

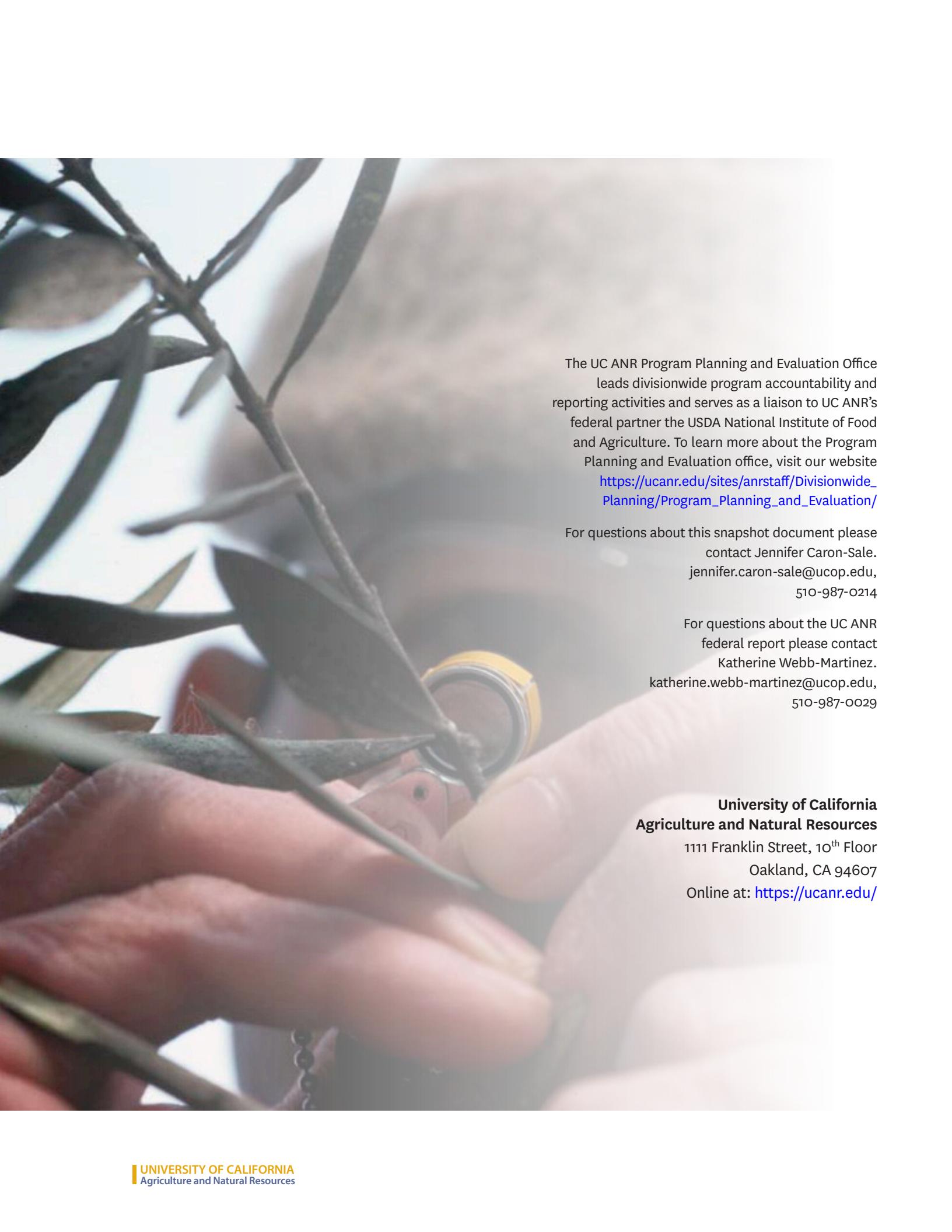
University of California

# Snapshot of 2017 UC ANR Activity and Outcomes

## Highlights from the Federal Report



UNIVERSITY OF CALIFORNIA  
Agriculture and Natural Resources



The UC ANR Program Planning and Evaluation Office leads divisionwide program accountability and reporting activities and serves as a liaison to UC ANR's federal partner the USDA National Institute of Food and Agriculture. To learn more about the Program Planning and Evaluation office, visit our website

[https://ucanr.edu/sites/anrstaff/Divisionwide\\_Planning/Program\\_Planning\\_and\\_Evaluation/](https://ucanr.edu/sites/anrstaff/Divisionwide_Planning/Program_Planning_and_Evaluation/)

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# Snapshot of 2017 UC ANR Activity and Outcomes

The information in this snapshot is from the 2017 federal annual report, which is required by our federal partner the National Institute of Food and Agriculture (NIFA). Most of the program information comes from the University of California Agriculture and Natural Resources (UC ANR) reporting system for Cooperative Extension academics (DANRIS-X) and the federal reporting system (REEpport) required for Agricultural Experiment Station faculty. In 2017, 1,970 research and extension projects were conducted by investigators at UC Berkeley, UC Davis, and UC Riverside, and by Cooperative Extension (CE) advisors and specialists. The activities and results highlighted in this summary represent a snapshot of the UC ANR activities reported to NIFA for 2017.

In 2017, there were more than 580 Agriculture Experiment Station faculty, 170 CE advisors, and 115 CE specialists, including 22 new advisor and specialist hires. UC ANR

received nearly \$8.5 million in Smith-Lever federal funds for extension and nearly \$6 million in Hatch federal funds for research in 2017.

Activities and accomplishments are organized by the following five strategic initiatives: Endemic and Invasive Pests and Diseases; Healthy Families and Communities; Sustainable Food Systems; Sustainable Natural Ecosystems; and Water Quantity, Quality, and Security. UC ANR is also encouraged by NIFA to provide a summary of activities related to Sustainable Energy each year. Although it is not a Strategic Initiative for UC ANR, an overview of Sustainable Energy projects is also included in this summary. This page summarizes activity across all initiatives. The following pages provide highlights of each category from the federal report to demonstrate the breadth of impact that occurred in 2017. Most UC ANR work is highly collaborative, but due to limited space, selected examples include one contact. This document is not exhaustive, and readers can view the entire federal report at [https://ucanr.edu/sites/anrstaff/Divisionwide\\_Planning](https://ucanr.edu/sites/anrstaff/Divisionwide_Planning).

## 2017 Highlighted Outputs & Activity

**>1,700**  
publications

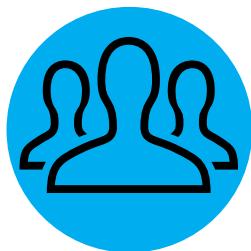


**RESEARCH**

**22**  
novel ideas led to  
patent applications



**3,100**  
courses, workshops and  
field days were held



**985,000**  
adult and youth direct  
contacts/educational  
exchanges



**EXTENSION**

# Endemic and Invasive Pests and Diseases

## 2017 Highlighted Activity & Outcomes

The Endemic and Invasive Pests and Diseases

(EIPD) Strategic Initiative provides a framework to coordinate and engage the resources of UC ANR to meet significant pest challenges. The EIPD Strategic Initiative works to keep our food, communities, and natural ecosystems healthy by educating California communities and stakeholders about new and emerging threats to healthy food systems. The initiative works in the following key areas: exclusion of pests and pathogens, emerging problems with pests and diseases, and integrated management.

### Quarantine effective at preventing spread of insect pest

The Glassy-winged sharpshooter (*Homalodisca vitripennis*) feeds on plants and can spread the disease-causing bac-terium (*Xylella fastidiosa*) to a variety of commercially sold plants. One lab has focused efforts on refining the existing standardized quarantine treatment protocols for shipping nursery material throughout the state so that all stages of the glassy-wing sharpshooters are eliminated from nursery stock. Currently, almost all of Southern California commercial nurseries that export product to the north are participating in this program. Since inception in 2010, long-term surveys show that the quarantine treatment program has been 100% effective in preventing the commercial spread of this insect. ([Richard Redak](#))

### Dust boxes prevent infestations of mites on poultry farms

In the first survey of its kind in North America, backyard chickens were found to have a higher diversity of ecto-parasites than commercial caged hens. If commercial operations move from cage systems to free range, there may also be an increase in ectoparasite diversity in those systems. Research showed that providing dust boxes with diatomaceous earth or hanging sulfur dust bags in cages can prevent economically damaging infestations of mites, including those resistant to permethrin, in poultry houses. ([Bradley Mullens](#))



### Parasitoids released for biological control of Asian Citrus Psyllid

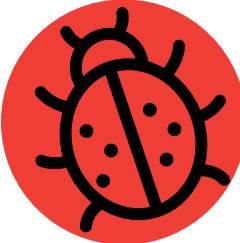
Asian citrus psyllid (ACP) populations are being detected with increasing frequency in the Central Valley. Release of the parasitoid wasp, *Tamarixia radiata*, have commenced in an effort to slow ACP population build up and spread. In Asia, *T. radiata* have been an effective parasitoid, with adults laying eggs in the host, and the larva eventually killing the host. More than 2.75 million parasitoids have been released at about 1,500 different sites in southern California, with about 98% establishment at monitored sites. The ongoing impacts that this parasitoid is having on ACP populations are being monitored at about 15 sites in southern California and these long term phenology studies are nearing completion. The developmental biology of *T. radiata* is also being assessed in areas of California where it is expected to establish. ([Mark Hoddle](#))

### Pheromone-baited traps reduce damage to tomatoes

The Conspurce stink bug has reached damaging levels in California's processing tomatoes. Tomatoes that are damaged either completely decay, which reduces yields, or the damage is recorded as rot at the grading station. UCCE conducted research with pheromone baited traps and insecticides applications. Results and updates were shared through outreach events. Pest Control Advisors and pest management consultants have adopted the use of pheromone-baited traps for early detection. Crop losses were minimal in 2016 and 2017 where these traps are being used and where the consultants are careful about sanitation. In contrast, where traps are not being used, and even in places where the stink bugs are generally less aggressive, this pest continues to be an economic issue. ([Tom Turini](#))

**711**

gained knowledge of detection and prevention strategies to manage invasive species



**852**

adopted recommended pest management strategies

#### **Endemic and Invasive Pests and Diseases (continued)**

##### **Best management practice in sulfur use improves air quality**

UCCE educational programs extended best management practices for sulfur use to tomato growers to reduce powdery mildew. In particular, they recommended the application of sulfur by ground equipment instead of by airplane or helicopter. UCCE's work helped increase the adoption of best management practices for sulfur use contributing to improved air quality. ([Brenna Aegerter](#))

##### **Changes to seed certification laws for rice**

In 2016 infestations of red rice, or weedy rice, which can reduce yield and quality of commercial varieties, were estimated at over 10,000 acres in California's rice producing counties. UCCE conducted research and reached over 1,600 rice growers and Pest Control Advisors. They in turn implemented best management practices, reported infestations, and submitted weed seed samples. Results informed changes to the California state seed certification laws and led to a new Quality Assurance program to certify rice seed. Both actions will prevent the spread of new infestations of weedy rice. ([Whitney Brim-Deforest](#) and [Luis Espino](#))

##### **CE advisors participate in bed bug workshops**

CE advisors were active in a national series of workshops for Integrated Pest Management about important pests in structures such as bed bugs, ants, and cockroaches, providing training for housing managers, maintenance supervisors, and social workers. ([Siavash Taravati](#))

#### **New strategies to protect oaks from SOD**

Management of sudden oak death (SOD) in California was improved by identifying minimum distances for removal of bay laurel to protect oaks. Bay laurels in particular help Phytophthora ramorum, the plant pathogen known to cause SOD, infect other trees. Helpfully, the disease can only move up to 200 yards. Research shows that drought may seriously affect and shrink populations of the SOD pathogen, but removal of these "refuge" trees may be very beneficial as it will lower the extent of the next outbreak when rains return. ([Matteo Garbelotto](#))

#### **Mating disruption as an alternative to pesticides**

CE Advisor entomologists used more than 1,500 acres of research and demonstration plots to show that mating disruption is an effective part of integrated pest management programs for navel orangeworm in the more than 1.8 million acres of California nut crops. ([David Haviland](#), [Jhalendra Rijal](#), [Emily Symmes](#), [Kris Tollerup](#))

#### **Research to manage new disease in olive**

A new disease of olive, *Neofabraea* leaf and fruit spot, branch canker, and twig lesion was identified. The disease causes severe defoliation and fruit loss mainly in the 'Arbosana' olive oil cultivar. The emergence of this new disease in California olives has been a major concern to olive farmers and represents a serious threat to the industry. A key finding was that the disease was shown to be highly correlated with mechanical harvest, where wounds produced by harvesters serve as the main infection sites for the pathogens. Research results comparing fungicides and spray programs showed that several products were effective in reducing infection by the pathogens and limiting disease incidence. ([Florent Trouillas](#))

#### **Coastal growers see economic gains from implementing new practices**

UCCE conducted a broad range of education activities about how to manage pests, diseases, water and nutrients in coastal strawberry and vegetable crops. One grower implemented recommended pest and weed management practices and reported a 25% increase in yields on over 500 acres. Two other growers managing over 3,000 acres reported economic increases based on adoption of recommended irrigation and nutrient management practices, from \$800-1,000 increases per acre. ([Surendra Dara](#))

# Healthy Families And Communities

## 2017 Highlighted Activity & Outcomes

The Healthy Families and Communities Strategic Initiative is dedicated to the key areas of: promoting healthy behaviors for childhood obesity prevention; encouraging and enhancing youth science literacy; promoting positive youth development; and community development.

### Interdisciplinary approach to reduce prevalence of childhood obesity

A five-year study expanded the implementation and measured the effectiveness of the Shaping Healthy Choices Program (SHCP), an integrated, school-based program to promote student health and prevent obesity. The study provided research needed to document student outcomes and school-site changes. The results have provided an evidence base for state- and nationwide dissemination of a tested, multi-component, interdisciplinary approach that will help reduce the high prevalence of childhood obesity. For example, SHCP has been included in the California Department of Public Health portfolio which serves as a guide for local health department implementing agencies. ([Sheri Zindenberg-Cherr](#))

### Nutrition program for migrant farm families

Butte County's two nutrition programs, EFNEP and UC CalFresh, partnered to deliver eight weeks of programming to mothers and children in a 100-unit migrant farm housing facility. After the program, participants reported eating more fruits and vegetables and increasing their level of physical activity. Other noted changes included decreased consumption of sugar-sweetened beverages and increased checking of nutrition labels on prepackaged foods. ([Jona Pressman](#))



### New methods to process food and retain health benefits

Research is being conducted on the impact that contemporary agronomic and post-harvest processing techniques have on food quality and chemical safety. The project has provided new methods for identifying the composition of a wide array of bioactive compounds that significantly contribute to the nutritional quality of foods. Results include new strategies and processing innovations for retaining and optimizing levels of health beneficial compounds in finished food products as well as decreasing the formulation of toxic or undesirable compounds in processed foods. Optimizing the quality of fresh and processed foods is key to ensuring the health of Californians. ([Alison Mitchell](#))

### Positive changes in youth culinary program participants

Contra Costa County's Children, Youth, and Families at Risk program recruited teens to participate in a semester-long culinary program to develop leadership, public speaking, and culinary skills while gaining nutrition knowledge and an appreciation for healthy food. The teens reported positive changes in their eating habits, their school attendance, and performance. They also shared how the program kept them out of trouble. ([Marisa Neelon](#))

### Money Savvy Youth teaches financial literacy

With the goal of increasing middle school youth financial literacy, UCCE Alameda 4-H, in collaboration with the East Bay Asian Local Development Center (EBALDC), developed, implemented, and evaluated a financial literacy curriculum called Money Savvy Youth. In pre- and post-tests, 4th and 5th grade participants scored five times higher than youth who did not. EBALDC will continue to use this research-based curriculum to reach limited-income youth. ([Charles Go](#))



**94%**

of 4-H youth gained skills through community service that will help them in the future

**5,490**

adults adopted recommended dietary practices

**3,753**  
adults adopted safe food handling techniques

**>253,500**

nutrition education classes conducted through EFNEP and UC CalFresh

**>26,000**

Master Gardener, Master Food Preserver, 4-H, EFNEP and UC CalFresh volunteers, equivalent to over 800 full-time employees.



## Healthy Families and Communities (continued)

### Teens trained to provide nutrition education

UC CalFresh, the Sierra Foothill 4-H Food Smart Families Program, and the UC Davis Center for Nutrition in Schools partnered to implement ten lessons from the Shaping Healthy Choice Program through an after-school program. Local teens were recruited and trained through youth-adult partnerships to implement the ten lessons. The teen instructors learned how to work together in the classroom and received training that focused on curricula delivery, inquiry-based teaching methods, and classroom management techniques. After participating in ten lessons, 91% of students reported that they learned how to make healthy food choices, 87% of students indicated that they eat more fruits and vegetables, and 66% of students reported that they eat less junk food. ([Chelsey Slattery](#))

### Sonoma and Marin Counties 4-H increase reach to Latino population

4-H programs must become culturally responsive and tailored to the needs and experiences of Latino youth. Sonoma County is experiencing a demographic shift where the Latino population has increased by over 300% in the past 20 years. Sonoma 4-H increased its reach with Latino audiences over 90%. Evaluation results demonstrated that children felt a sense of belonging and reported high levels on indicators of positive youth development (including competence, confidence, connections, empathy, character, and contribution). Similarly, Marin 4-H increased equity and access to programs that improve youth confidence in STEM. In total, through new programming, Marin 4-H reached 1,395 youth, 97% of which identify as Latino, in 15 schools and programs. Program components included professional development for 48 staff and curriculum for 64 activities for eight grade levels (1-8). Participating students showed increased confidence in their scientific ability. 4-H has helped Latino youth become more confident in their science and engineering abilities

and helped youth to see themselves as the scientists and engineers of the future. (Sonoma: [Diego Mariscal](#); Marin: [Steven Worker](#))

### Turning crop waste into shelf-stable food

UC ANR collaborated with the UC Davis Innovation Institute for Food and Health to test the process of gleaning crop waste, preserving it, and then distributing it through the local food bank in consumer-friendly packaging. As a result of this project, local, primarily Latina women contributed to the project by sharing preferences through a survey and submitting recipes. Finalists participated in a cooking competition to choose the winning recipes. This project increased the quality and acceptability of shelf-stable food products available through the Yolo Food Bank. ([Marcel Horowitz](#))

### TechXcite curriculum engages students in science and engineering

4-H in Monterey, San Benito, and Santa Cruz Counties use the TechXcite curriculum to engage students in science, technology, engineering and math (STEM) fields and careers through substantive and applicable hands-on lessons. The program is a collaboration with the National 4-H Council and the Pratt School of Engineering at Duke University. 4-H provided professional development workshops, curriculum supplies, and technical support to deliver the curriculum modules in 4-H Community Club and afterschool programs. The engineering curriculum included activities with prosthetic arms, infrared remote controls, solar-powered cars, harvesting rainwater, and imaging of biological systems. The results indicated that the modules are applicable to real-world situations (96%) and provided real-world examples and uses of technology (85%). Most instructors agreed that after participating in TechXcite students showed improved attitudes toward science and engineering and increased initiative to explore science and engineering topics. ([Lynn Schmitt-McQuitty](#))



## Sustainable Food Systems

### 2017 Highlighted Activity & Outcomes

The Sustainable Food Systems Strategic Initiative supports California by focusing our work on our total food and intensive agriculture systems; bringing good science and outreach to bear on key areas related to: sustainable production; safe processing and enhanced access. Advancing this work requires new scientific and technological innovations across both agriculture and nutrition.

#### Assistance for drought-stricken Hmong farmers

Research was conducted with Southeast Asian smallholder farmers in Fresno County to determine the challenges Hmong farmers face in accessing drought relief programs. Interviews identified that Hmong refugee, smallholder farmers are disproportionately negatively affected by the drought relative to their more capitalized, land-owning neighbors. They also have very little awareness of drought relief programs for which they are eligible. In response, CE assisted several Hmong farmers in accessing the California Department of Food and Agriculture's State Water Efficiency and Enhancement Program. ([Ruth Dahlquist-Willard](#))

#### Increased food security for Klamath Basin Tribes

A five- year Klamath Basin Tribal Food Security Project focused on community-driven outreach to improve tribal health and food security among the Karuk, Yurok, and Klamath Tribes. Fifteen tribal staff were trained to provide hands-on educational opportunities to manage, gather, grow, prepare, and preserve local and traditional food. Nearly 7,000 people participated in the activities. In a Basin-wide evaluation, 77% of respondents said they had learned something new; 67% had tried out new skills at home; 64% felt the community is more food secure; and 77% indicated the programs have changed the communi-

ty in other positive ways. All three tribes have leveraged project successes, securing nearly \$2M for ongoing and expanded youth and community programming, and over \$1.4M for ecological research. ([Jennifer Sowerwine](#))

#### Wheat improved through breeding

The wheat breeding and genetics project continues to develop and evaluate common and durum wheat lines through regional variety trials for agronomic traits, quality characteristics, and disease resistance. Breeder seed of the new hard white spring wheat UC1743 (Patwin 515-HP) was delivered to the Foundation Seed Program at UC Davis to produce Foundation seed in 2016. This improved version of Patwin 515 includes high-grain protein content and partial resistance genes against stripe rust. ([Jorge Dubcovsky](#))

#### Almond regulations to reduce pesticide exposure

Replanted almond orchards are treated with pre-plant soil fumigants to control soil borne pests. A collaborative project with USDA and UCCE conducted research, outreach, and education, showing how utilizing totally impermeable film (TIF) is effective in reducing fumigant emissions and reducing the amount of fumigant applied. The TIF research was utilized by the California Department of Pesticide Regulation to develop buffer zone regulations, which will reduce pesticide emissions nearby public schools and daycare facilities. The regulations can help improve public health statewide by limiting human exposure to pesticides. ([David Doll](#))

#### Coffee production increases in California

UCCE conducted a multi-year, on-farm, research and development program with the goal of producing a profitable, high-quality, specialty coffee. Additionally, different marketing options such as farmers' markets, farm tours, and internet sales were explored. As a result of these



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### Sustainable Food Systems (continued)

efforts, planted areas have increased between 2010 and 2017, with approximately 30,000 coffee trees now established on 24 farm sites from Morro Bay to San Diego, with production concentrated in Santa Barbara, Ventura, and San Diego counties. ([Mark Gaskell](#))

### Improved regulations in aquaculture industry

Commercial freshwater and marine aquaculture in California is a diverse industry producing dozens of species of finfish and shellfish. Program outreach in production technology and animal welfare has delivered information that has increased the skills of aquaculture company personnel in aquatic animal production technology, facility site selection, production system design, system management, species biology, disease, toxicology, animal welfare, and permits and regulations. Work in shellfish sanitation has assisted state agencies in California and nationally to reassess how they monitor and assess sanitation conditions in shellfish growing areas to better regulate and safeguard public health. ([Fred Conte](#))

### New assessment practices for hen housing systems

To improve understanding of on-farm animal welfare assessment for laying hens, researchers collected data on hen health, physical condition, and behavior from a commercial egg farm in the Midwest. This farm housed hens in conventional cages, enriched cages, and a cage-free systems. The performance-based European Union Welfare Quality Assessment (WQA) tool was used for the physical evaluation. The data revealed new information about hen housing system differences in the incidence and severity of different welfare problems. These results are now being used by a variety of food system stakeholders to make egg

supply, purchasing, and auditing decisions related to hen housing systems. ([Joy Mench](#))

### Precision irrigation technologies in specialty crops

A series of projects on precision irrigation technologies using wireless sensor networks for almond and grape production have had positive economic and environmental impacts. In particular, a continuous leaf monitoring system to monitor plant water status has been successfully developed, tested and patented. This system has been licensed for commercialization by UC Davis. The extensive field testing has shown that the system has the potential to save up to 30% water in almond production and even more in grape production with respect to Evaporation Transpiration (ET) based irrigation without any significant loss in yield. Tests are also being conducted in walnut and pistachio crops. ([Shrinivasa Upadhyaya](#))

### Almond orchard management techniques

Research on management techniques for almond orchards leads to a variety of benefits. During tree growth deficit irrigation, efficient nitrogen fertilization and selective pruning techniques in densely planted orchards have shown improvements in canopy management. Additionally, deficit irrigation management may make the orchards less susceptible to insect and/or fungal pests. Employing these techniques would provide direct benefits to growers by decreasing costs of production and reducing potential for worker and environmental pesticide exposure while producing products with lower pesticide residues for consumers. ([Bruce Lampinen](#))

810

small farmers and ranchers gained knowledge of business management practices and marketing strategies



1,086

farm and ranch owners and managers and allied industry professionals gained knowledge of cultural practices for crop management



# Sustainable Natural Ecosystems

## 2017 Highlighted Activity & Outcomes

The Sustainable Natural Ecosystems (SNE) strategic initiative works to preserve forests, rangelands, and wetlands. SNE research and extension efforts aim to identify and prioritize issues and solutions affecting these regions. The initiative works in the key areas of: healthy rangelands, forests and working landscapes; fighting fire, resilient forests, and fire-safe urban areas; healthy landscapes and urban forests; and enhancing our water supply.

### Better understanding of drought response for range plants

A five-year and continuing study is focused on determining how range plant species, their density, and range management practices influence multiple ecosystem services. Ecosystem services are the benefits that society receives and include plant production, erosion control, soil fertility, water quality, water storage, invasion control, and soil carbon storage. Results showed that in relatively wetter areas (coastal hills and riparian), the drought continues to enhance perennial grasses. However, in the drier areas (Central Valley and lower foothills) previously robust stands of perennial grasses are decreasing in cover. It also appears that the forb seedbank, containing flowering plants other than grasses, is critical for resilient vegetation cover and production during drought, and that the recovery of grass production may be delayed once the drought is over. It may take a couple growing seasons to reestablish grass seed density. These discoveries provide valuable considerations for rangeland owners and managers for responding to climate change. ([Valerie Eviner](#))

### Increasing survival and growth rates for desert tortoises

Desert tortoises have low survival as juveniles, are long lived and slow growing, and can take 15-20 years to reach sexual maturity and begin reproducing. Methods that increase survival and growth rates of juveniles may enhance opportunities to recover declining populations and mitigate potential declines of tortoises from development. One project aimed to determine and compare survival rates for desert tortoises in the Mojave National Preserve. Head-starting juvenile desert tortoises in semi-natural outdoor enclosures with added water from sprinklers and protection from predators greatly increased their growth and survival, relative to free-ranging tortoises that were released and monitored in the field. ([Brian Todd](#))



### Mobile app for wild pig damage

In managed rangelands and agricultural areas, wild pigs (*Sus scrofa*) are a significant pest species. Capturing the geographical extent of wild pig damage will allow land managers to more effectively mitigate damage by allowing identification of specific areas that are conducive to wild pigs. It could also allow for a clearer delineation of economic losses. Researchers created a mobile app to assist land managers by assessing the type, nature, and extent of damage occurring on their property. Long-term data collection from the mobile app could influence policy decision-makers given the new ability to report impacts on a county, regional, state, or national level. ([John Harper](#))

### Role of oaks and bats in vineyards

A collaborative study including scientists from UC, the US Forest Service's Pacific Southwest Research Station is examining the habitat value to insectivorous bats of remnant valley oak trees within vineyards. Bat echolocation-call recorders and insect traps were set up at fourteen cooperating vineyards in San Luis Obispo County to assess insect and bat abundance. This research found that valley oak trees bring insect-eating bats into vineyards; this has the potential to help growers manage pests and thus reduce the use of chemical pesticides. ([Bill Tietje](#))

### Wildfire impacts on molecular nitrogen

Forest fires are increasing in frequency and intensity in the western United States. One study evaluated the effects of wildfire on the molecular transformation of nitrogen by wildfires. These increases could affect water quality by potentially altering the chemistry and quantity of dissolved nitrogen and dissolved organic matter causing adverse effects on both aquatic ecosystems and human health. Results indicated that potential pollutants are highly dependent on wildfire temperature and oxygen availability; however, elevated pollutant loads were especially



### Sustainable Natural Ecosystems (continued)

pronounced in the first year following wildfire. Research results are being used by downstream water managers to address reservoir eutrophication potential. As wildfires are expected to become more frequent and intensive due to climate change, understanding wildfire impacts on water quality is important to guiding watershed management and post-fire remediation actions. ([Randy Dahlgren](#))

### Effects of climate change on invasive grass

Researchers studied the interaction of climate change and local-scale patterning on an invasive rangeland grass barb goatgrass (*Aegilops triuncialis*) by manipulating rainfall, seed density, and local-scale seeding pattern on the northern California Coast Range. Seeding pattern was either evenly distributed or aggregated. Demographic and environmental data were collected for three years following initial establishment. Results showed that pattern and scale figure prominently in the demographic response of barb goatgrass to climate change. Aggregated planting led to a multi-year increase in per-plant seed output,

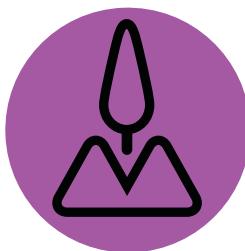
especially in the final and driest of the three study years. Pattern also interacts with rainfall and seeding density in its influence on per-plant seed output. This data will be helpful for range managers to address this invasive grass. ([Kevin Rice](#))

### Using forest biomass to produce electricity

Research has been done on the potential benefits of using forest biomass to produce electricity as an alternative method from using pile burning to reduce residual biomass fuel hazards in forests. This method produced both energy and emission benefits. The energy (diesel fuel) expended for processing and transport was equivalent to only 2.5% of the energy content of the biomass fuel. Based on measurements from a large pile burn, air emissions reduction was 98% to 99% for CO, non-methane organic compounds, CH<sub>4</sub>, black carbon, and 20% for NO<sub>x</sub> and CO<sub>2</sub>-equivalent greenhouse gasses. ([Bruce Hartsough](#))

### California Naturalist Program receives award

In 2017, the California Naturalist Program was awarded the Outstanding Team Award from the Alliance of Natural Resource Outreach and Service Programs. This recognition was partially a result of the integrated and collaborative program delivery approach that had positive impacts at multiple levels from partner organizations, to course instructors, and to the trained naturalists and the people they reached. Within five years, the program established partnership agreements with 40 organizations including park associations, museums, university research stations, land trusts, community colleges, conservation corps programs, and others. The program currently has over 65 active instructors trained in the delivery of the California Naturalist course which has been taught over 130 times in different locations around the state including eight of the state's ten bioregions. As of the end of 2017, over 2,300 participants have been trained through the program, and have recorded over 99,000 hours of volunteer service with an estimated value of \$2.7 million for the state of California. ([Sabrina Drill](#))



**476**

land managers  
gained knowledge  
of techniques for  
sustainable use of  
natural resources

**270**

land managers  
gained knowledge  
on how to manage  
their property with  
prescribed fire



**366**

land managers  
gained knowledge  
of recommended  
techniques for  
rangeland monitoring,  
management, grazing  
and browsing



# Water Quality, Quantity, and Security

## 2017 Highlighted Activity & Outcomes

The Water Quality, Quantity, and Security Strategic Initiative has three goals: 1) to increase system understanding and characterization of water quality and quantity conditions; 2) to develop and implement management practices to achieve water quality and quantity objectives, and 3) to facilitate integrative research and extension program delivery.

### Strategies to address salinity and boron in crops

Salinity and boron continue to affect crop production in California. Salinity and sodicity affect crops in the San Joaquin Valley, coastal valleys, and the Imperial and Coachella Valleys. Research in this area has been ongoing and relayed to irrigation managers, consultants, and growers through materials and meetings. They are learning the importance of well water quality assessment, being able to interpret water quality reports, test their soils and crops for salinity and boron related problems, and leach soils during the winter months when evapotranspiration is low. While crops suffered from salinity and boron related problems in the drought, the adopted irrigation strategies helped minimize crop damage. ([Steve Grattan](#))

### Using wastewater in vineyards

Results from assessments on the potential impacts of reuse of winery wastewater on vineyards and wine production and quality show that properly managed use of winery wastewater does not impact production or quality. The use of this water can reduce vineyard water demand and lessen offsite impacts from winery waste. The next steps of this research could include evaluating the efficacy of cleansers and sanitizers used in the wine industry as well as green alternatives. Determining optimal cleanser and sanitizer combinations could lead to 'cleaner' wastewater

and water savings as well as helping wineries maintain wine quality in their facilities with proper cleaning and sanitization. ([Anita Oberholster](#))

### Using biochar to improve water flow and plant growth in harsh soils

Through a grant from the California Department of Water Resources, experiments have begun at farms in the low desert, Central Valley, and Coastal regions to measure the impact of biochar and compost on soil water content, crop growth and yield, and soil microbial populations. Additionally, novel biochars were tested for their ability to establish plants in harsher environments, such as road medians; results showed improvements in establishment. There have also been positive effects on soil water flow with high rates of biochar in heavy clay soils and on crop growth in sandy soils. Combinations of biochar and compost were used to improve water flow in a well-studied heavy clay soil and to ameliorate potential salt and other toxicity. Wheat yield increased greatly with high application rates of biochar. ([Milton McGiffen](#))

### Aerial and remote sensing to improve water efficiency

Microirrigation technologies can help maximize potential water savings and crop yields. Management of the technologies is critical to reach these goals. Research is being performed on canopy cover sensing to help determine orchard water use and water needs. This work involves in-field data collection as well as aerial and space remote sensing. The research to date has led to increased yields and thus increases in water use efficiency. ([Daniele Zaccaria](#))

### Policy to manage pollution and ensure safe drinking water

Regulatory instruments and policy options were evaluated to better understand how to manage nitrate pollution in our groundwater systems. Further efforts were made to outline potential funding mechanisms to fund the provision of safe drinking water in Tulare Lake and Salinas

## Water Quality, Quantity and Security (continued)

Basins communities, which have been affected by nitrate pollution. ([Katrina Jessoe](#))

### Breeding drought tolerant field crops

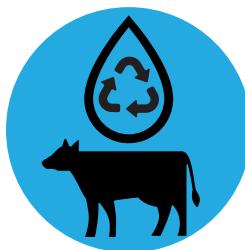
Plant genetics research is focusing on breeding drought tolerant varieties of several field crops. This research involves identification of pathways and methodologies for testing drought tolerance. For example, in 2016 a plant physiological model and simulations were finalized and researchers optimized corn physiology in a simulation. These simulations will be used to guide breeding programs with the scope of broad areas of adaptation across the USA.

([Matthew Gilbert](#))

### Determining water requirements for wine grapes

In order to help protect and sustain the supply of fresh water needed for viticulture in the San Joaquin Valley, research was performed to generate empirical data on the water requirements for wine grape production. In particular, this work will help determine the blue water footprint of grapevines as a function of three irrigation treatments.

([Larry Williams](#))



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farm and ranch managers adopted practices to improve water quality

### Addressing non-point sources of pollution in groundwater

Several projects are underway to monitor nitrogen, nitrate, and salt in groundwater. For example, there is ongoing collaboration with the California State Water Board to assess modeling tools that can be used to evaluate the assimilative capacity in groundwater basins with respect to salts and nitrate. Modeling tools that address management of important threats to groundwater dependent ecosystems are also being developed with the California North Coast Regional Water Board and Siskiyou County. Additionally, scientists are working with the California Almond Board and a grower-cooperator to establish a long-term nutrient, soil, and groundwater monitoring site to evaluate nitrogen fluxes in an almond orchard and their response to improved irrigation and nutrient management. Finally, scientists met with stakeholder groups in the San Joaquin Valley to develop future scenarios for agriculture and urban area groundwater management and land use under new groundwater regulations. ([Thomas Harter](#))

### Groundwater management planning

A collaborative team involving UCCE and several other agencies released the report “Assessment of Interconnected Subbasins” and conducted related outreach. The report describes the current state of groundwater modeling in California and includes recommendations on the utility of current regional and local groundwater models for groundwater management planning and implementation. The report also highlights limitations of current regional and local groundwater models for sustainable management and recommends how governmental agencies should invest future resources to improve them. This report is being used to inform policy makers and water rights holders of the increasing role groundwater modeling will have in the next 25 years. This science-based information helps California as the state strives to manage groundwater in a more sustainable and coordinated manner. ([Allan Fulton](#))

# Sustainable Energy

## 2017 Highlighted Activity & Outcomes

California continues to pursue renewable sources of energy, and research is needed to understand the potential for both high-value renewable products and fuels created from agricultural and natural feedstocks and waste products.

### Sorghum as a drought tolerant renewable biomass feedstock

Replicated field trials are being conducted to evaluate both grain and biomass production throughout the state. Research is being conducted on sorghum, an annual crop that could be both a short-term and long-term solution for California's need for a renewable, sustainable biomass feedstock for renewable fuel production. There is also an ongoing program to evaluate sorghums for their water use efficiency. The Department of Energy Advance Research Project's Agency-Energy program is funding two multi-disciplinary sorghum research programs. Based on outcomes, genes and molecular markers will be identified to devise genetic strategies for improving drought tolerance in sorghum and other bioenergy crops. ([Jeffery Dahlberg](#) and [Robert Hutmacher](#))

### Enabling plants to be converted to renewable products

Several research projects are using breeding and agronomic evaluation to improve crops and cropping systems with a focus on alfalfa, red clover, orchard grass, and other forage species. The goals include increasing yields through a better understanding of water use efficiency in plants, improved water quality, and plant breeding. Additionally, research will evaluate the use of these crops for biofuels as an option to enhance rural vitality while promoting more secure energy sources. ([Charlie Brummer](#) and [Dan Putnam](#))

### Impact of renewable energy and intermittency

One project continues to quantify how short-run volatility in renewable electricity (i.e. intermittency) affects the amount of air pollution emitted by interconnected fossil fuel generating units in the California electricity market. Research will lead to recommendations to improve renewable energy policies and renewable siting processes to mitigate the potential environmental impacts of renewable intermittency. ([Kevin Novan](#))



### Policies for renewable fuels

Federal and state energy programs and policies are being analyzed to better understand how various forms of subsidies affect ethanol investment, production, entry, and exit decisions. This work has analyzed the renewable fuel standards and low carbon fuels standards and their impact on production of renewable fuels in California. ([C.-Y. Cynthia Lin Lawell](#))

### Creating novel biomaterials

One project is focused on altering biosynthesis and composition of plant cell walls. The purpose of the research is to cause plants to synthesize modified plant cell walls that result in improved yield of biofuels from cell wall biomass. ([Eugene Nothnagel](#))

### Developing a bio-based energy substitute

Current production of oil in agronomic plants is limited to the seed and can provide only a small portion of U.S. transportation needs. Research is focusing on improving the efficiency of converting starch into oils, and producing oil in tissues with extensive biomass by genetically reprogramming leaves and stalks. This work could lead to a bio-based energy substitute. ([Katayoon Dehesh](#))

### Strategies to deploy feedstock knowledge

Multiple projects are developing strategies to deploy feedstock supply knowledge, processes, and logistic systems that will provide timely and sufficient quantities of biomass to feedstock plants. ([Zhiliang \(Julia\) Fan](#) and [Jean Vander-Gheynst](#))

**To see the full extent of research and extension work that was reported to the Federal Government in 2017 please see the “2017 University of California Combined Research and Extension Annual Report of Accomplishments and Results”.**

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