ADDITIONAL ASSISTANCE FOR HISTORICALLY UNDERREPRESENTED ORGANIZATIONS

Farms to Grow, Inc. *$101,665*

Farming to Grow California's Black Specialty Crop Farmers

This grant describes an approach to supporting five percent of California's 300 African American farmers through customized technical assistance intended to increase production of culturally relevant specialty crops. The overall goal of this project is to enhance the competitiveness of specialty crops grown by historically marginalized African American farmers in California. Building on a longstanding record of training and support, Farms to Grow proposes to build the capacity of African American farmers to more fully access and participate in the specialty crop market. The primary outcome is to build the capacity of the farmers to adopt sustainable practices of specialty crop production, including crop planning, irrigation techniques, and orchard production. A secondary outcome of the project is to support the development and growth of sustainable, diverse, and resilient specialty crop systems. The success of this project will be measured using multiple indicators devised by an external contract evaluator.

Punjabi American Growers Group *$101,117*

'Demonstration Trial' for High Tunnel Grown Specialty Crops to Demonstrate Research Based Information and Sustainable BMPs

Fresno county is home to the largest population of South-East Asian and South Asian specialty vegetable crop growers, a large majority of whom are farmers of Punjabi origin. Punjabi origin growers, most of whom are Sikhs have contributed to California agriculture for more than a century. South Asian crops are popular among ethnic communities, but their best management practices have not been established by mainstream research organizations. Most growers rely on traditional farming practices and maintain this passage of knowledge. The proposed demonstration trial will display research-based information and best management practices on soil and water conservation to educate Punjabi American growers who have historically grown specialty crops with little technical support. Under this project at least two field days would be organized every year. These field days will be advertised at platforms like radio, television, print media, in all popular languages of California (such as Hmong, Spanish, Punjabi, and English) to encourage participation from all communities. Participation in these field days and adoption of the Best Management Practices would be documented as a measure of success of this project.

Neighborhood Housing Services of Los Angeles County *$105,109*

Increasing Access to Specialty Crops in Low-Income South Los Angeles Communities

Communities Neighborhood Housing Services of Los Angeles County (NHS) will increase specialty crop access and specialty crop consumption in the city of Compton, a multiracial, multicultural community of approximately 100,000 residents located in the southeast portion of Los Angeles County. Compton has been designated a food desert by the U.S. Department of Agriculture, and this project will serve low-income families who have limited access to healthy and affordable food. NHS will educate residents about specialty crops and offer hands-on training in gardening, cooking, and other agricultural practices that involve the use of specialty crops. Job training and community education will emphasize the importance of growing and consuming specialty crops and empower community members to pursue careers in agriculture. Project success will be measured using intake forms, sign-in sheets, resident interviews, and community surveys.

Community Agroecology Network *$101,554*

La Central: An Intergenerational Food and Knowledge Sharing Learning Community

The Community Agroecology Network and Growing Justice Youth, in collaboration with Tierras Milperas (7 urban micro-farms), will facilitate a culturally-appropriate education and training program that will increase production and consumption of culturally-significant specialty crops and increase access for California's Pajaro Valley Latinx farmworker families. Growing Justice Youth will learn to grow and prepare nutrient-rich greens (epazote, papalo, pipicha, coriander, watercress), tomatoes, a variety of tomatillos, peppers, and cacti at River Park Community Urban Micro-Farm. They will form a learning community with socially disadvantaged urban micro-farmers and community elders to learn historical and cultural solutions for seed saving, soil and pest management, and processing crops into healthy meals. Project success will be measured by an increase in consumption of specialty crops, new skills and knowledge gained by youth, and participating learning community members.

GROWN IN CALIFORNIA

Sunsweet Growers, Inc. *$450,000*

Sharing California Prune Health Benefits to Grow Sales Among United States Health Enthusiasts

California prune growers have faced long-term price declines for their specialty crop. The most recent 3-year price average is approximately 20 percent lower than the prior 3 years (U.S. Department of Agriculture, National Agricultural Statistics Service). At 2019's price, growers lost $158 per ton, based on cost studies conducted by the University of California, Davis. Prices/returns increase when demand/sales can be built for high-value prune products; selling more California prunes into this channel is needed for grower viability. Opportunity exists to achieve this goal by targeting United States health enthusiasts (consumers who work out 2 times per week; audience of 138 million). Sunsweet Growers (SSG) will promote the functional and nutritional benefits of California prunes and prune juice (digestive and bone health) to this audience via a national public relations and media campaign to drive California prune product sales and shift more prunes to this high value use. This project will increase sales by $4.46 million (goal), boosting grower returns (outcome). As a grower-owned cooperative all Sunsweet Gowers, Inc. earnings flow directly to California growers. Sunsweet Growers Inc. will evaluate and measure success through syndicated IRI and internal sales data.

Pacific Coast Producers *$450,000*

Growing Demand for California Processing Peaches and Pears by Sharing Nutritional Value and Positive Attributes With Influencers and Dietitians

California is the leading producer of peaches and a top pear producer in the United States, growing nearly 100 percent of the processing varieties of these fruits, used for healthy shelf-stable fruit products. Since 2016, California grower crop prices for these fruits combined, dropped approximately 26 percent (U.S. Department of Agriculture, National Agricultural Statistics Service), in part from low fruit consumption in the United States – only 12 percent of adults eat the needed daily fruit (Center for Disease Control). California fruit growers need to build consumption and demand for viability. Opportunity exists given United States consumer trends toward plant-based meals and consumers buying more shelf-stable California fruit, due to COVID-19. To leverage, Pacific Coast Producers, representing 280 California peach and 25 California pear growers, will launch a marketing campaign sharing the value and benefits of California processing peaches and pears with influencers and dietitians to ultimately boost consumer demand for this fruit. The project goal and outcome are to achieve a one percent sales increase of California processing peaches and pears, measured by

Nielsen data. As a grower-owned cooperative all profits directly flow to California specialty crop growers.

California Fig Advisory Board *$450,000*

California Figs Fit in the Cart and in the Kit

To raise awareness and ultimately drive sales of California grown figs, the "California Figs Fit in the Cart and in the Kit" campaign will demonstrate how California figs meet the demands of consumers, and therefore, the needs of product developers in the fast-growing meal kit delivery segment. More than ever, consumers are looking for nutritious and delicious snacks and ingredients. California figs meet the demand and more. California figs are full of fiber, a critical nutrient most consumers are lacking in their diet, and they are an all-natural energy source containing potassium, calcium, iron, and more. California figs add natural sweetness and flavor without added sugar or salt. This is important when dietary guidance around the world suggests that consumption of both be reduced. A digital media campaign will deliver these key messages to consumers. At the same time, the California fig industry will target key influencers in the manufacturing industry to showcase figs as a clean, flavorful solution for meal kit development.

Santa Barbara Vintners *$362,575*

Santa Barbara County Wine Expansion in Southern California

United States sales of California wine are growing, yet California wine trends downward in state, with 4.3 million fewer bottles sold (-$52.4M). Californians buy wines from Washington (+9.6 percent), Oregon (+4 percent), Italy (+4.6 percent), France (+4.5 percent), and Chile (+13.5 percent). Santa Barbara County is negatively impacted by this trend due to its reliance on Southern California, with a -4.9 percent decline in direct sales since 2016 (Los Angeles Census; Shanken Impact Databank). Santa Barbara's grape growers and wineries, most family-owned and too small for a distributor's attention, are dependent on direct to consumer (DtC) sales for most of their sales (SVBank/Wine Business Monthly Insights, 2019). This project is the second of a powerful marketing campaign that extends the Los Angeles strategy south to Orange and San Diego counties to reach consumers, wine trade, and media. Using visitation data, sales records, and digital analytics, Santa Barbara County seeks to report increased DtC sales by 3.72 percent (based on 2019 Santa Barbara County DtC sales of: $116,302,200).

Paso Robles Wine Country Alliance *$300,038*

Paso Robles Wine Targets Mid-Markets

The wine market in the United States is extremely competitive, with strong wine sales from Europe, South America, and Australia, and the growing hard-seltzer category. Paso Robles, a known, yet still emerging wine region with proven quality, critical acclaim, and increased distribution, is poised to build and strengthen California grown

wine sales. By influencing the influencer in targeted mid-tier markets, Paso Robles can continue to build its reputation and grow its sales of wine. Influencers today include wine, travel, and lifestyle media, bloggers, retailers, and sommeliers; they all wield influence on buying habits. Arizona, Colorado, and Texas all offer strong opportunities for California's wine producers based on their size, consumption behavior, the concentration of the target audience, and current population growth. This multifaceted program will reach influencers within media, retail, restaurants, and social media. By educating consumers and wine enthusiasts about Paso Robles, California grown wine sales will increase.

Santa Lucia Highlands Wine Artisans *$298,900*

Pinot Noir Producers Market Showcase

Growers and producers of California pinot noir, including over 100 growers and wineries who produce grapes and wines from Santa Lucia Highlands in Monterey County, face three direct threats to their livelihood: decreased sampling and sales from closed tasting rooms and reduced restaurant wine sales due to the pandemic, declining grape prices and crop losses from 2020 wildfires, and a hot market for Oregon pinot noir. The Santa Lucia Highlands, one of the state's sought-after pinot noir growing regions, sells more than 50 percent of its pinot noir directly to consumers through tasting rooms and online, the most lucrative marketing channels. This project will increase direct sales and consumer demand of California grown pinot noir from Santa Lucia Highlands by 3 percent with 90 million targeted consumer impressions and tasting events in 4 direct-to-wine country flight markets: Los Angeles, San Diego, Denver, and Phoenix. Increased marketing will lift sales, bottle prices, and sagging grape prices for California Santa Lucia Highlands pinot noir.

California Blueberry Commission *$380,184*

California Grown Promotions in Southeast Asia Featuring California Blueberries

The California Blueberry Commission (CBC) will conduct a series of California Grown retail promotions in the Philippines, Vietnam, Singapore, and Malaysia featuring fresh California blueberries. As blueberry production in California continues to rise, it is imperative that the industry increase its export volumes. By organizing large-scale collaborative promotions directly with retail outlets in these Southeast Asian markets, the CBC will increase consumer demand, demonstrating the profitability of high-quality California blueberries. By leveraging the California Grown identity, the CBC will highlight the availability of California blueberries as the first fresh imported fruit of the summer season. Sales data will be collected and discussed with importers, who will be surveyed on their perception of California blueberries and interest in continuing to purchase volumes in future seasons.

EQUITY, OPPORTUNTIY, AND EDUCATION FOR ALL CALIFORNIA SPECIALTY CROP FARMERS

Organic Farming Research Foundation *$165,946*

Increasing Access to Soil Health Resources for Spanish Speaking Specialty Crop Farmers

The U.S. Census of Agriculture revealed a 13 percent increase in the number of producers whom identify as being of Hispanic, Latinx, or Spanish origin, even as the total number of farmers has decreased (2017). Resources for Spanish speaking farmers are critical to establishing a new, more diverse generation of farmers. Farmers in California have identified a need for Spanish language education and outreach programs on organic soil health practices. Organic Farming Research Foundation's2015 survey of organic farmers verified soil health as the top challenge facing California organic farmers; this challenge was partially addressed by introducing an online training program in English in 2020. Organic Farming Research Foundation, with its university and non-profit partners, will take the next step by translating and adapting this resource into Spanish to address the needs of the Hispanic farming community. Success of the project will be based on the number of course users.

American Farmland Trust *$271,036*

Supporting New Generation Socially Disadvantaged Specialty Crop Farmers through Access, Training, and Economic Research

Technical assistance and financial assistance service access gaps exist for Latino, Southeast Asian, women, and other socially disadvantaged specialty crop farmers so they can gain farm and business skills and adopt climate smart practices. American Farmland Trust , Asian Business Institute & Resource Center, and Cachuma Resource Conservation District will deliver case studies on economic benefits of adopting climate smart practices, packaged with targeted education through Learning Circles, Community Resource Fairs, tailgates, Business Development Trainings, and radio and television broadcasts, addressing demographic service gaps and improving farm viability through increased participation in services, climate smart agricultural practices, and sound business practices. Project partners will administer surveys to specialty crop producers six months after each Learning Circle, Fair, tailgate, and Business Development Training to measure project impacts.

California Land Stewardship Institute *$446,500*

Providing Sonoma Producers Needed Training on Sustainable Farming Practices to Mitigate Impacts of California Wildfires

Seven of California's ten most destructive fires occurred within the last five years; natural disasters are expected to worsen under changing climate conditions. Fires have greatly impacted California specialty crop farms, especially in Sonoma where fires have burned 182,049 acres since 2017. For those not directly impacted by flames, fire is still tragic with approximately 70 percent of Sonoma winegrape producers reporting 2020 wildfire losses. Education on and adoption of environmentally responsible farming practices can help producers adapt to climate change, mitigate wildfire losses, and realize other economic and environmental benefits. As such, California Land Stewardship Institute in partnership with Sonoma County Winegrowers, the California Department of Forestry and Fire Protection, and others, seek to provide 1,800 Sonoma specialty crop producers (mostly winegrape), as well as farmworkers, with needed training and education to drive adoption of responsible farming practices on 10,000 new acres and/or 120 farms by 2024. Project results will be evaluated and measured through surveys and number of certifications.

California State University, Fresno Foundation *$239,780*

Educational and Training Workshops for On-Farm Water and Energy Automation

Major specialty crops in the San Joaquin Valley (SJV), such as almonds, pistachios, and grapes, rely on groundwater pumping. However, groundwater levels in the SJV are declining due to over drafting, and new regulations for groundwater pumping are anticipated under the Sustainable Groundwater Management Act (SGMA) starting in 2020. Growers need monitoring and automation systems to simplify farming operations, reduce water and energy use, and improve production efficiency. This project will conduct 15 workshops for almond, pistachio, and grape growers to demonstrate water and power monitoring, demonstrate automation systems, and train end-users. Growers will benefit from new tools to assist in SGMA and Irrigated Lands Regulatory Program compliance, and with nitrogen management plans. The workshops will be conducted by the Center for Irrigation Technology (CIT) and the California State University, Fresno using CIT facilities and the University Agricultural Laboratory fields located at the California State University, Fresno.

Center for Land-Based Learning *$449,803*

A Multi-Year Approach to High-Skilled Job Training and Placement in California's Specialty Crop Industry

A U.S. Department of Agriculture-funded study by Purdue University (2020) predicts that agriculture will have 59,400 new skilled jobs to fill each year; yet, employer demand

for qualified college graduates will exceed the number of qualified graduates available. Since 1993, the Center for Land-Based Learning's Farming, Agriculture, and Resource Management for Sustainability (FARMS) Program has provided high school youth with opportunities to learn about the specialty crop Industry. In 2015, tier 2 (FARMS Advanced) and tier 3 (paid internships and job shadows) were added to the FARMS Program giving youth a chance to deepen their understanding of and experience in the field and allowing service to a broader age range (16-24 years). The current project is three-fold, 1) continue tiers 2 and 3 of the program, increasing paid internships and job shadows in tier 3 from 25 to 50 total statewide; 2) hire a full-time Alumni and Internship Coordinator to engage current and past program participants; and 3) evaluate the success of the last five years of each tier of the program.

Western Agricultural Processors Association *$106,534*

Workplace Safety for Postharvest Tree Nut Hulling and Processing

Hundreds of agricultural workers operate stockpile yard equipment at nut hulling and processing facilities without comprehensive safety training because equipment-specific training material is not available. Western Agricultural Processors Association will create safety training curriculum to address the unique equipment found at nut huller facilities and then provide bilingual training sessions to supervisors. The train-the-trainer style sessions will equip supervisors with the tools and materials to conduct safety training at their operation. This project will go beyond the training to evaluate what happens after the training is provided. Field observations and individual interviews will be conducted to analyze the level of training effectiveness. Results will be compiled and used to make changes in the following year's training.

The Regents of the University of California, Agriculture and Natural Resources *$449,991*

Sustainable Pest Management in Culturally Relevant Crops Grown by Small Scale, Diversified, and Socially Disadvantaged Farmers

Small-scale, socially disadvantaged farmers from Tulare to Santa Clara counties grow over 80 different types of culturally relevant vegetables in open field and protected agricultural systems. While the University of California, Integrated Pest Management (IPM) guidelines may exist for many individual pests, IPM guidelines for these pests and their management in small-acreage, culturally important crops and small-scale, diversified cropping systems are either currently unavailable or need expanded guidelines on organic approved methods. Cultural, biological, and mechanical pest control practices are alternative pest control options for these cropping systems, given the minimal availability of chemical control options and new opportunities to access markets for organic produce. This project will develop IPM guidelines for culturally relevant crops and provide agricultural education to socially disadvantaged farmers

using a whole-farm IPM approach through on-farm demonstrations and peer-to-peer training to assist farmers in adopting nonchemical methods of pest management.

Students for Eco-Education and Agriculture *$96,600*

Science, Technology, Engineering, and Mathematics (STEM) is Girls Representing and Entering Agriculture Today (GREAT) Initiative

The STEM GREAT initiative aims to provide opportunities for young women of color from underrepresented races (Black/African American, American Indian, Hispanic, and Asian ethnic groups) to engage in the areas of science, technology, engineering, and mathematics, as they relate to agriculture. Through a four-part seminar series, local high school students will gain a foundational knowledge in agronomy, twenty-first century technology, sustainable engineering solutions, and the economic and business-driven world of agriculture. Students will meet with local female professionals in the field, touring the varied operations of local specialty crop producers, while developing professional skills that they will carry with them as they work to become the next generation of agricultural professionals.

HEALTHY SPECIALTY CROPS FOR ALL CALIFORNIANS

Center for Ecoliteracy *$339,442*

Eating, Learning, Growing: A Culturally-Responsive Model for Transforming California Specialty Crop Education

Culture is powerful. Yet, there are few formalized efforts to reflect the culture and diversity of California students in Farm to School education. The "Eating, Learning, Growing" project advances a culturally-responsive strategy to increase student knowledge and consumption of California specialty crops, especially among the 4.8 million non-white students who are many consumers in California's $2.8 billion school food industry. This project, 1) develops and pilots a culturally-responsive educational framework for virtual workshops with 150 educators; 2) creates 28 vibrant school environments that celebrate healthy specialty crops; and 3) disseminates the framework, workshop recording, and a turnkey resource on transforming school environments to 12,078 adults. As a result, 19,631 middle school students may increase their awareness and knowledge of, and/or intention to eat more specialty crops. Success will be measured through student and educator surveys and digital analytics.

The Regents of the University of California, Davis *$312,415*

Promoting Pollinator Plant Awareness, Access, and Habitat Expansion to Benefit California’s Nursery Industry

Bee pollinators are essential to California's specialty crops, but bee health is declining from lack of adequate, healthy forage. In addition to creating on-farm habitat, a solution is using bee forage plants in developed landscapes. For this to be successful, the ornamental horticulture industry needs knowledge of best practices so they may use bee-compatible inputs to grow appropriate plants and educate consumers on their use. Project goals are to, 1) deliver educational programs on bee plants to the horticulture industry and consumers and 2) to deliver grower-useable systems to assess pollinator attractiveness as new plants enter the market. The project team expects that an informed horticulture industry will expand access to these plants to provide vital pollinator habitat in California. Project success will be measured by changes in plant awareness and access among stakeholders, increased pollinator habitat planted by consumers, and number of educational and consumer resources created.

KVIE Public Television *$449,770*

California's Specialty Crops Showcased in a Ten-Episode Series on Award-Winning Public Television Show "America's Heartland"

Many consumers are unaware of the abundant variety of California specialty crops. What do they look like? What do they taste like? How can they be incorporated into a healthy diet? KVIE Public Television will provide entertaining and educational specialty crop episodes through its nationally broadcast series America's Heartland. These episodes will showcase farmers' stories, specialty crop health benefits, and a regular cooking segment titled Farm to Fork featuring KVIE's own celebrity chef demonstrating innovative ways to incorporate specialty crops into daily life. The programs will air on 350 Public Broadcasting Service stations and the nationwide Rural Free Delivery Television cable/satellite channel influencing viewers to demand and consume more specialty crops. KVIE will capture program reach, viewership, and demographics, and will also conduct a survey to quantify consumers' awareness of specialty crops and their plans to incorporate them into their diets after viewing the segments.

Ceres Community Project *$176,250*

Getting Youth Excited About Vegetables: Paid Internship and Community Nutrition Education for Low-Income and Underserved Youth

Ceres Community Project will launch a new paid internship program for youth offering experiential learning in an urban farm and commercial kitchen, as well as training on how to educate other youth in the community on cooking and nutrition with California specialty crops. This project builds on nine years of a successful youth volunteer program. Interns will be recruited from underserved and low-income communities in Sonoma County through partnerships with other organizations and schools with a high percentage of reduced-cost lunch participants. By providing a paid work experience, the program will be more accessible for youth who need to work to support themselves and their families. After completing a summer training curriculum, interns will then lead classes for 3,000 additional youth on cooking and nutrition with California specialty crops at community locations such as libraries and schools. Interns will also learn and teach about how to find California specialty crops locally.

The Regents of the University of California, Davis *$427,565*

Effects of Processing on the Nutritional, Functional, and Sensory Properties of Almond Milk and Fouling of Industrial Equipment

Almond milk consumption has increased as an alternative to dairy milk. However, its low nutrient density and use of emulsifiers in the milk have cast a negative light on almond milk. The project goal is to develop an extraction process to produce a more functional, nutrient-dense, and well-accepted almond milk and to identify heating strategies to

reduce the fouling of industrial equipment; an economic problem faced by almond processors. Project success will be measured by chemical and sensory characterization of the milk produced (protein content, solubility, digestibility, sensory perception, and consumer's acceptance) to establish the best practices to produce a more nutritional milk and, by the willingness of almond processors, to adopt the new methods developed. Higher acceptance of almond milk by consumers searching for higher nutritional quality, especially the ones suffering from digestive/allergic problems, and longer processing times without equipment cleaning, are expected.

San Francisco Unified School District *$397,991*

Student Nutrition Advocate Crew: Youth-Led Community Education to Celebrate the California Harvest

San Francisco Unified School District's project will empower Student Nutrition Advocates (SNAs) to increase knowledge and consumption of California Specialty crops in their communities through peer education. SNAs at eight low-income schools will receive training in, 1) personal resource management and specialty crop acquisition through Farmers' Market visits; 2) specialty crop production in school gardens; and 3) incorporating specialty crops into a healthy diet through cooking activities. SNAs will use their training and peer influence to create virtual and in-person specialty crop curricula to reach students and families through specialty crop celebrations, Family Nutrition Nights, health education lessons, and a student champion poster campaign. A total of 6,750 students, 145 family members, and 40 staff members reached at the eight schools will complete pre- and post-surveys to measure increased knowledge of and increased intention to eat more California specialty crops, with students also reporting on consumption.

Sierra Harvest *$409,960*

Growing Farms and Minds: Nutrition Education, Farm Direct Purchasing, and Hands on Learning for California Kids

Sierra Harvest (SH) transforms lives and strengthens communities through fresh, local, seasonal food. This project would enhance the competitiveness of California specialty crops by advancing Sierra Harvest's existing Farm to School (FTS) program which serves 97 percent of kindergarten through eighth grade students in Western Nevada County. FTS currently offers tastings of specialty crops through Harvest of the Month education, field trips to farms, cooking classes and nutrition education using specialty crops to improve access to fruits and vegetables at school. Building on the success of the existing FTS program, this project will allow growth in three ways 1) by reaching the underserved eastern portion of Nevada County; 2) an expansion of proven programs like "Tasting Week Chefs" that spotlights available specialty crops and farmers, and 3) including new program elements such as school garden education and procurement for

school meals to increase the impact on California's specialty crop industry.

The Regents of the University of California, Davis *$216,399*

Increasing Access and Consumption of Specialty Crops through Improved Science-Based Preservation and Preservation

This project will enhance access and consumption of locally grown specialty crops by promoting safe food preparation and preservation knowledge. The project team will utilize locations in Mariposa, Merced, and Tuolumne Counties to educate communities and outreach to surrounding counties. Leveraging the Master Food Preserver model, this project will extend science-based preparation, storage and preservation practices, building a network of volunteer educators to help disseminate innovative research, recipes and safe preparation and preservation methods to promote awareness and consumption of specialty crops. With input from the University of California small farm advisor, and collaboration with local food distribution programs and small-scale producers, the project team will introduce new specialty crops, demonstrate proper preservation techniques, and distribute educational materials to underserved populations. A specialty crop website will be created to upload demonstration videos and recipes and share local distributor information to increase access.

Common Vision *$450,000*

Transforming School Gardens into Specialty Crop Farms

This project seeks to grow specialty crops in 4 target school districts at 12 Title 1 elementary schools by integrating agricultural and garden education with nutrition, cooking demonstrations, and access to specialty crop fruits and vegetables for children, their families, and communities. School gardens, which have suffered from closures during the pandemic— are being reframed as outdoor classrooms and productive, urban specialty crop farms to address learning, food insecurity, health disparities, access, and equity. This project will elevate the knowledge and use of culturally relevant specialty crops in the daily lives and diets of underserved and historically disadvantaged neighborhoods. Classes, workdays, festivals, and promotions will create new links between the school farms and families, neighbors, businesses, food entrepreneurs, and local growers cultivating resilient communities and benefitting the specialty crop industry.

Life Lab Science Program *$448,924*

Increasing Specialty Crop Awareness and Consumption among Pajaro Valley School Children

This project will increase specialty crop awareness and consumption among Pajaro Valley students through district-wide farm-to-school procurement improvements, in addition to garden, nutrition, and cooking programs at a school site with special new

instructional kitchen and garden classroom. Students will understand where specific California fruits and vegetables come from and will demonstrate high willingness to try diverse California specialty crops and enjoyment of them, building healthful eating habits to last a lifetime. Over 18,000 students will be directly impacted by districtwide gains and 600-plus students will benefit from programs at the new integrated programs site. Pajaro Valley Unified School District and Life Lab's six-year partnership has held a demonstrative success. As a result, the California Department of Food and Agriculture Farm to School Program Lead called Life Lab and Eat REAL's partnership in Mount Diablo Unified School District the best integrated Farm-to-School program out of 175 seen partnerships in 2019-202

Fresno Unified School District *$132,389*

Fresno Unified Specialty Crop Farmers Market Project

Through educational experiences this project will, 1) increase the healthy eating habits of the targeted population, emphasizing locally sourced specialty crops; 2) increase awareness, access, and consumption of the regions specialty crops; 3) increase marketing events, partnering with local specialty crop growers prioritizing minority farmers; 4) develop menu items utilizing locally sourced specialty crops for the district's cafeterias and 5) secure procurement contracts with local specialty crop growers to meet the growing district needs.

ENVIRONMENTAL STEWARDSHIP AND CONSERVATION

The Regents of the University of California, Davis *$322,949*

Developing High-Throughput Genetic Screening Tools for Drought Tolerance in Grape Rootstocks

This project will generate new breeding tools and irrigation management strategies to increase water-use efficiency and mitigate the impacts of climate change on grape growers. Improving rootstock drought tolerance is a key strategy to reduce irrigation use and adapt to climate change but breeding efforts have been limited by a lack of high-throughput screening tools. The project will genotype and phenotype root drought tolerance traits across a population generated from a drought tolerant/sensitive rootstock cross (110R/101-14) to identify new genetic markers for rootstock drought tolerance. The project will also use root traits to define rootstock-specific soil moisture thresholds for irrigation and work with growers to evaluate whether incorporating these guidelines and automated soil-moisture sensing into irrigation management increases the water- and cost-savings from drought tolerant rootstocks. These innovations are crucial for grape growers to mitigate climate change and increase sustainability.

The Regents of the University of California, Davis *$313,085*

Life Cycle Assessment of Environmental Impacts and Tradeoffs for Certified Organic Practices in Key Specialty Crops

This project builds on prior work supporting development of a scalable, process-based, agronomically responsive cropping system life cycle assessment (SPARCS-LCA) model, able to produce a comprehensive life cycle impact assessment (LCIA) and analyze environmental tradeoffs for specific management practices, crops, and regions. Here, the SPARCS-LCIA model will be used to assess key specialty crops prioritized by the University of California Organic Agriculture Institute to determine tradeoffs associated with organic practices in these crops, and to quantify environmental impacts and benefits and define them with respect to a "sustainability continuum." This project will benefit specialty crop growers by informing their decisions on adoption of management practices for positive environmental impact, and by informing policy and commodity board priorities to incentivize such practices. Outreach success will be quantified via event attendance records and before-and-after knowledge surveys.

U.S. Department of Agriculture, Agricultural Research Service *$264,841*

Multi-Generational Adaptation of Blue Orchard Bees (Osmia Lignaria) in Response to Climate Change in Orchard Crops

Blue orchard bees (BOBs) are increasingly being used to pollinate California fruit and nut crops but they are often, annually trapped in the wildlands of Utah, Washington, and California rather than propagated where they are used as pollinators. This makes it critical to understand the adaptability of populations to new and warming environments because BOBs are currently moved to areas with temperatures warmer than within natal ranges. Local climate adaptation may be seen in future generations when the bees remain in crops locally. Compared to first generation bees whose parents were newly imported, second and third generations may have higher survival and developmental phenology that better aligns with the timing of crop bloom. However, the potential negative impact of warming temperatures on local and transported BOB populations could be decreased bee fitness and pollination efficacy. The main objective of this project is to determine if BOBs from different regions adapt to new warming conditions after multiple generations.

The Regents of the University of California, Davis *$449,132*

Co-Managing Deficit Irrigation-Disease Interactions to Optimize Water Conservation and Productivity in Processing Tomatoes

Irrigation management is pivotal to the environmental and economic sustainability of the California processing tomato. As water scarcity increases under climate change and cyclical droughts, deficit irrigation (DI) is a common strategy to conserve water. Recent studies indicate an interplay between DI and decreased yields due to late season biotic and abiotic diseases. As specific disease risks remain ambiguous, growers have no tools to mitigate impacts, putting DI fields at risk of severe losses. To reduce disease risks and enable water savings, this project proposes to, 1) define DI interactions with biotic and abiotic diseases; 2) define economic thresholds over which disease-driven losses exceed water cost savings, 3) adapt information systems, and 4) adapt genetic-based strategies for disease-irrigation co-management. Adoption will be enabled through outreach. Success will be evaluated based on workshop, field day, and meeting attendance; website access; download metrics; and tool adoption data.

California State University, Monterey Bay *$445,929*

Evapotranspiration Monitoring of Three Major Salinas Valley Specialty Crops

The project broadly addresses sustainability indicators identified by the State of California in response to declining groundwater levels and degraded water quality. Ground-based and satellite-based (OpenET) measurements of water consumptive use

will be made in Central Coast lettuce, broccoli, and winegrape fields. The field trials will characterize OpenET accuracy for those three crops and demonstrate the potential for applied water savings by linkage with evapotranspiration-based recommendations of the CropManage specialty crop decision-support application. Project benefits include improved definition of relationships between applied water and consumptive use, development of linked technologies for evaluation of crop water requirement and nitrogen discharge, and facilitated grower compliance with legislative provisions of the Irrigated Lands Regulatory Program Ag Order 4.0 and the Sustainable Groundwater Management Act.

The Regents of the University of California, Davis *$187,465*

Long Term Saline Irrigation Strategies for Pistachios on Integerrima Rootstock

The April 22, 2019 California Water Research Report noted 51 percent of Merced, 36 percent of Fresno, 89 percent of Tulare, 66 percent of Kings, and 55 percent of Kern counties' soils are moderately (four deciSiemens per meter [dS/m]) to extremely (16 dS/m) saline. Of California's 371,386 bearing pistachio acres, 312,901 are in these counties and 150,000 are on the salt sensitive *Pistacia integerrima*, (PGI) rootstock. Good quality water for winter leaching, if the water table is low enough, is decreasing. The goal of this cooperative project is to determine if long-term, salt damaged 'Kerman' pistachios on PGI rootstock and a 6 to 10-foot water table can be reclaimed and managed with the addition of in-season leaching with saline and good quality water. The outcome will be a new method of salinity management and an extension education program on salinity management. Success will be evaluated by how well in-season leaching reclaims salt damaged trees and maintains pistachio production, and by the number of growers reporting new knowledge adoption.

California State Polytechnic University, Pomona *$396,434*

Breeding Lettuce to Improve Nitrogen and Water Use Efficiency by Enhancing Root Biomass

Lettuce growers are faced with producing their crop with less water and nitrogen (N) fertilizer. The project team previously developed advanced lettuce breeding lines whose N uptake and assimilation (NUA) is 22 percent higher than commercial cultivars, but discovered these lines have low root biomass. In this project, three new recombinant inbred lines segregating for root biomass and NUA will be screened to identify genetic lines that combine NUA and root biomass, and to quantify root biomass, leaf biomass, and NUA. Carbon and N isotope discrimination will be used to determine water use efficiency and N metabolism, respectively. Each population will be subjected to genotyping by sequencing and loci associated with these traits will be mapped. Markers for breeders will be developed and breeding lines will be released. Outreach to growers

and industry will include presentations at grower's and breeder's meetings and through reports sent directly to the industry and made available on a website.

The Regents of the University of California, Imperial County Cooperative Extension *$431,736*

Improving Avocado Resource-Use Efficiency Through Updated Crop Water Use Information and Irrigation Management Strategies

Avocado is primarily grown in Southern and Central California. These regions face uncertain water supplies, mandatory reductions of water use, and the rising cost of water, while efficient use of irrigation water is one of the highest conservation priorities. Data on water use by avocado orchards and optimal irrigation strategies is limited, and the lack of information hinders the achievement of efficient water and fertilizer management. This project intends to acquire relevant information on crop water consumption and crop coefficients, optimal irrigation water management, and to assist growers in employing adaptive tools that support profitable and sustainable avocado production. A combination of field experiments, case studies, and a robust outreach program will be used to develop and disseminate information and tools to growers and stakeholders. Project success will be quantified as the number of deliveries and growers who gained knowledge and/or adopted the tools and practice.

The Regents of the University of California, Agricultural Research and Extension Center *$444,283*

Management Strategies for Mitigating Water Infiltration Problems in Almond and Pistachio Orchards in the Central Valley

Almond and pistachio are major crops in the Central Valley of California and mostly irrigated by drip irrigation. While water infiltration problems in the Valley are typically associated with flood irrigated orchards, an increasing number of growers with drip irrigation are having difficulties filling the soil profile during the summer months to meet the crop water demand due to water infiltration problems and standing water. Low water permeability is typically associated with certain soil textures but could also be exacerbated by soil compaction and soil crusting. This project will work with commercial almond and pistachio growers in the Valley and conduct an applied research program to develop and test management strategies to improve water infiltration rates and alleviate the rootzone saturation problems that increase root diseases such as Phytophthora. The project will develop educational materials and conduct traditional cooperative extension activities such as field days and workshops.

California State Polytechnic University, San Luis Obispo *$449,985*

Can Biodegradable Plastic Mulch Increase Long-Term Soil Carbon Storage: Integrating Soil Responses With Grower Values

California strawberry production and floriculture relies heavily on plastic films to increase crop health and yield. However, agricultural plastic mulches also cause deleterious effects on soil and aquatic systems through their breakdown and mismanagement. While biodegradable plastic mulches (BPM) may be more sustainable, a paucity of knowledge about the impacts of BPM on soils is a barrier to adoption by farmers. In addition, negative plasticulture externalities are also poorly quantified. Thus, this project will study the utility and consequences of BPM as an alternative technology in California plasticulture systems by investigating, 1) basal plastic pollution levels in agricultural soils and its consequences; 2) the effects of BPM versus conventional plastic on soil health; and 3) the perceptions of these technologies among key stakeholders in strawberry and floriculture production. This research will be used to inform grower decision-making in choosing to adopt BPM as an alternative technology.

The Regents of the University of California, Davis *$344,977*

Investigation of the Risk of Smoke Exposure: Volatile Phenol Absorption and Translocation

The California wine industry is worth $43.6 billion with 635,000 acres of winegrapes and 5,900 growers. An economic analysis estimated a $3.7 billion loss in wholesale revenue due to 2020 wildfires. Experts agree wildfires will occur with greater frequency and intensity, posing risks for all winegrape growing regions in California. Exposure to smoke compromises the quality and value of winegrapes and adversely affects grapevines. During wildfires, a substantial amount of volatile phenols (VPs) are released into the air from burning wood. These compounds are absorbed through the berry skin and can result in tainted wine. Successful vineyard mitigation strategies to prevent smoke exposure impact do not exist and the understanding of VP absorption rates and translocation within grapevines is limited. These insights will aid development of mitigation strategies in the vineyard. Acquired information will add to a grape wildfire response guideline that will be shared through an extension network.

The Regents of the University of California, Davis *$449,718*

Nitrogen Management Guidelines for Olive Growers to Improve Soil Health and Sustain Production

The rapid expansion of newly developed high- or super-high-density (SHD) olive orchards in California, critical nitrogen (N) inputs required for olive production, and renewed interest in soil health are leading to a rising demand for developing best management practices for N use in olives. The goal of this project is to assess N

recommendations and improve N management guidelines for California olive growers to manage SHD orchards. This will be done by providing information on how soil health parameters, crop N uptake, yield, and fruit quality respond to the use of different N rates and organic amendments in olive orchards. This project will, 1) determine N uptake dynamics of trees under different N fertilization rates and organic amendments to estimate N use efficiency; 2) evaluate olive production and quality; 3) investigate soil carbon sequestration potential and greenhouse gas emissions; and 4) refine N recommendations and improve N management guidelines. Extension and education activities will inform stakeholders.

The Regents of the University of California, Fresno County Cooperative Extension *$450,000*

Addressing Groundwater Challenges for Small-Scale Diversified Vegetable Farms in the San Joaquin Valley

This project will train small-scale, socially disadvantaged farmers on improved irrigation practices for diversified vegetable farms. It will also evaluate groundwater monitoring and the potential for groundwater recharge on these farms. A group of 57 farmers have implemented drip irrigation, moisture sensors, variable frequency drives, and pump repairs, presenting an opportunity to optimize their systems and demonstrate best practices to similar farmers to reduce groundwater and energy use. Water and energy use data from these farms will be analyzed to determine tailored recommendations for irrigation scheduling and evaluate groundwater monitoring methods for small-scale, diversified farms. On-farm trials of cover crop used to mitigate environmental impacts during flooding will evaluate the potential for managed aquifer recharge on small-scale, diversified vegetable farms with winter fallow periods. These efforts will contribute to reducing groundwater use and increasing groundwater supplies.

PLANT HEALTH AND PEST MANAGEMENT

The Regents of the University of California, Riverside *$396,821*

Walking the Pipe: Reducing Use of Irrigation Pipes as Super-Highways by Argentine Ant in Citrus Orchards

In citrus, Argentine ant (AA) is a significant pest because it harvests honeydew from sap sucking pests (SSPs) and protects them from natural enemies. AA use irrigation pipes to move rapidly from subterranean nests to trees infested with SSPs. Pipes are smooth which enhances AA mobility. Surfaces with uneven topography slow AA. Small trials suggest that organic mulch laid over pipes may reduce ants ascending trees to tend SSPs. Another approach is to change the surface topography of pipes. Disruptive topography designed using AA body dimensions has been demonstrated to impede movement. 3D-printed pipes with disruptive topography can be field-tested for impacts on ant movement to trees. Ultra-low dose (ng) residues of insecticide kill AA colonies through physical transfer to nest mates. Applications to small sections (< 1m) of pipe need evaluation. This project will demonstrate that mulches, disruptive pipe topography, and insecticide barriers reduce pipe use and suppress AA in activity citrus.

California Department of Food and Agriculture *$89,552*

Enhancing Diagnostics of Regulated Plant Parasitic Nematodes in Specialty Crops

This project aims at developing and applying Recombinase Polymerase Amplification (RPA) technology as a novel molecular tool for diagnostics of regulated plant parasitic nematodes (*Ditylenchus dipsaci*, *Aphelenchoides fragariae*, *Rotylenchulus reniformis*, and *Radopholus similis*) in California. The RPA technique has some clear advantages over polymerase chain reaction, 1) does not require any Deoxyribonucleic acid (DNA) purification steps; 2) do not require thermal cycling; and 3) amplification products may be detected at end-point or in real-time during 15-30 minutes.

The field application of RPA methods will be also validated with plant and soil samples infected by target nematodes. Molecular diagnostic protocols will be available to U.S. Department of Agriculture, state, and private laboratories. The method will represent substantial improvements regarding time and costs over existing diagnostics based on a PCR approach. The tools developed will enhance significant accuracy and early detection of regulatory nematodes in specialty crops of California.

California Department of Food and Agriculture *$408,536*

Integrated Pest Management of Diamondback Moth on Cole Crops

Diamondback moth (DBM) is an invasive insect pest in California. In the last two decades, DBM has generated significant crop losses and remains an economic threat to

California's $1.3 billion cole crop industry which includes broccoli, cauliflower, cabbage, Brussels sprouts, and various other specialty crops. Annual economic losses of up to $6 million have been attributed to DBM in California. Current DBM pest control challenges stem from the development of suspected insecticide resistance, lack of pest monitoring, and the absence of co-evolved natural enemies that can significantly suppress DBM populations. This comprehensive project aims to strengthen California's DBM integrated pest management program by validating the utility of seasonal DBM monitoring, clarifying DBM insecticide resistance issues, and developing a classical biological control strategy for natural, long-term DBM control.

The Regents of the University of California, Davis *$351,342*

Recycled Olive Waste as a New Tool to Control Nematodes and Weeds in Perennial Crops

Olive pomace, comprised of olive meat, seed, and skin, has unique natural antimicrobial properties, which distinguish it from other agricultural byproducts. Preliminary data indicate that pomace can safely decrease pest nematodes and prevent weed germination. Biosolarization, a process which combines solar heating and microbial activity, likely intensifies these effects, creating fermentation products which act as natural fumigants. This project will characterize the pest control potential of olive pomace. Objectives are to, 1) determine which rates of pomace best suppress nematodes and weeds; 2) determine pomace's mode of action with and without biosolarization; 3) validate biosolarization with pomace as a pre-plant disinfestation method; 4) characterize the efficacy of pomace applied as a post-plant strategy; 5) perform a techno-economic analysis of feasibility; and 6) extend results through field days, online publications, presentations and outreach to stakeholders.

The Regents of the University of California, Davis *$350,420*

Investigate and Improve Detection Methods for Spotted Wing Drosophila Pyrethroid Resistance in California

The introduction of spotted wing drosophila (SWD) has confounded insect management in California berry and cherry crops. Growers who relied on integrated pest management prior to SWD invasion must now apply insecticides specifically for SWD to avoid crop loss. Although growers strive to practice resistance management, the lack of alternative control strategies, low damage tolerance in high value crops, and fast generation time of SWD suggests resistance development is inevitable. The project team has found SWD populations with tolerance to various insecticide chemistries in California berry crops. This project will investigate pyrethroid resistance mechanisms in SWD populations by combining insecticide bioassays and high throughput DNA and RNA sequencing. Identification of genetic mechanisms underlying resistance will enable development of diagnostic assays to enable early detection and efficient screening of resistant SWD, optimize spray programs, and minimize economic loss.

California Department of Food and Agriculture *$363,580*

Classical Biological Control of Brown Marmorated Stink Bug Using Trissolcus Japonicus, the Samurai Wasp

This project will provide sustainable, cost-effective management of the Brown Marmorated Stink Bug (BMSB), an invasive agricultural pest in California and many other states. BMSB is highly polyphagous and is presently established in at least 16 counties, including several in the San Joaquin Valley. The primary goal of this project is to establish populations of the samurai wasp (*Trissolcus japonicus*) in California's key agricultural production areas at risk of economic harm by BMSB. The Samurai wasp co-evolved with BMSB in Asia and is the most important host-specific natural enemy of this pest in that part of the world. Samurai wasp was found in 2018 in an urban center of southern California, having naturally found its own way there. The California Department of Food and Agriculture's Biological Control Program will purposefully rear and redistribute this parasitoid to agricultural regions in critical need of BMSB control. Self-sustaining populations of samurai wasp are expected to spread naturally, reducing BMSB populations.

U.S. Department of Agriculture, Agricultural Research Service *$444,551*

A Metagenomics Marker System for Identification of All Fusarium Oxysporum Taxa in Field Soils

Fusarium oxysporum (*F. oxysporum*) is a widespread soil fungus that includes saprophytes as well as host-specific vascular wilt pathogens capable of infecting scores of specialty crops. One of the biggest challenges of working with this taxon is the lack of molecular tools for accurate identification and diagnostics. Techniques for positive or negative identification of some specific pathogens have been developed, but the ability to assess all strains present in an ecosystem or field, including saprophytes, have not. The project objective is to further develop a metagenomics marker system that enables identification of all strains of *F. oxysporum* present in a sample by amplification of specific regions of the genome and sequencing by Illumina. This work is made possible by the assembly of a large and expanding database of *F. oxysporum* pathogens and saprophytes. The ability to do this will provide growers with information on risk of disease and impact of management practices on populations of all *F. oxysporum* pathogens in the field.

The Regents of the University of California, Riverside *$432,806*

Managing Citrus Huanglongbing Disease Using a Model-Driven Approach

The goal of this project is to develop strategies to manage citrus Huanglongbing (HLB). HLB has recently caused annual losses of over $1 billion and 7,900 jobs in Florida. As

HLB spreads in the United States, similar losses are expected in California unless new and more effective management strategies are developed. This project will use a model-driven approach to analyze Survivor Trees in Florida, which are trees with a very slow rate of decline even though they are in orchards where most of the trees exhibit the normal rapid HLB decline. After 4.5 years, the project team has identified trees that have only declined by 0.5 in a 0 – 5 disease rating system. The expected outcomes are the identification of molecules and molecular targets in citrus Survivor Trees that will be used to create effective new strategies to manage HLB. Success will be evaluated by determining whether the team successfully identified molecules and targets that are differentially abundant or expressed in Survivor and Non-Survivor Trees.

The Regents of the University of California, Riverside *$426,987*

Dissecting Genetic Control of Tolerance/Resistance to Huanglongbing in Citrus Using the Host Transcriptional Response

The most immediate threat to California citrus is the bacterial disease Huanglongbing (HLB). Commercial citrus in California has been protected from disease through a combination of measures including monitoring of both the insect vector and host and management in cases where HLB infection is detected. These strategies have safeguarded commercial orchards from HLB for nearly a decade, but the continued success of citrus in the state depends on stable, long-term solutions including the development of HLB-resistant cultivars. Despite intensive efforts there are still major gaps in the understanding of the genetic control of resistance to HLB. This project proposes to survey the genome-wide response to HLB infection across a genetically diverse collection of citrus. Gene expression is highly amenable to genetic mapping compared to complex traits like the disease status of mature trees alleviating some challenges that have delayed progress in understanding the genetic basis of tolerance and resistance.

U.S. Department of Agriculture, Agricultural Research Service *$368,999*

Development, Validation and Application of Fungicide Resistance Monitoring Tools for Botrytis Spp. of Specialty Crops

Botrytis is one of the most important fungal diseases of specialty crops. Over the past decade, numerous studies have shown fungicide resistance levels continue to rise. Despite rotating products, few synthetic fungicides remain that can control *Botrytis* effectively. This proposal builds off previous *Botrytis* projects to develop molecular markers for detecting fungicide resistance. Markers have been developed for FRAC groups 17 and 11 but there is considerable variation in genetic loci for FRAC 7, 9, and 2. This proposal focuses on validation and deployment of previously developed molecular markers using field samples, designing new markers for FRAC 7, 9, and 2, and testing efficacy of new FRAC 7 products for cross resistance to older FRAC 7

products (e.g. fluopyram and boscalid). Furthermore, the project team will identify the genetic basis and molecular targets for FRAC 12 resistance, the last major effective synthetic compound for reliable *Botrytis* disease control.

The Regents of the University of California, Davis *$443,605*

An Integrated Approach to Combatting Tomato-Spotted-Wilt Virus in Pepper

Processed peppers drove a $1.4 billion salsa industry and a $1.6 billion hot sauce market in the United States in 2019. California produces over one third of peppers in the United States. Tomato-Spotted-Wilt Virus (TSWV) consistently produces economic losses for farmers. The project team recently verified three new resistance-breaking strains (RB-TSWV) in California, threatening the industry. The project proposes an integrated approach that combines rapid assays to detect and monitor RB-TSWV and resistant, locally adapted breeding germplasm and breeding tools. Outcomes are monitoring of disease for farmers to make decisions on control and variety selection, tools, and germplasm for efficient breeding of resistance into pepper. Success will be monitored by assessing sensitivity and use of assays by growers, California's extension, adoption of DNA markers and germplasm directly as varieties and licenses to industry for production of hybrids peppers. Long-term outcome will be reduction of economic losses, yield, and quality due to TSWV in pepper and related species.

Technology Evolving Solutions *$399,933*

12 Citrus Leaves Are Not Enough

Citrus laboratories in California test thousands of 12 leaf samples per tree every year, yet HLB infected trees still go undetected. Twelve leaf sampling was developed because hand sample processing was the only viable process. The Citrus Clonal Protection Program and Technology Evolving Solutions have developed a new leaf tissue extractor instrument to replace hand leaf chopping in citrus diagnostics. The machine shreds petioles and the tissues are made ready for downstream nucleic acid extraction and pathogen detection. The goal of this project will be to develop new protocols for larger sample sizes and evolve the shredding machine to accommodate those sizes. If the project team can double the sample size, at the current California low infection rates, the probability of finding HLB will almost be doubled. The most cost-effective sample size must be determined. Then validation of the instrument and protocol will look at sensitivity, specificity, reproducibility, and determine the cost per leaf tested.

The Regents of the University of California, Riverside *$234,534*

Towards the Enhancement of PCR Detection of Pathogens in Specialty Crops

Early detection is critical to controlling and managing pathogens in agriculture. This project aims to extend to specialty crop pathogens our discovery that a simple additive to established protocols for viroid detection in citrus plants improves their detection limits by tenfold. The project will focus on the detection of pathogens, such as the grapevine red blotch associated virus (GRBaV), Erwinia amylovora, the causative agent of fire blight in apples and pears, and Candidatus Liberibacter asiaticus (CLas), the agent associated to the current Huanglongbing (HLB) citrus crisis. As the additive affects the central step of RNA and DNA detection, fundamental to many established detection protocols, the project team also aims to develop a reliable protocol that allows specialty crops diagnostic laboratories to enhance their own detection protocols. To establish the reliability of this protocol, the team has enlisted the help of the Foundation Plant Services, University of California, Davis and the Citrus Clonal Protection Program, University of California, Riverside.

The Regents of the University of California, Riverside *$421,985*

Enhanced Production of Disease-Free Citrus Varieties Using Sustainable Next Generation Indoor Farming Systems

The Citrus Clonal Protection Program (CCPP), a National Clean Plant Network center, ensures that citrus propagative materials are disease-free and available for citrus productions in California. This project will lead to an operational modular plant growth unit (MPGU)-freight container tailored to citrus. The goal of this project is to adopt, adapt, and validate the MPGU to increase CCPP's plant production capacity (a minimum 8,700 containerized trees will be needed in the next three years) and optimize disease symptom expression for citrus diagnostics (research on graft-transmissible diseases bioindexing). Project success will be determined by, 1) increased volume of citrus plants for CCPP disease testing, therapy, and budwood sources and materials for Huanglongbing research; 2) reduce the production of disease-free citrus varieties by 18 months; and 3) creation of automated and sustainable citrus nursery technologies with less plant space, energy, greenhouse gas emissions, fertilizer, and water.

FOOD SAFETY

The Center for Produce Safety *$346,909*

Microbial Characterization of Irrigation Waters Using Rapid, Inexpensive, and Portable Next Generation Sequencing Technologies

New microbial detection approaches utilizing whole genome sequencing are being increasingly applied for tracing microbial contaminants entering the food chain. The produce industry can directly benefit from powerful new methods such as shotgun metagenomics, which allows for the rapid identification of all the bacterial, viral, fungal, and protozoan pathogens in irrigation water, soil, or food samples in a single test. Furthermore, whole genome sequencing technologies are quickly becoming less expensive, and compact sequencing technologies like the Oxford Nanopore MinION device could potentially allow testing directly on-site in produce fields or other processing facilities for food safety surveillance programs. However, the application of these new whole genome sequencing technologies and approaches need to be verified and validated for use by the produce industry. The goal of this project is to investigate two technologies that offer slightly different approaches for pathogen detection, to identify the benefits and limitations of each, verify the results, and validate their applications by the produce industry for use in rapid pathogen detection in agricultural waters. The results of this study will provide recommendations, protocols, and guidelines to the produce industry regarding the proper implementation of these technologies for pathogen surveillance.

The Center for Produce Safety *$389,722*

Towards a Holistic Assessment of the Food-Safety Risks Imposed by Wild Birds

Birds introduce complex food-safety risks, as they carry multiple pathogens, are difficult to exclude from farms, and regularly defecate on crops. Yet very few wild bird species have been studied, and those that have form a minority of farm bird communities. Moreover, existing studies stop at examining pathogen prevalence in birds and do not holistically assess food-safety risk. For a species to pose a significant risk, it must carry pathogens, visit fields, defecate on crops, and produce feces that support pathogen survival. The project team proposes to first identify species that carry pathogenic *Escherichia coli* (*E. coli*), *Salmonella*, and *Campylobacter* by coupling existing studies with assays of field-collected feces. Second, the team will survey birds and collect feces on 15-20 farms near rangeland, natural habitats, or produce farms to determine which species enter farms and defecate on crops and in which contexts. Third, the team will compare *E. coli* survival between feces placed on different substrates (crops, organic and conventional soils, plastic mulch) and between feces from different species. Finally, the team will compile holistic risk assessments for over 50 species into a photographic

guide to help growers identify and manage birds. Ultimately, the team hopes to help growers implement practices that bolster beneficial species without compromising food safety.

The Center for Produce Safety *$347,733*

Quantifying Risk Associated with Changes in EHEC Physiology During Post-Harvest Pre-Processing Stages of Leafy Green Production

The goal of this project is to determine if the time between harvest and end use of romaine lettuce impacts *Escherichia coli* (*E. coli*) O157:H7 pathogenicity and detectability resulting in increased health risk. Laboratory scale experiments with inoculated lettuce undergoing simulated harvest and cooling will be used to measure changes in *E. coli* O157:H7 stress tolerance and virulence. Input from industry partners including temperature data from commercial romaine harvesting and cooling, and details on supply chain logistics, will be combined with the laboratory scale experimental data and used to model risk associated with specific harvest and handling practices. The resulting quantitative tool will be publicly available and allow for growers and producers to determine any practices that should be implemented to reduce the potential for O157 transmission on romaine lettuce.

The Center for Produce Safety *$420,109*

Assessing Romaine Lettuce "Forward Processing" for Potential Impacts on EHEC Growth, Antimicrobial Susceptibility, and Infectivity

Consumption of romaine lettuce has been linked to multiple foodborne illness outbreaks due to contamination of pathogenic *Escherichia coli* (*E. coli*) strains. Recently, these outbreaks have occurred in the United States every year since 2016, causing great damage to consumer health and economic wellbeing of the fresh produce industry. The pathogen strains isolated from these outbreaks showed great similarity by genomic analyses. These outbreaks showed a pattern of heavy concentration especially in northeastern United States, prompting questions from the leafy green industry that the practice of "forward processing" could be linked to the outbreaks. "Forward processing" is a practice that the raw lettuce commodity is transported in trucks to facilities far away from the production area for washing and packaging, and regional marketing. The project team proposes to work closely with the leafy green industry to comprehensively assess the forward processing for its effects on the integrity and safety of the raw commodity and the packaged products. In addition, the forward processing conditions will be simulated in the laboratory with the pathogenic *E. coli* strains. Emphases will be on how these conditions would affect the physiology of the pathogenic strains as well as other microorganisms on the raw commodity and packaged products. The findings in the research could provide important information that can be used by the leafy green

industry for improving the forward processing practice and reducing the risks of fresh produce such as romaine lettuce.

The Center for Produce Safety *$222,152*

Cross-Contamination Risks in Dry Environments

Cross-contamination of fresh produce is a significant risk factor that can contaminate multiple batches of fresh produce and can result in a food safety outbreak. With extensive research, the project team has developed understanding of the risk factors that promote cross-contamination of fresh produce during wet handling and processing as well as developed tools and technologies to reduce these risk factors. However, there is a lack of knowledge of the risk factors for cross-contamination of fresh produce in a dry environment as well as technologies and tools to reduce these risks. This proposed research plan is aimed at, 1) addressing key gaps in knowledge for managing cross-contamination risks including identification of surface and surface conditions that promote transfer of microbes from a contaminated surface to fresh produce; 2) developing a quantitative risk model to evaluate cross-contamination risks for diverse food contact surfaces; and 3) development and validation of novel sanitation technology using food grade light activated antimicrobials. Thus, this comprehensive research approach addresses gaps in knowledge and develop tools and technologies to reduce food safety risks. In addition, development of a novel sanitation technology will address key gaps in sanitation of dry environments for both organic compliant and conventional fresh produce industries.

The Center for Produce Safety *$410,446*

Assessing the Potential for Production Practices to Impact Dry Bulb Onion Safety

The Center for Produce Safety will partner with Oregon Sate University to determine contamination risks in dry bulb onion production practices. In 2020, the dry bulb onion industry faced their first significant outbreak of foodborne illness when red onions grown in California were epidemiologically linked to more than 1,000 cases of salmonellosis. This project will design and conduct four field trials, with red, white, and yellow onions as the test crops to determine the risks of using contaminated water or other agricultural input when applying crop protection sprays (pesticides and/or clay) and during overhead irrigation. . The primary goal is to collect evidence demonstrating risks of these practices and to communicate project findings to relevant stakeholders to reduce the potential for outbreak like this from recurring in the future. Findings will be shared via a broad outreach strategy that communicates with industry throughout the two-year study. Results also will be summarized in project reports, presented at the annual CPS Research Symposium, and published in peer-reviewed journals. Outreach activities culminate with the development and delivery of a workshop and best practices guide

that enables growers to better understand risks and implement changes to minimize the likelihood of crop contamination.

The Center for Produce Safety *$169,925*

Cyclospora cayaetanensis Monitoring in Agricultural Water

The parasite *Cyclospora cayetanensis* produces illness in people consuming infected produce. Because this pathogen has very low concentrations on actual produce, making it close to impossible to detect, and for prevention reasons, it is more effective to check for its presence in irrigation water, from where it is typically transferred on produce. However, even in water, this parasite is very difficult to detect. It only can be detected by lengthy molecular laboratory procedures such as polymerase chain reaction. One major problem for scientists to develop better and faster detection methods is the fact that there is no antibody or other recognition molecule that would be able to bind to the surface of this intact parasite. This project proposes to design and synthesize, for the first time, aptamers, molecules that will be able to bind to intact *Cyclospora cayetanensis* oocysts, and use them to design simple paper based colorimetric tests that can detect it in the field without the need of sample preparation or specialized laboratories. The paper-based test will turn from pink to purple to indicate the water sample being tested is positive for this parasite, making this a very simple and easy to use detection method for *Cyclospora cayetanensis*.

The Center for Produce Safety *$418,848*

Practical Application of Superheated Steam to Harvesting, Processing, and Produce Packing Tools and Equipment

Pathogens can contaminate environmental surfaces in produce handling operations. The industry uses sanitation programs to clean these surfaces and prevent product contamination. Highly effective sanitation procedures reduce the likelihood that pathogens will cross-contaminate products. In facilities that do not use water in their sanitation programs, tools like brushes and rags are used to clean. No-rinse sanitizers are sometimes used as well, but they cannot be used in organic operations. Superheated steam is a novel surface sanitizer that can kill pathogens on environmental surfaces. It is sometimes referred to as “dry steam” because it does not leave moisture or condensation on surfaces, making it a viable option for dry produce facilities. This project is designed to evaluate superheated steam use under industry relevant conditions. The project team will not only determine how well it works, but will assess other key performance indicators including cost, range of appropriate applications, and the effect of extended use on equipment wear-and-tear and change to ambient relative humidity. This project will provide industry with the tools to comprehensively assess tradeoffs in superheated steam implementation. These resources will help improve the design of sanitation programs and enhance control over pathogen cross-contamination.