A. Project Information

Final report: 8/1/13 – 6/30/16

Project Title: Nitrogen Management Training for Certified Crop Advisors

Agreement Number: 13-0241-SA

Project Leaders:

Doug Parker, Director
California Institute for Water Resources
University of California
1111 Franklin Street
Oakland, CA 94607
510-987-0036
Doug.parker@ucop.edu

Patrick Brown, Professor
Dept of Plant Sciences
University of California
Davis, CA 95616
530-752-0929
phbrown@ucdavis.edu

Allan Fulton, Advisor
Coop. Ext. Tehama County
1754 Walnut Street
Red Bluff, CA 96080
530-527-3101
aefulton@ucanr.edu

Tim Hartz, Specialist
Dept of Plant Sciences
University of California
Davis, CA 95616
530-752-1738
tkhartz@ucdavis.edu

Dan Munk, Advisor
Coop. Ext. Fresno County
550 E. Shaw Avenue, Ste 210
Fresno, CA 93710
559-241-7515
dsmunk@ucanr.edu

Daniel Geisseler, Specialist
Dept of Land, Air & Water Resources
University of California
Davis, CA 95616
530-754-9637
djgeisseler@ucdavis.edu

B. Objective:

The objective of this program was to facilitate California’s Certified Crop Advisors understanding of sound nitrogen management practices and increase their ability to make informed recommendations to growers, thereby improving environmental performance relative to nitrogen management for crop production.

C. Abstract:

The University of California, Division of Agriculture and Natural Resources, with support from the California Department of Food and Agriculture’s Fertilizer Research and Education Program, developed a training program aimed at helping growers to develop
efficient nitrogen management practices. The training was offered in 2014, 2015, and 2016 to Certified Crop Advisers (CCAs) through the California Association of Pest Control Advisers, in locations around the state. Over 800 CCAs have been trained to date, and evaluations show that participants increased their understanding of nitrogen management, the nitrogen cycle in crop production, and nitrogen budgeting.

D. Introduction:

The Nitrogen Management Training and Certification Program was a joint effort between the California Department of Food and Agriculture; University of California, Agricultural and Natural Resources; California Certified Crop Advisor Program of the California Association of Pest Control Advisers; and the Regional Water Boards to develop and implement a voluntary nitrogen management curriculum specifically targeted for California Certified Crop Advisors. The effort was coordinated by the University of California’s California Institute for Water Resources. The curriculum addressed the management of nitrates to reduce unintentional emissions in waters throughout the state.

E. Work Description:

This project involved curriculum development, website development and maintenance, trainings, and publications. The project was carried out in two phases with deliverables provided in stages.

Phase I: (August 1, 2013 – December 31, 2014)

This phase involved curriculum development and an initial round of trainings.

Curriculum Development. The initial curriculum was developed by small teams (5-15 people). A team leader organized each team. Participants were involved in curriculum development with in-person meetings and virtual collaboration.

Trainings Sessions. The course was developed to be one and a half days in length. Team members led training sessions. Logistics for the training sessions were provided by the California Association of Pest Control Advisors. The dates and locations for the first set of trainings took place as follows:

2. Woodland – February 18-19, 2014
4. Salinas – March 5-6, 2014
5. Tulare – March 11-12, 2014

Website Development. A website was developed at ciwr.ucanr.edu/nitrogen management. Presentations from the training sessions are available and were updated to make the annotated versions of the presentations available. Video of presentations are also available.
Phase II: (October 1, 2014 – June 30, 2016)

This phase involved curriculum modification based on what was learned during the first set of trainings, a second round of trainings, and development of publications and other outputs from the curriculum that can be used for additional outreach.

Curriculum Modification. The curriculum used in the first round of trainings was reviewed based upon feedback from evaluations during those trainings. Modifications to the curriculum were implemented.

Training Sessions. Three additional training sessions were held in early 2015 and 2016 as follows:

2. San Luis Obispo – February 24-25, 2015

Publications. A total of 11 publications (see list below) were drafted from the training materials, lessons learned from the training sessions, and from additional research. They will be finished under a subsequent contract. The topics are as follows:

1. Nitrogen cycle principles, fertilizer management, nitrogen budgeting
2. Irrigation and nitrogen management
3. Cole crops and leafy greens
4. Wheat
5. Corn – silage and grain
6. Strawberry and cane berries
7. Tomatoes and melons
8. Cotton
9. Nuts
10. Citrus and avocados
11. Deciduous fruits and grapes

F. Data/Results:

The curriculum for the trainings was developed as follows:

Day 1: Nutrient Management
9:00 am Module 1: Objectives
9:30 am Module 2: Nitrogen Cycle in Crop Production Systems
11:15 am Module 3: Nitrogen Sources
1:00 pm Module 4: Irrigation and Nitrogen Management
2:00 pm Module 5: Nitrogen Budgeting
3:00 pm Module 6: Tools and Resources
3:45 pm Regional Board Update
4:30 pm Questions/summary/check-out

**Day 2: Annual and Permanent Crops** (participants chose a crop type track)
8:00 am Current practices and BMPs
10:30 am Nitrogen management planning exercise

Figure 1. Doug Parker, director of the California Institute for Water Resources, and Terry Stark, executive director of the California Association of Pest Control Advisers.

Figure 2. Participants at the first nitrogen training event in Modesto.
At this time, training materials and videos are available on the web at ciwr.ucanr.edu/nitrogen management. We developed fully updated, annotated presentations for the curriculum to make the material more accessible for participants across trainings.

G. Discussion and Conclusions:

The objective of this program was to facilitate CCAs understanding of sound nitrogen management practices and increase their ability to make informed recommendations to growers, thereby improving environmental performance relative to nitrogen management for crop production. After each training session, participants were asked to evaluate their understanding of nitrogen management before and after the training. The results were compiled as follows:

A.) My overall understanding of nitrogen management.

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td>6%</td>
<td>0%</td>
</tr>
<tr>
<td>Moderate</td>
<td>34%</td>
<td>4%</td>
</tr>
<tr>
<td>Good</td>
<td>51%</td>
<td>53%</td>
</tr>
<tr>
<td>Complete</td>
<td>9%</td>
<td>42%</td>
</tr>
</tbody>
</table>

B.) My understanding of the nitrogen cycle in crop production.

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td>3%</td>
<td>0%</td>
</tr>
<tr>
<td>Moderate</td>
<td>23%</td>
<td>3%</td>
</tr>
<tr>
<td>Good</td>
<td>58%</td>
<td>51%</td>
</tr>
<tr>
<td>Complete</td>
<td>16%</td>
<td>46%</td>
</tr>
</tbody>
</table>
C.) My understanding of nitrogen sources in crop production.

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td>3%</td>
<td>0%</td>
</tr>
<tr>
<td>Moderate</td>
<td>18%</td>
<td>3%</td>
</tr>
<tr>
<td>Good</td>
<td>58%</td>
<td>52%</td>
</tr>
<tr>
<td>Complete</td>
<td>21%</td>
<td>45%</td>
</tr>
</tbody>
</table>

D.) My understanding of irrigation management and its relationship to nitrogen fertilization.

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td>3%</td>
<td>0%</td>
</tr>
<tr>
<td>Moderate</td>
<td>27%</td>
<td>3%</td>
</tr>
<tr>
<td>Good</td>
<td>45%</td>
<td>48%</td>
</tr>
<tr>
<td>Complete</td>
<td>24%</td>
<td>49%</td>
</tr>
</tbody>
</table>

E.) My understanding of the process of nitrogen budgeting.

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td>17%</td>
<td>1%</td>
</tr>
<tr>
<td>Moderate</td>
<td>38%</td>
<td>7%</td>
</tr>
<tr>
<td>Good</td>
<td>34%</td>
<td>56%</td>
</tr>
<tr>
<td>Complete</td>
<td>11%</td>
<td>37%</td>
</tr>
</tbody>
</table>

F.) My understanding of nitrogen management tools and resources.

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>Moderate</td>
<td>42%</td>
<td>8%</td>
</tr>
<tr>
<td>Good</td>
<td>36%</td>
<td>54%</td>
</tr>
<tr>
<td>Complete</td>
<td>3%</td>
<td>34%</td>
</tr>
</tbody>
</table>

G.) My understanding of nitrogen management in annual or permanent crops.

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td>10%</td>
<td>1%</td>
</tr>
<tr>
<td>Moderate</td>
<td>31%</td>
<td>12%</td>
</tr>
<tr>
<td>Good</td>
<td>52%</td>
<td>53%</td>
</tr>
<tr>
<td>Complete</td>
<td>7%</td>
<td>34%</td>
</tr>
</tbody>
</table>

H.) My capacity to advise in the development of a nitrogen management approach.

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td>16%</td>
<td>2%</td>
</tr>
<tr>
<td>Moderate</td>
<td>37%</td>
<td>10%</td>
</tr>
<tr>
<td>Good</td>
<td>41%</td>
<td>47%</td>
</tr>
<tr>
<td>Complete</td>
<td>6%</td>
<td>41%</td>
</tr>
</tbody>
</table>
In general, across all categories, the percentage of participants with slight to moderate understanding of nitrogen management before the training was reduced as the percentage of participants with good to complete understanding increased after the training. In addition, 95% of participants found the presenters very knowledgeable and informative, and found many parts of the training helpful. Most importantly, most participants felt they were better prepared to address nitrogen mitigation regulatory requirements after the training.

H. Project Impacts:

The following table summarizes the reach of the training program in numbers of Certified Crop Advisers that participated:

<table>
<thead>
<tr>
<th>Training Date</th>
<th>Location</th>
<th>Completed</th>
<th>No Shows</th>
<th>Partial Hours</th>
<th>Total Registered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/14/14 –</td>
<td>Modesto</td>
<td>113</td>
<td>0</td>
<td>0</td>
<td>113</td>
</tr>
<tr>
<td>1/15/14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2/18/14 –</td>
<td>Woodland</td>
<td>89</td>
<td>1</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>2/19/14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2/25/14 –</td>
<td>Fresno</td>
<td>111</td>
<td>4</td>
<td>1</td>
<td>116</td>
</tr>
<tr>
<td>2/26/14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/05/14 –</td>
<td>Salinas</td>
<td>104</td>
<td>0</td>
<td>3</td>
<td>107</td>
</tr>
<tr>
<td>3/06/14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/11/14 –</td>
<td>Tulare</td>
<td>112</td>
<td>7</td>
<td>4</td>
<td>123</td>
</tr>
<tr>
<td>3/12/14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/13/15-1/14/15</td>
<td>Fresno</td>
<td>67</td>
<td>4</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>2/24/15-2/25/15</td>
<td>San Luis Obispo</td>
<td>68</td>
<td>0</td>
<td>7</td>
<td>76</td>
</tr>
<tr>
<td>3/10/15-3/11/15</td>
<td>Sacramento</td>
<td>74</td>
<td>5</td>
<td>4</td>
<td>94</td>
</tr>
<tr>
<td>1/20/16-1/21/16</td>
<td>Fresno</td>
<td>68</td>
<td>4</td>
<td>0</td>
<td>93</td>
</tr>
<tr>
<td>TOTALS</td>
<td></td>
<td>806</td>
<td>25</td>
<td>22</td>
<td>887</td>
</tr>
</tbody>
</table>

The 806 newly trained certified crop advisors have increased their knowledge and skills in making fertilizer use recommendations. This should lead to increased fertilizer use efficiency and increased profits to growers. Actual changes in fertilizer recommendations were not measured as part of this project.

I. Outreach Activities Summary:

The results of this project are a series of trainings for Certified Crop Advisors. The training and outreach activities are detailed above.
J. Factsheet/Database Template:

1. **Project Title:** Nitrogen Management Training for Certified Crop Advisors

2. **Agreement Number:** 13-0241-SA

3. **Project Leaders:**

   - Doug Parker, Director
     California Institute for Water Resources
     University of California
     1111 Franklin Street
     Oakland, CA 94607
     510-987-0036
     Doug.parker@ucop.edu

   - Patrick Brown, Professor
     Dept of Plant Sciences
     University of California
     Davis, CA 95616
     530-752-0929
     phbrown@ucdavis.edu

   - Allan Fulton, Advisor
     Coop. Ext. Tehama County
     1754 Walnut Street
     Red Bluff, CA 96080
     530-527-3101
     aefulton@ucanr.edu

   - Tim Hartz, Specialist
     Dept of Plant Sciences
     University of California
     Davis, CA 95616
     530-752-1738
     tkhartz@ucdavis.edu

   - Dan Munk, Advisor
     Coop. Ext. Fresno County
     550 E. Shaw Avenue, Ste 210
     Fresno, CA 93710
     559-241-7515
     dsmunk@ucanr.edu

   - Daniel Geisseler, Specialist
     Dept of Land, Air & Water Resources
     University of California
     Davis, CA 95616
     530-754-9637
     djgeisseler@ucdavis.edu

4. **Start Year/End Year:** 2013/2016

5. **Location:** Statewide

6. **County:** Statewide

7. **Highlights:**

   - The objective of this program was to facilitate California’s Certified Crop Advisors (CCAs) understanding of sound nitrogen management practices and increase their ability to make informed recommendations to growers, thereby improving environmental performance relative to nitrogen management for crop production.

   - A training curriculum was developed and training sessions were offered in 2014, 2015, and 2016 through the California Association of Pest Control Advisers around the state.
• Over to 800 CCAs have been trained to date. Evaluations show that participants increased their understanding of nitrogen management, the nitrogen cycle in crop production, and nitrogen budgeting. All materials are now available on the web.

8. Introduction:

In 2012, the report "Addressing Nitrate in California's Drinking Water" was released by University of California, Davis researchers after being commissioned by the California State Water Resources Control Board. The researchers reported that one in 10 people living in some of California’s most productive agricultural areas is at risk of exposure to harmful levels of nitrate in their drinking water.

One key findings of the report was that 90 percent of the nitrate leached to groundwater came from agricultural fertilizers and animal manure applied to cropland. The report also noted reducing nitrate in groundwater is possible through improved fertilizer and water management.

The California Department of Food and Agriculture's Fertilizer Research and Education Program approached the University of California Agriculture and Natural Resources, which has a long history working on nitrogen issues, to develop a training program helping California’s Certified Crop Advisers optimize nitrogen management practices.

8. Methods/Management:

The Nitrogen Management Training and Certification Program was a joint effort between the California Department of Food and Agriculture; University of California, Agricultural and Natural Resources; California Certified Crop Advisor Program of the California Association of Pest Control Advisors; and the Regional Water Boards to develop and implement a voluntary nitrogen management curriculum specifically targeted for California Certified Crop Advisors. The effort was coordinated by the University of California's California Institute for Water Resources. The curriculum addressed the management of nitrates to reduce unintentional emissions in waters throughout the state.

The training curriculum was developed by a core group of UC faculty and cooperative extension specialists and advisors. The training focused broadly on nitrogen management, and included modules on the nitrogen cycle and nitrogen sources in crop production, such as irrigation water. Nine training sessions were offered between 2014 and 2016 around the state, with over to 800 CCAs trained.

9. Findings

The objective of this program was to facilitate CCAs understanding of sound nitrogen management practices and increase their ability to make informed recommendations to growers, thereby improving environmental performance relative to nitrogen management for crop production. After each training session, participants were asked to evaluate their understanding of nitrogen management before and after the training.
The percentage of participants with slight to moderate understanding of nitrogen management before the training was reduced as the percentage of participants with good to complete understanding increased after the training. Ninety-five percent of participants found the presenters very knowledgeable and informative, and found many parts of the training helpful. Most importantly, most participants felt they were better prepared to address nitrogen mitigation regulatory requirements after the training.
K. Copy of the Product/Result:

All of the training materials and videos from the trainings can be found on our website: http://ciwr.ucanr.edu/nitrogenmanagement/.