCHOOL
Farm to School
San Diego Unified School District has been a pioneer in Farm to School since 2009. Their program brings local, farm fresh produce straight from the farm to the school cafeteria and has helped inspire many other local districts in San Diego County to start local purchasing efforts. By working with local farmers and their produce distributor, the school district has steadily increased the amount of local and organic foods offered through its school meal programs. Students get to eat healthy, locally grown foods on their salad bars in addition to learning more about where their food comes from. The district now has two full time staff members dedicated to sourcing local foods and educating students about nutrition and farm fresh foods.
School Meal Hero: Vanessa Zajfen, Farm to Schoo...
Close
Old Grove Orange
Tales from the Field
Welcome to CA Farm to Fork!
Posted on October 1, 2013 by California Farm to Fork
Welcome to the California Farm to Fork website! We're excited to be here as a new resource to help all Californians access the amazing food our state grows.
Quick Survey
Please help us serve you better by taking a brief survey >
10:06 AM
10/7/2013

Blog:


CALIFORNIA FARM TO FORK
TALES FROM THE FIELD
FARM TO FORK SURVEY
THE CALIFORNIA FARM TO FORK BLOG
TALES FROM THE FIELD
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Welcome to CA Farm to Fork!
3 Replies
Welcome to "Tales from the Field," the California Farm to Fork blog!
California farmers grow so many of the foods we need for a healthy diet. We want to make sure that all Californians, no matter where they live or what they earn, get to eat these nutritious and delicious foods. This means helping individual consumers, food service institutions (like schools and hospitals), and community groups connect directly with our growers. It also means understanding more about our food – where it comes from, who grows it, how to get it, and how to cook it.
Many organizations around the state are already working to bring Californians food straight from the farm – you can check out some of the amazing work going on around the state on our website's "Explore Local Efforts" page. We will feature more stories and tips from groups working in the field to help you learn about what's going on and how different organizations are tackling different issues.
On our "Regional and Seasonal" page, you can learn about which crops are grown around our state and when they're typically in season. This rough guide to seasonal and regional produce also contains links to recipes for some inspiration on how to turn these local fruits and vegetables into tasty meals. Planning ahead? You can check what's growing any time of the year by changing the month in the drop-down menu.
As the website develops, we will include information on more California agricultural products – including whole grains, lean proteins, and dairy – and house additional resources for farmers, school food service, and other institutional food providers. Please fill out our survey to help guide our website's direction.
Search
LINKS
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Tales from the Field
Farm to Fork Survey
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RECENT COMMENTS
Matthew Belasco on Welcome to CA Farm to Fork!
adiend on Welcome to CA Farm to Fork!
Silvia Bishop on Welcome to CA Farm to Fork!
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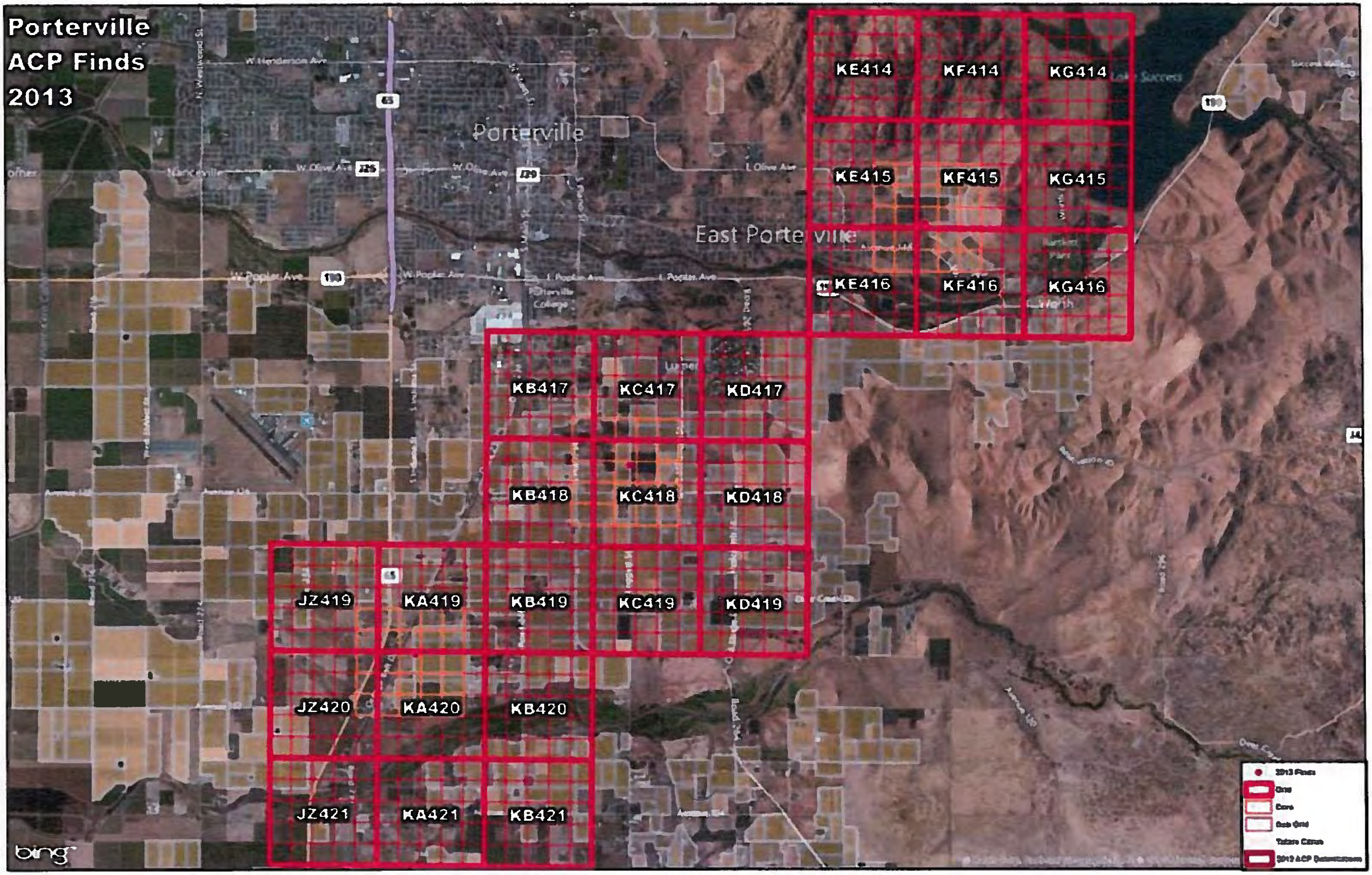
CA Farm To Fork website


Porterville
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East Porterville
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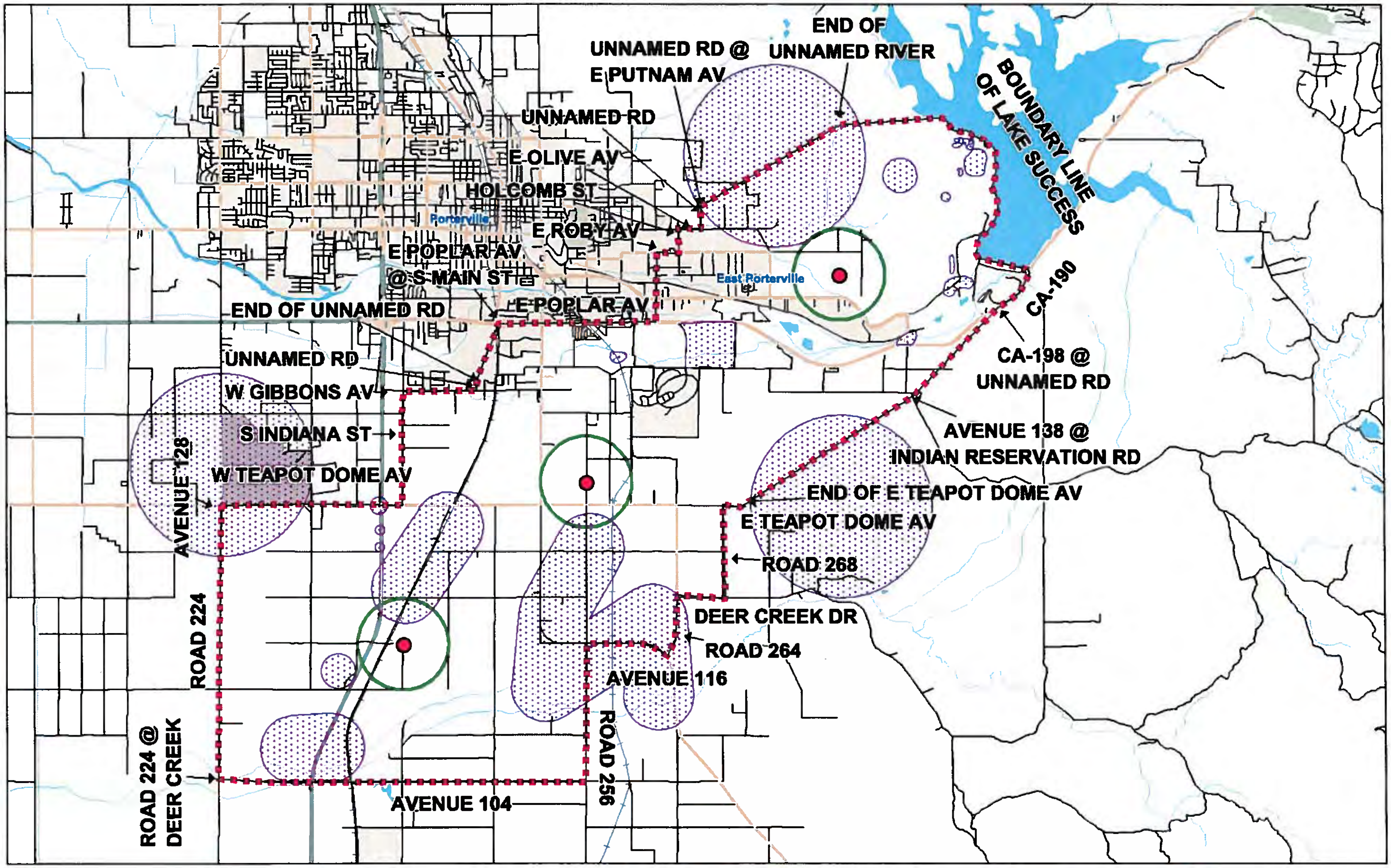
ATTACHMENT 2

ASIAN CITRUS PSYLLID
PORTERVILLE, TULARE COUNTY
2013



cdfa

DETECTION SITE

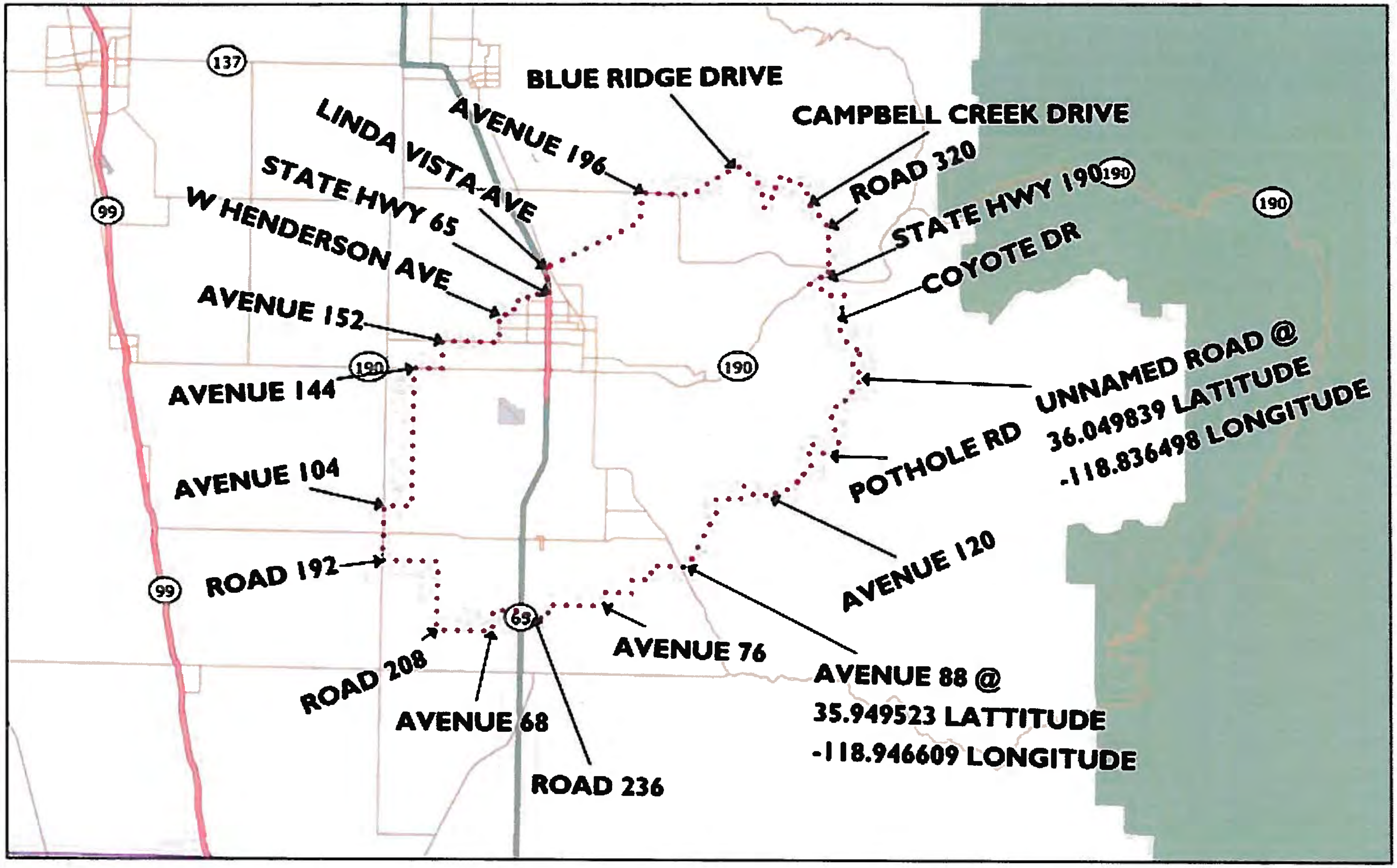
MAXIMUM PROGRAM BOUNDARY

PROPOSED 800M TREATMENT BOUNDARY

SENSITIVE ENVIRONMENTAL AREA / TREATMENT MITIGATIONS IN PLACE

2013 Asian Citrus Psyllid
Tulare County

ATTACHMENT 3



Quarantine Boundary 7/30/2013
(178 sq miles)

Map Printed 07/30/2013
MapInfo 11.5.1 StreetPro v 2012.12

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