

2018 University of California Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

The Division of Agriculture and Natural Resources is the major land grant arm for the University of California (UC ANR). The Agricultural Experiment Station (AES) and Cooperative Extension (CE) are integrated to develop cutting-edge research information that can be applied to solve real-world problems in agriculture, natural resources, and communities. UC ANR's mission is to engage UC with the people of California to achieve innovation in fundamental and applied research and education that supports:

- sustainable, safe, nutritious food production and delivery systems
- economic success in a global economy
- a sustainable, healthy, productive environment
- science literacy and youth development programs

Agricultural Experiment Station (AES) faculty members conduct research and teach in three colleges and one professional school on the UC Berkeley, Davis, and Riverside campuses. The AES has around 570 academic researchers, most of whom also have professorial appointments representing dozens of scientific disciplines. Cooperative Extension (CE) is the principal outreach arm of the Division. There are around 115 CE specialists and 175 CE advisors conducting research, outreach, and education. The CE specialists are located in departments on the UC Berkeley, Davis, Riverside, and, more recently, Merced and Santa Barbara campuses, as well as at RECs and county offices. The CE advisors are located in county-based offices and at RECs. The nine RECs, located in a variety of ecosystems across the state, provide a core research and extension base. In addition, ten statewide programs and two statewide institutes focus on specific issues that engage UC ANR academics and UC faculty from all the other campuses, allowing integrated teams to work on complex issues that need multidisciplinary approaches.

FY 2018

During FY 2018, UC ANR held a four-day, in-person statewide conference focusing on Innovation in Action. The goals were to: 1) assess current and future directions for UC ANR; 2) highlight innovative methods of science, outreach and program delivery; 3) provide in-service trainings; 4) provide an opportunity for Program Teams and Workgroups to meet; and 5) provide networking opportunities for all UC ANR academics and staff. There were 679 participants, with academic and staff representation from across the UC Agricultural Experiment Station locations and statewide Cooperative Extension.

UC ANR continued to make significant progress toward its Strategic Vision 2025 through the implementation of the ANR Strategic Plan 2016-2020, which further operationalizes the vision. The plan includes five strategic objectives: 1) advance and encourage forward-thinking, science-based solutions through discovery and engagement with Californians to address local issues with global impact; 2) attract, develop, and retain diverse, highly productive, talented, and motivated people who seek a mission-driven experience; 3) develop a sustainable, diverse revenue model with efficient administration to support UC ANR's mission; 4) optimize delivery of programs and services through best management practices with efficiency, transparency, and integrity; and 5) communicate the value of UC ANR to the UC community, our partners, and the people of California. There are fifteen goals with specific key strategies and metrics

with targets to realize these strategic objectives.

Of particular relevance to federal reporting, during FY 2018 UC ANR's Strategic Plan Goal 5: Prioritize Programs and Services collected data on effort and outcomes towards the identified division-wide public values and respective condition changes. UC ANR's approach to collecting and communicating outcomes information is now in the form of condition change impact stories by the federal planned programs. In addition, UC ANR continues the commitment to hire to exceed projected turnover, toward the goal of academic growth. During FY 2018, seven CE specialists and 22 CE advisors were hired. UC ANR also continued to invest resources in four internal funding opportunities, for which a brief overview follows. Outcomes from the specific grant projects are included in the federal planned program narratives.

- Ten new projects for a total of \$1.7 million over 5 years were funded through the Competitive Grants Program 2017 Call and started April or August of 2018. To date 79 projects have been funded through this program for a total investment of roughly \$15 million dollars. This program invests in short-term, high-impact research, education, and outreach projects that address high-priority issues that are consistent with the UC ANR Strategic Vision; encourages collaboration among academics; strengthens the research-extension network; and demonstrates relevance and likelihood of impact on significant agricultural, economic, environmental, and social issues in California.

- Two projects for a total of \$181 thousand over 3 years were funded through the High-Risk/High-Reward Grants Program 2017 Call. This program provides funds (no more than \$100,000) to initiate and complete research and proof-of-concept efforts that serve as the basis for larger funding opportunities. These projects must be of a high-risk/high-reward nature that is best conducted in a controlled, research setting and, if successful, lend themselves to subsequent larger funding opportunities and/or intellectual property development.

- Eight projects for a total of \$79,884 were funded for the Opportunity Grants Program, which provides small amounts of resources (no more than \$10,000) to initiate and complete critical short-term research, outreach, or training efforts. These projects must be time-sensitive in nature and take advantage of a unique opportunity where a small pilot project to collect initial data or an immediate, crucial outreach effort must take place in a timely manner to address an issue of importance.

- Two projects were approved for the Matching Grants Program, which provides cash resources to develop and submit for external funding support of research, outreach, or training efforts in response to requests for proposals from a grantor that stipulates a matching funds requirement.

UC ANR continued work on its five multidisciplinary, integrated Strategic Initiatives: 3) Sustainable Food Systems; 2) Sustainable Natural Ecosystems; 3) Healthy Families and Communities; 4) Endemic and Invasive Pests and Diseases; and 5) Water Quality, Quantity, and Quality. The following narratives describe FY 2018 program highlights for these Federal Planned Programs.

Sustainable Food Systems

Global change continues to pose challenges to our food supply systems. Many of the issues that are important at the global level are locally important to food systems in California: water, labor, pressure on land use, management of risk, and equitable access to a healthy and nutritious diet, among others, all manifest themselves as problems at the state level. UC ANR academics work to find solutions to these problematic issues at local, national and global scales.

Research and outreach on Sustainable Food Systems is focused on sustainable production and supporting diversity in the food system. From growers working in traditional production systems that produce over 400 commodities, to an increasing number of urban and peri-urban farmers growing local food on a small scale, our producer-stakeholders are diverse and distributed across the entire state. Food produced by this diverse group finds its way to market via an incredible array of processing and distribution systems, and is consumed by a population that is among the most diverse in the nation in terms of culture,

ethnicity, wealth, and food access. At UC ANR working to make food systems more sustainable for our 40 million stakeholders goes hand in hand with scientific discovery and innovation that contribute to the sustainability of food systems globally.

During FY 2018, 202 Hatch and Multistate Research projects were conducted by investigators at UC Berkeley, Davis, and Riverside. Campus-based CE specialists worked on 109 research and extension projects. CE advisors and other UC ANR academics worked on 401 research and extension projects, and led an additional 30 research projects under the Federal Planned Program: Sustainable Food Systems. The following illustrates the breadth of work and includes selected examples highlighting accomplishments in this program area.

Sustainable Production - Animal Systems

Maintaining safe, healthy, and productive animal agriculture production practices while conserving natural resources is a key goal in the development of animal welfare and production management systems. Highlighted examples of UC ANR advances include:

- Sustainable animal production systems are dependent on understanding and improving the welfare of livestock. Work on welfare in gestating sows has revealed that the social networks, which develop among group-housed sows, play an important part in determining the welfare of the individual animals. Sows form networks of preferred groups that are based on animal age. These networks influence the development of aggression in group pens. The results of this research, which forms one component in a multi-state research project, have been presented to scientific and industry audiences and offer opportunities to improve welfare and productivity in pig production systems.
- Understanding genetic control over important traits for sustainable production of animals and plants is a key component of sustainable agriculture. As our capacity to manipulate genetic sequences directly increases, so too does the need to communicate the science involved to the public. The work undertaken in this multi-state project has been exemplary in engaging directly in outreach to the public on the issues surrounding the use of genetic engineering in agriculture. The project team made over 60 presentations to audiences at state, national, and international venues, either of the research undertaken on the genetic control important production traits, or on the wider issues of genetic engineering and food production.
- One outreach project helped fill the need for objective, evidence-based public outreach materials on the topic of biotechnology. The documentary movie, *Food Evolution*, contextualizes the debate around this controversial scientific topic. The movie was first released in December of 2016 and has more than 740 completed screenings at venues around the world to a variety of audiences, including the National Academies of Science in Washington D.C. and the Food and Agricultural Organization in Rome. The film has garnered critical acclaim from the *New York Times*, *Los Angeles Times*, and *Forbes*.
- UC ANR continues as an important partner in the California Dairy Quality Assurance Program (CDQAP), working in collaboration with USDA Natural Resource Conservation System and others. The CDQAP partnership conducted quarterly meetings to bring industry, government agencies, and academia together to discuss concerns related to water and air quality. Technical support and an online decision-making tool was provided to dairy producers. They gained important information to better understand how water and air quality regulations fit their specific operation. During FY 2018, no dairy producers were out of compliance with the state regulations to protect water.

Sustainable Production - Plant Systems

Challenges in the form of declining agricultural productivity within the context of climate change, water constraints, regulation, and other factors create an urgency to increase crop production in ways that are more efficient and sustainable. To meet these challenges, advanced genetic resources and more sustainable production practices must be identified and integrated into commercial agriculture. Highlighted examples of UC ANR advances include:

- Modern science is increasingly a collaborative activity. Efforts to improve crop yields typify this trend. An important aspect of this teamwork approach is that sometimes labs play key supporting roles in checking and improving work led elsewhere. The Freeling lab's work on advanced testing of two key genomic toolboxes exemplifies this crucial aspect of modern scientific research. The work supports research by large numbers of plant improvement projects by checking the validity of public resources and adding extra features to them. In addition, in contributing to a public resource, the work stands as one example, among many, of UC ANR's commitment to open science.

- Plant breeding offers the most sustainable way to overcome the challenges facing crop production globally. In addition to adding high value varieties of mandarin such as Tango and Gold Nugget to the US citrus industry, this lab is at the forefront of finding a genetic solution to the citrus disease Huanglongbing (HLB). The disease has devastated citrus production globally, reducing orange production in Florida by 60% over the last decade. No commercially grown citrus varieties have useful resistance to the pathogen that causes HLB, but the lab has identified potentially effective resistance in citrus relatives and has made good progress in transferring it to citrus and in evaluating the use of resistant species as interstocks - wood grafted between citrus rootstocks and fruit-bearing scions.

- Risk, and traditional indemnity-based insurance solutions for it, trap low wealth farmers in poverty. Index insurance - in which payouts are linked to the occurrence of a predetermined value on an index variable correlated with the risk-causing event - offers a potential solution to this. The farming poor both domestically and internationally may benefit from the wide availability of good quality index insurance. This team has been successful in establishing index insurance for crop farmers in Mozambique and Tanzania and are gathering useful information about what factors lead to successful uptake of index-based insurance, improving the chances for using the approach in US agriculture.

- If risk acts as a disincentive to investment in particular production activities, or its absence makes others more attractive, government policies - such as those providing insurance - should lead to measurable changes in production. This econometric and statistical work on the impacts of insurance on the production of key commodities in California agriculture has yielded new insights into the production responses in the dairy sector to crop insurance policies. The work has made important methodological contributions that allow much better understanding of production responses to policy changes, opening the way to more informed policy design in the future.

- An agricultural machinery safety project is developing the first agricultural all-terrain vehicle (ATV) safety test station in the nation. In addition, a universal lift assist mechanism to raise and lower the Foldable Rollover Protective Structures (FROPS) from the vehicle seat was designed and developed. The experimental tests were conducted at the University of Tennessee, as part of the ongoing research collaboration. Manually raising and lowering the FROPS is a strenuous and time-consuming process. The lift assist mechanism is a valuable tool for physically challenged farmers to raise and lower the FROPS without leaving the tractor.

- One project to improve pistachio production developed a nut growth heat-based model to predict the critical growth stages to inform decision-making on pest management, irrigation scheduling, and optimal harvest date. There is an online tool available to pistachio growers where they only need to input the orchard information of bloom date, cultivar, and location.

- Another statewide effort on mechanizing cultural practices in vineyards developed new mechanical methods that can be used in classical viticulture. It is now possible to prune, shoot thin, and remove leaves mechanically in wine grape vineyards.

- One post-harvest engineering project developed a new method for drying walnuts, working in collaboration with walnut growers and driers, packaged food companies, and sensing equipment developers. The new method results in higher quality walnut, e.g. better color, less cracked kernels compare to those traditionally dried. This has the potential to improve profitability. Information on how implement this method was extended to the state's Walnut Grades and Standard committee.

- A plant nutrition project continued work on more sustainable practices for the ornamental industry, developing recommendations for nursery production on new rates of dolomite that are incorporated into the nursery rooting media to help regulate pH and provide calcium and magnesium over a one year

production period. This work has the potential for improved use of fertilizers and secondary water sources to optimize plant growth in containerized ornamental nursery production. Ultimately, adoption of these more sustainable production practices minimize the use of natural and synthetic resources and reduce negative impacts to the environment.

- A project working with strawberries and vegetable growers along the Central Coast resulted in the adoption of recommended irrigation, nutrient, and pest and disease management, resulting in a minimum yield increase of 16.5% and at least \$2 million additional revenues.

Diversity in the Food System

The public's interest in agriculture and where food comes from continues to grow in California and the nation, especially among urban populations. This interest has led to an increased demand for research and extension programs that support a new and more diverse clientele through urban agriculture and local/regional food systems programs. Highlighted examples of UC ANR advances include:

- The disappearance of middle-sized farms is a problem that afflicts many agricultural systems globally; farming in California is not immune to it. At the same time, success in many areas of agriculture policy may implicitly depend on the existence of these farms. One project is working to understand how the sustainability of middle-sized farms can be increased, for example by identifying ways they can increase supply to local food systems. The economic benefits of middle-sized farms to their regions are important - 90% of expenditure on inputs by middle-sized farms occurs within the region where they are located, compared with only 50% for larger farms.

- Community Supported Agriculture (CSA) offers a way for the public to connect more directly with the food system and a range of other potentially attractive attributes for policymakers, such as proportionally higher employment rates compared with conventional farming systems. One study recently identified the customization paradox as a key factor involved in problems experienced by CSA's in retaining members; in essence the customization paradox is that while ex-CSA members often cite dissatisfaction with the choices offered to them for the share they contribute to the CSA, there is no evidence that offering more customization to members increases retention rates. By identifying why the obvious solution does not apparently fix the problem, research offers the prospect of sound advice to CSA farmers on how to improve the long term sustainability of CSA schemes.

- While access to healthy food is frequently considered in the context of the urban poor, it is a problem that is all too common in rural households, affecting the labor force who work to produce food. Research is helping to understand participation patterns in schemes such as Supplemental Nutrition Assistance Program (SNAP) and the Women, Infants and Children (WIC) program. Theory suggests that if benefits are increased, recipients will treat the increase essentially as cash, but analysis of available data indicates that households increase the share of their budget spent on food by a greater amount than is predicted on a cash-equivalent basis. Research in this area closes the loop of work on sustainable food systems, since sustainable production requires an available and sustainable labor force, and the existence of such a labor force depends on the sustainability of the individual households which comprise it, whose presence in the rural population depends on sustainable access to affordable, nutritious food.

- Urban agriculture--the production and distribution of food in urban spaces--continues to gain momentum and has been shown to have a wide range of benefits. The UC ANR Urban Ag Collaborative team developed web-based resources and conducted in-person workshops in the San Francisco Bay Area, Los Angeles, Sacramento, and San Diego, reaching 581 attendees. Participants reported improving production and business management practices.

Sustainable Natural Ecosystems

California's ecological land types, along with the associated natural resources management issues and challenges, are extraordinarily diverse. These lands typically are upstream or downstream from intensively

managed agricultural and residential lands. The sustainability of the state's natural ecosystems is complex given the ecological diversity and mixed ownership. But it is critical since these natural ecosystems provide valuable goods and services to society as well as habitat for other flora and fauna.

UC ANR's Sustainable Natural Ecosystem Strategic Initiative and Federal Planned Program aims to identify and prioritize issues and solutions affecting California's natural ecosystems. Some of those issues include understanding and valuing ecosystem services, maintaining working landscapes, biodiversity, climate change, regulations, and land use change and fragmentation.

During FY 2018, 147 Hatch and Multistate research projects were conducted by investigators at UC Berkeley, Davis, and Riverside. Campus-based CE specialists worked on 39 research and extension projects. CE advisors and other UC ANR academics worked on 136 research and extension projects, and led an additional 14 research projects under the Federal Planned Program Sustainable Natural Ecosystems. Projects are being conducted in several areas that are essential to sustaining California's natural resources. Examples of the breadth of projects along with selected examples of high impact programs follow.

Forest Management and Wildfire

Trees are one of California's most valuable renewable resources. Not only do they provide products used in construction, but they are essential in habitat for wildlife, recreation, and carbon sequestration. Sustainable ecosystems must include forests, and they must be understood to preserve and protect them. Highlighted examples of UC ANR advances include:

- UC ANR teams initiated seven post-wildfire impact, response, and readiness research and extension projects with local program delivery through the internal Opportunity Grant Program. These projects include field surveys to assess ash and smoke impact on adjacent agricultural crops and urban backyard chicken eggs, post-fire food needs and availability, and community-based workshops to promote improved fire adaptability and preparedness.
- Putting fire back on the landscape as a management tool is a critical part of long-term fire adapted landscapes in California. Fire is a natural ecological process that can both improve forest health and enhance community safety. This is easier said than done however, as issues of risk, fuel load, air quality, and local capacity and understanding have all contributed to limit the adoption of prescribed fire as a management tool. Regional UC ANR teams have developed workshop curriculums for both in-class and field training. Furthermore, they have helped local communities with capacity building by creating local prescribed fire groups. Several trainings and prescribed burns have been completed. As this effort gains traction the scope of work will increase as interest from stakeholders is very high.
- The vast and rapid die-off of conifers in Sierra Nevada Forests was both alarming and in some ways overwhelming to managers. Forest inventories estimate that 128 million trees died from 2012-2016. UC ANR researchers have tackled this issue on a grand scale. While western bark beetle is the key vector, researchers understood the nature of conifer die-off was much more complex with several potential contributing factors including short-term drought, longer-term climate change, tree density, and understory plant composition. Eight representative research sites have been established on a north to south gradient across the Sierras. With these sites there are 283 plots where extensive data is taken relating to forest health, tree density, and understory composition. To further strengthen this project the UC ANR team has established the Tree Mortality Data Network which engages forest managers and stakeholders at scales beyond what field research can encompass. This network serves as both an outreach component and information source. Lastly, the team has begun testing UAVs (drones) as a tool for early detection of new conifer die-off locations. Early detection of affected trees has a profound effect on subsequent insect spread and outbreak intensity.

Rangeland Resources Management and Wildfire

Rangeland and grassland ecosystems provide benefits vital to agriculture and the environment including grazing and forage for livestock and native animals, watersheds for rural and urban uses, habitat for plants, insects, and animals, water for sustainable landscapes, areas for recreational activities, and renewable energy and mineral resources. Highlighted examples of UC ANR advances include:

- As with forested areas, rangeland fires are increasing in size and frequency. Fire impact in terms of vegetative recovery varies considerably in different rangeland ecological types. Thus, to be effective, local or at least regional information is needed. One-size-fits-all recommendations do not work. At opposite ends of the state UC ANR teams have established plots monitoring effects of wildfire on post fire plant community and range health given parameters such as fire burn intensity and post-fire grazing management. This research will guide livestock producers and managers of both private and public rangelands potentially affecting millions of acres of rangeland.
- Another project helped ranchers recover from the wildfires by developing an online tool to calculate forage loss, which helps with financial recovery, whether from an insurance claim or federal funding for disaster relief. In addition, the local meeting provided ranchers not only with the information they needed to submit insurance claims but also to plan for the future.
- UC ANR range experts have published findings on the challenges and constraints of using livestock for invasive species control, while also developing guidelines for grazing management to reduce fine fuels on rangelands. This information can be used to help land managers strategically use livestock grazing to reduce fire intensity on chaparral and some annual rangeland sites.
- Some 70,000 head of cattle graze US Forest Service allotments in California. The potential impacts from grazing on meadows and riparian areas continue to be a point of concern for managers and stakeholder groups. A team of UC ANR range management researchers has completed 4 years of field data collection on 78 mountain meadows throughout California linking annual grazing utilization with long-term meadow and riparian health. This data is being used to inform managers and grazing permittees at the local grazing allotment scale as well as to guide policy at the US Forest Service Region 5 scale. Based on the results of this project, the UC ANR team is now developing a monitoring template which informs adaptive management grazing decisions on US Forest Service land.

Wildlife

Wildlife preservation and habitat enhancements are another component of California's natural ecosystems and the working landscapes. Conflicts with wildlife occur in both the rural and urban settings. Highlighted examples of UC ANR advances include:

- A research team is investigating impacts of noise pollution and diet quality on the sage grouse fitness, primarily their reproductive success. Understanding habitat and diet preferences will help land managers prioritize activities on a landscape scale. Also, the team is investigating whether vegetation management projects, such as manipulating sagebrush cover, improves sage grouse diet quality and increases their use of these areas. Effects of noise pollution are thought to impact the success of grouse breeding activities which rely on acoustic communication as well visual attraction. These results will guide land management decisions regarding energy development and other activities in the vicinity of sage grouse strutting grounds. Ultimately, this study will help inform management of sage grouse populations on the east slope of the Sierra Nevada.
- Potential wildlife / human conflicts involving predators in urban and suburban areas is increasing and coyotes are usually the predominant species. Research and outreach is helping Southern California residents better understand risk. "Coyote Cacher" an online database where residents can log in first-hand interactions with coyotes. A study of stomach contents of coyotes showed that an array of small wildlife species and human sourced foods such fast-food containers, candy wrappers, fruits, and vegetables were common. Of the coyotes sampled, cats made up 8% of their diet.
- Another team compiled a list of protection tools to reduce impacts of predators on livestock. Tools

were evaluated based on available science literature and real-world experience. This is the first compilation and assessment of tools available to ranchers of its type in California. Given the extreme diversity of livestock production systems throughout California, this is helping livestock producers understand potential effectiveness and limitations of available tools on their operations.

- Black-tail deer are an iconic species across much of California. Changing landscapes, land-use and other habitat impacts affects deer population dynamics. On-going study focuses on impacts of fencing on deer habitat use patterns and susceptibility to predation. As deer habitat becomes increasingly fragmented with mixed land uses, this information is highly sought by wildlife managers and conservation groups.
- Another research study revealed that isolated oak trees in the interior of vineyards provide foraging areas for bat species, including 11 species of insectivorous bats adapted to woodland habitat. This research was shared through 25 meetings with stakeholders.

Healthy Families and Communities

California faces several critical challenges in the area of human and community development. Nearly 30% of California's youth in grades 9-12 and over 60% of California's adults are overweight or obese, according to the Centers for Disease Control and Prevention. At the same time, one out of eight Californians are food insecure, having limited or uncertain access to adequate food. California ranked 42nd in the nation in 2016 for performance in education. It has a slightly lower high school graduation rate than the national average, and yet it is the fifth largest economy in the world. Promoting healthy pathways to college and work are urgent concerns, not only for individual youth and their families but also for the state's effort to remain economically competitive in the global economy.

UC ANR's Healthy Families and Communities Strategic Initiative and Federal Planned Program follows a broad mandate to promote health and well-being at multiple scales (individual, family, community, region, state) and across all racial, ethnic, and socio-economic groups. Our work addresses critical issues in the areas of community development and public policy, food literacy and healthy lifestyles, promoting positive youth development, and scientific literacy.

During FY 2018, 61 Hatch projects were conducted by campus-based Agricultural Experiment Station investigators. Campus-based CE specialists worked on 35 research and extension projects. CE advisors and other UC ANR academics worked on 340 research and extension projects and led an additional 13 research activities under the Federal Planned Program Healthy Families and Communities. The following illustrates the breadth of work and includes selected examples highlighting accomplishments in each program area.

Community Development and Public Policy

Cooperative Extension's historic mission is to promote democratic participation in civic life, helping local residents gain the power and means to shape their lives, families, and communities. In contemporary communities, democratic engagement is critical to pursuing the health and well-being of families and individuals. A key underlying strategy is community capacity building, not only with geographic communities but particularly with underrepresented groups, new cultural audiences, or other communities of identity or interest. Key examples of UC ANR advances include:

- In February 2017, the Nutrition Policy Institute initiated a multi-sector collaboration among California state agencies to increase awareness of food waste and ways to prevent it. California's first inaugural Food Waste Prevention Week was launched successfully in March 2018 and gained official support and participation from California's Governor, Secretary of Agriculture, Superintendent of Public Instruction, and other leaders. The multi-agency shared messaging campaign was estimated to reach millions, based on

unique page views via social and traditional media.

- A study of food policy councils in California based on 60 interviews, 10 local case studies, and a survey of 31 of California's 33 known food policy councils was able to document the nature of relationships between food policy councils, university researchers, Extension and government, and best practices for building these networks. Their work helped facilitate peer-to-peer learning between councils and raised the visibility of these councils in addressing local and state level food policy.

Food Literacy, Healthy Lifestyles, and Food Security

UC ANR seeks to promote a broad culture of health and food literacy across the developmental spectrum, from young children to aging adults. Estimates suggest that nutrition and lifestyle-related conditions are responsible for 75% of all health care costs and threaten quality of life, function, and emotional well-being. Simultaneously they are also highly modifiable with lifestyle improvement addressing nutrition and physical activity. In addition, 4.6 million Californians face food insecurity. Given one out of every eight Californians does not know where their next meal will come from, UC ANR provides educational programs to enable individuals and households to improve their food budgets and food management practices. Highlighted examples of UC ANR advances include:

- UC CalFresh Nutrition Education Program (UC CalFresh) nutrition educators and the Hanford Elementary School District READY Program mentored student tutors and provided technical assistance for teachers to teach nutrition and physical activity lessons that reached over 800 students. The READY After School Program and its partners have received recognition for nutrition education efforts by the California Department of Education. The effective partnership and program have also led to changes to the School Wellness Policy in the school district to improve healthy eating.

- A close collaboration between UC CalFresh, UCCE Master Gardner and UC 4-H Youth Development Program leads to a community garden, in one of Riverside's oldest and poorest neighborhoods becoming a focal point for healthy lifestyles. In the Eastside neighborhood, UC CalFresh revitalized the neighborhood's existing garden and led a team of partners and volunteers to build a new garden on the property. UCCE Master Gardeners helped to provide gardening and nutrition lessons during the monthly garden club meetings and provided education to the participants of the food distribution program. The UC 4-H Youth Development Program engages youth in ongoing activities to promote healthy eating and active living.

- UC ANR academics and collaborators completed the largest national study to examine relationships between community efforts, preventing child obesity, and improving child nutrition and physical activity. Findings of this 6-year project, of which one UC ANR academic was the Principal Investigator, collected information about 5,138 children in grades K-8 from 130 U.S. communities as well as information on community programs and policies over the prior 10 years through key informant interviews. The findings confirmed that successful programs require sustained efforts of 4-6 years and strategies of greater intensity, such as changing food environments and focusing on behaviors not to do as well as behaviors to do. This aligns with SNAP-Ed's newer requirements for agencies to deliver more than one policy, system, and environment strategy in addition to nutrition education.

- UC ANR research confirmed that urban farms contribute to food security. 35 urban farms in the East Bay Area of San Francisco contributed 13,000 pounds of produce to more than 30 organizations representing faith-based non-profits supporting food insecure people, youth groups, student groups, UC village residents, and food pantries, including the UC Student Food Pantry.

Food Safety

The Center for Disease Control estimates that one in six people get sick from foodborne diseases each year, including 128,000 hospitalizations. UC ANR conducts research and delivers educational programs that promote improvement in farm, household, and individual level food safety practices.

- The potential health benefits of augmenting foodstuffs with "friendly" bacteria, particularly *Lactobacillus* has been recognized for some time. Understanding how beneficial bacteria may be used as probiotics, as beneficial species in fermentation, or to increase food safety by reducing spoilage, is an important component in the design of food processing systems for the future. Research and outreach on these topics has had a significant impact on understanding how the desired effects can be achieved. Increased mechanistic understanding of the biology goes hand in hand with direct communication to food processors and members of the public.
- Food safety has become a critical public concern as outbreaks of food poisoning associated with fresh produce have occurred sporadically in recent years. Safe production practices are vital to get any supply chain off to a clean start, but safe practices during processing are also vital to reduce the transmission of harmful microorganisms. This work is identifying new diagnostics for assessing successful decontamination of produce during washing, handling, and movement. The outreach program works directly with leadership in the produce supply chain to guide research and enhance uptake of results by industry.
- The UC Master Food Preserver program (UC MFP) was delivered in 17 counties by over 400 volunteers who donated over 19,000 volunteer hours. In San Luis Obispo and Santa Barbara Counties, almost 900 low-income residents, the majority of whom are Spanish-speaking, received safe food preservation information and tools such as ice cube trays for implementing new practices. Over 600 participants responded to surveys. 98.8% reported increased knowledge of food safety and/or safe food preservation techniques.

Promoting Positive Youth Development

California has some of the biggest disparities in youth outcomes among any state and needs effective strategies that promote youth development. UC ANR is a leader for promoting models for positive youth development that are extended through in-school and out of school time programs and through influences on the curricula and programs of other youth-serving organizations. Highlighted examples of UC ANR advances include:

- A research project examined the impact of stress (poverty, violence, maltreatment) on family relationships and child development. From this work they led multiple trainings for social workers and foster parents. These trainings informed social workers and foster parents of the harmful effects of stress and trauma on child development, and provided practical suggestions on how to mitigate these effects and promote positive development.
- UC ANR developed and evaluated outcomes of curricula related to youth scientific literacy, "At the Interface between Livestock and Predators" and "Bio-Security in 4-H Animal Science." These research-based curricula address relevant issues and use theoretical frameworks that complement the learn-by-doing approach used in 4-H. Outcome testing for all curricula has revealed statistically significant improvements in content understanding, as well as application of skills learned through multiple service learning projects that extended scientific information to the participants' peers and communities.
- In 2014, Latinos became the "new majority" in California yet are also among the most under-represented groups in conservation, outdoor recreation, and environmental education organizations. ¡Descubre Outside! Discover Afuera! is a program designed by UC ANR 4-H Youth Development Program in collaboration with UC Berkeley's California Outdoor Engagement Coalition. The experiential learning program is designed to motivate youth to explore the outdoors in their community and at McConnell State Park. Participant outcomes include caring more about the environment, spending more time outdoors, and learning about environmental issues.
- The 3-year UC ANR 4-H Latino Initiative launched a pilot in seven counties to develop culturally relevant and responsive programs to welcome Latino youth, families, and volunteers to the 4-H Youth Development Program. The local programs developed partnerships with other organizations serving Latinos and identified the needs of the California Latino community. In 2017 there was a 34% annual increase in Latino participation (45,528 Latino children), and a 52% annual increase in Latino adult

volunteer participation (2,259 Latino adult volunteers).

Endemic and Invasive and Pests and Diseases

Pests threaten the productivity, biodiversity, and health of California's natural areas and agricultural production, i.e. plant and animal systems and urban environments including structures. These pests include arthropods, nematodes, mollusks, and other invertebrates, weeds, plant and animal diseases, birds, rodents and other mammals, and other taxa. Many of the damaging pests are non-native to California and these exotic pests enter the state in spite of state and federal regulatory programs and inspections at state and international borders and other ports of entry. New pathways for introduction are frequently identified such as the aquarium trade for aquatic pests, movement of beehives, or produce shipping containers for certain hitchhiking pests. Natural dispersal and adaptation of pests also leads to new pest management challenges in California and this is often driven by changes in global climate patterns, crop selection, and crop or livestock management practices.

UC ANR has identified the Endemic and Invasive Pests and Diseases Initiative (EIPD) as a priority mechanism to coordinate and engage the resources of UC ANR to meet these significant pest challenges addressing detection, biology, and management of pests and diseases that can impact human, livestock or plant health, stored products, post-harvest products, buildings, or those that affect natural systems such as wildlands and waterways. This initiative's goals are to foster research and extension programs that 1) exclude pests, pathogens, and diseases using diagnostics, detection, interception, response, and mitigation; 2) develop information that responds to emerging and re-emerging problems with pests and diseases; and 3) provide long-term integrated pest management (IPM) solutions for established pests that are economically and environmentally sustainable, and socially appropriate.

During FY 2018, 123 Hatch projects were conducted by investigators at UC Berkeley, Davis, and Riverside. Campus-based CE specialists worked on 63 research and extension projects. CE advisors and other UC ANR academics worked on 206 research and extension projects, and led an additional 24 research activities under the Federal Planned Program, Endemic and Invasive Pests and Disease. A significant amount of research and extension activity addresses pest management issues on specialty crops including vegetables, tree and vine fruit crops, and tree nut crops. The following sections contain some selected examples within each of these EIPD initiative goals.

Detection and Diagnostics

Early detection of pests, especially new invasive species, and proper diagnosis, i.e., identification, are critical steps for optimizing the chances of limiting establishment. Lack of early detection may result in expensive pest and disease management costs in the long-term, disruption in commerce and industry prosperity, and human and animal health impacts if diseases are involved. However, eradication of pests and diseases may be feasible if an early detection system is in place. UC ANR projects addressing the areas of detection of invasive pests and diseases include:

- Work is being performed to develop a molecular diagnostic tool for the rapid identification of Western Cherry Fruit Fly and differentiate it from co-inhabiting fly species that are morphologically similar, e.g. Apple Maggot Fly and Spotted Wing Drosophila, thereby reducing crop losses from delays in shipping due to quarantine or in storage. This scientist is also working to develop a rapid molecular diagnostic tool for *Tuta absoluta*, a serious pest of tomato not yet officially reported in the US, to differentiate it endemic tomato pinworm.
- Additional work is underway to develop a rapid assay to detect the spinach downy mildew pathogen during the latent period which will guide management and production decisions.
- Sequencing 40 strains of *Clavibacter* resulted in six completely finished genomes. That information

was used to develop a multiplex PCR primer pair that can specifically detect pathogenic *Clavibacter michiganensis* subsp. *michiganensis*, the causal agent of bacterial wilt and canker of tomato, a bacterial pathogen that causes considerable damage to tomatoes; but, not saprophytic (nonpathogenic) *Clavibacter*, thereby avoiding false positives in detection.

- A study to determine that there are molecular patterns that accumulate in leaves specifically in presence of trunk infection will enable early detection of trunk diseases and the timely removal of infected parts.
- Another research project is identifying that the two native forms of the walnut twig beetle, vector of the fungus causing thousand cankers disease, hybridized resulting in the invasion of both the western and eastern U.S. and threatening the eastern walnut forest.
- Work to synthesize and field-test sex attractant pheromones of the North American wireworm species is underway and represent the first correct identifications of pheromones for any species of North American wireworm species, some of which are major agricultural pests.
- Another research project is developing the first antibody-based diagnosis of citrus greening disease using pathogen effectors as detection markers.

Emerging and Re-emerging Pests and Diseases

Emerging problems can arise from endemic or newly established invasive species and these must be addressed to minimize their impacts on agriculture, natural resources and urban systems. In contrast, re-emerging pests and diseases are those that were once major problems and then declined dramatically but are again becoming significant problems whose impact is increasing due to human activities or climatic and ecological changes. Advances in this area of inquiry include:

- Significant research advances were made in understanding the impact of the fungal pathogen *Batrachochytrium dendrobatidis* on imperiled amphibians. These findings are translated into management actions for the National Park Service.
- Another research project showed that weed beds and the detritus from decaying weeds benefit invertebrates, and are thus likely vital to fish productivity. Therefore, while weed management can be done judiciously to suppress invasives and maintain open waterways, total weed eradication could reduce fish populations. Alternatively, mosquitoes grew faster as well in decaying weeds and that could impact their control.
- Another study found that the geographic distribution of the light brown apple moth, an invasive pest threat to fruit, flowers, and trees, now extends from Sonoma county in the north to San Diego county in the south, contrary to previously thinking that it was confined to the fogbelt coastline.
- Similarly, Africanized bees have been found as far north as Sacramento, which is much farther north than previously reported. How far they will spread and how they will affect agriculture are of great concern.
- UC ANR scientists surveying California woodlands for the presence of Sudden Oak Death have generated the largest database for any disease in the world.

Integrated Management of Established Pests and Diseases

Integrated management approaches are used to reduce the impact established of pests and diseases on agriculture, natural resources, and urban systems through the development of science-based pest management programs that are economically and environmentally sustainable, and socially appropriate. These integrated pest management (IPM) programs for existing, established pests require frequent refinement to stay relevant. Changes in efficacy of current management tactics, adjustments in production strategies, revisions in crop landscapes, unusual environmental conditions, and other controllable and uncontrollable situations modify the impacts of pests. The following are examples of UC ANR projects addressing integrated management of pests and diseases:

syndrome (PRSS) was both larger in terms of physical and financial loss than has been estimated in other studies. The finding that vaccination significantly reduces the effects of a PRSS outbreak led to the recommendation that all sow farms in a region should be encouraged to vaccinate.

- Research found that adding selected substrates to Verticillium wilt conducive soils can shift soil prokaryote communities to become Verticillium wilt suppressive soils. This has the potential to control crop diseases while causing no or minimal detrimental environmental impact.
- Another research project is providing environmentally friendly strategies for nematode suppression. It found anaerobic soil disinfestation (ASD) is highly effective in reducing detrimental populations of plant-parasitic nematodes in the soil profile.
- One study reported that the time of snowmelt and summer rainfall appear to influence pest squirrel reproduction and project that climate change will impact the reproduction rate of these vertebrate pests.
- Another project compared taxonomic and life history traits of weeds with evolved herbicide resistance (EHR) to a control group, leading to the discovery that weeds with EHR are significantly over-represented in Amaranthaceae, Brassicaceae, and Poaceae. This implies that special management methods should be employed to reduce the development of herbicide resistance in the plant families.
- Collecting and rearing biocontrol parasitoids for control of the pink hibiscus mealybug (PHM), an invasive pest that attacks more than 200 kinds of plants including beans, citrus, cotton, corn, grape, and peanuts, has resulted in the parasitoids becoming well established and PHM numbers are declining.
- Another research project is pioneering the world's first use of CRISPR/Cas9 genome editing technology to whitefly in the laboratory. Engineering resistance to whitefly can help protect against the yellowing and death of leaves that this pest causes.
- Developing a computer algorithm to identify new repellents from chemical structures with a 70% success rate and numerous new natural repellents for *Drosophila*, a fruit fly first found in 2008 damaging fruit in many California counties, were identified. In parallel electrophysiology analysis, a large number of olfactory neurons in *Drosophila* that responded to DEET and other repellents were identified. These repellents have higher volatility than DEET and were able to repel from a slightly further distance making them excellent candidates to protect plants and people from insects.
- Another project is demonstrating the potential benefits of quantifying sugar beet cyst nematode populations at least every few years to avoid poor crop management decisions based on outdated information.
- There is work breeding *Meloidogyne hapla*, also known as root knot nematode, resistant carrots that resulted in lines resistant to all nematode isolates, and in particular a selection from carrot line Homs with very strong resistance.
- Another project confirmed that glassy-winged sharpshooters found in California's Southern Central Valley is now relatively resistant to both neonicotinoids and pyrethrins. This invasive pest can spread the disease-causing bacterium *Xylella fastidiosa* from one plant to another. This level of increased resistance is of critical concern and threatens our ability to manage populations of this serious vector of *Xyella fastidiosa*.
- Research was conducted on identifying bacterial endophytes collected from survivor trees that inhibited the growth of the symbiotic fungi associated with the shothole beetles, a pest that attacks dozens of common native and landscape trees.
- Similarly, some isolates of bacteria and fungi collected from Huanglongbing (HLB) survivor trees in Florida inhibit the growth of *Liberibacter crescens*, a culturable relative of the HLB-associated pathogen.

Water

Water supply and water quality for agricultural, urban, and environmental systems create some of the state's largest challenges.

UC ANR's Water Quantity, Quality and Security Strategic Initiative and Federal Planned Program work to directly impact California watersheds and California's water security. Projects in a number of areas

directly impact California watersheds and California's water security.

During FY 2018, 35 Hatch and Multistate research projects were conducted by investigators at UC Berkeley, Davis, and Riverside. Campus-based CE specialists worked on 31 research and extension projects. CE advisors and other UC ANR academics worked on 57 research and extension projects, and led an additional seven research projects under the Federal Planned Program Water Quantity, Quality and Security. The following illustrates the breadth of work and includes selected examples highlighting accomplishments in this program area.

Groundwater Recharge

Management of groundwater recharge is important for both quantity and quality purposes. The 2011-2017 drought increased attention on sustainable groundwater management throughout the state.

- Work is being performed to assess the potential to use storm/flood water on agricultural lands to increase groundwater recharge. The study is looking at the potential for this on almonds, vineyards, irrigated pasture, and low nutrient input row crops and alfalfa and will consider extending it to other crops depending upon results. This could increase freshwater recharge and lessen overdraft of groundwater aquifers. This work will be increasingly important, as precipitation variability will increase with climate variability.
- Understanding aquifer structure and dynamics is critical to sustainable groundwater management. Scientists are using new tools to collect data and model groundwater systems.

Groundwater Quality

Increases in irrigation efficiency can lead to increased concentrations of salts being leached to groundwater aquifers.

- One research project looks at irrigation sustainability at the centuries to millennia time scale to assess the potential for long-term salinity buildup in groundwater. Results show gradual degradation of groundwater quality throughout the state.
- Additional work is underway to look at the potential for recycled wastewater to increase this degradation through increased salt accumulation. Mitigation for salt accumulation includes rainfall and irrigation with fresh water. Agricultural production with recycled, reused, or otherwise lower quality waters is of increasing importance in regions that face chronic water shortages.

Nitrate pollution to groundwater sources is a major concern in California.

- A collaboration with the California State Water Board is working to assess modeling tools that can be used for evaluation of the assimilative capacity in groundwater basins with respect to salts and nitrate.
- Another collaborative effort with the California Almond Board and a grower-cooperator is working 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. Almonds are now one of the dominant crops in California and have high nitrogen input requirements.
- Research to reduce nitrate pollution has focused on the main pathway, leaching. Increasing irrigation efficiency and optimizing nitrogen applications can reduce leaching.
- Additional research on the use of bioreactors to clean up nitrogen-laden groundwater and surface water flows is showing promising techniques to increase their efficiency. New research and curriculum development is increasing capacity within the state to solve this problem
- A team of 10 UC ANR researchers evaluated the nitrogen content of the most common vegetable and berry crops grown in more than 150 commercial fields in the coastal region of California during a 3-year study. Through 30 presentations, the team extended the information about the amount of nitrogen needed

for each crop to achieve commercial yields. The data were also incorporated into technical guidelines and CropManage, an online tool for growers that provides crop-specific recommendations for nitrogen and water needs.

Water Use Efficiency

Increasing water use efficiency is critical to creating value from water supplies.

- Work was performed on micro-irrigation technologies to maximize potential water savings and crop yields. Management of the technologies is critical to reach these goals. Work on canopy cover sensing is being performed 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.
- Research was performed to generate empirical data on the water requirements for winegrape production in the San Joaquin Valley in order to protect and sustain the supply of fresh water needed for viticulture in that region. In particular, this work will help determine the blue water footprint of grapevines as a function of three irrigation treatments.
- Work is proceeding on the use of plant genetics for breeding drought tolerant varieties of several field crops. This involves identification of pathways and methodologies for testing drought tolerance.
- Work is proceeding to reduce water use and manage salinity in turf grasses. Breeding, genetics, weed control and irrigation management can help to lessen the impacts of turfgrass in the state. Management and irrigation scheduling can have significant impacts on water use by turfgrass. This work is being extended to look at water use in other urban landscapes and in the horticultural and ornamental industries.

Water Policy

The importance of water to California and its economy is evidenced by the intensity of its policy debates. UC continues to inform these debates with sound science and with scientific policy analysis.

- Research and outreach evaluated regulatory instruments and policy options 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 the affected communities of the Tulare Lake and Salinas Basins.
- One research project studied the impacts of a change in water supply on the agricultural economy of the San Joaquin Valley.
- Urban water use, conservation and pricing are all critical components to meeting future water demand. Work on economic and behavioral modeling is helping shed new light on these decision-making tools.
- Water and energy are interlinked. Research on the water-energy nexus is being conducted to help untangle these connections and interactions.

Water resilience to extreme weather and climate change

- Climate change will ultimately impact water use and water supply. Understanding these relationships between use and supply under changing conditions will increase resiliency and lessen impacts.
- There are many impacts to our water systems from forest fires. Work to better understand debris flows from rain events after fires will better prepare our communities to reduce damages and recover from these disasters.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	323.0	0.0	358.0	0.0
Actual	326.8	0.0	394.6	0.0

II. Merit Review Process

1. The Merit Review Process that was Employed for this year

- Internal University Panel
- Combined External and Internal University Panel
- Combined External and Internal University External Non-University Panel
- Expert Peer Review

2. Brief Explanation

Scientific Peer Review

Each project funded under the Hatch Act is peer reviewed at the department level in the colleges/school at UC Berkeley, Davis, and Riverside. A peer review committee is appointed by the department chair. The committee evaluates the relevance, quality, and scientific value of the proposed research. Upon completion of the peer review, the project is also reviewed at the dean's office for USDA compliance and forwarded to the Vice President's office for final review and submission to NIFA.

Merit Review

UC ANR's organizational structure emphasizes that resource allocation decisions will be driven by programmatic considerations and developed through a broad participatory process. This process includes review of the quality and relevance to program goals for all of the Division's programs.

At the statewide level, the UC ANR Program Council met almost monthly. It was chaired by the Associate Vice President, and included the four Executive Associate Deans, five strategic initiative leaders, and two CE representatives, as well as other ex-officio administrative members. This group coordinates division-wide planning and delivery of programs and develops recommendations for allocation of Division resources. The Program Council reviewed all programmatic budget requests from a statewide perspective to make specific recommendations on budget expenditures and resource allocation principles. These recommendations were then considered by the Vice President for final allocation decisions.

UC ANR's Strategic Initiative leaders and advisory panels are key players in helping the Division. They help to unify, communicate, and advocate for UC ANR's work. During FY 2018, the five Strategic Initiative leaders met together almost monthly and held regular panel meetings which bring together diverse programmatic perspectives to provide input in program priorities. UC ANR's Program Teams provide an umbrella structure for the Division's many Workgroups to meet. These Program Teams carry out their essential leadership functions and enhance inter-Workgroup communication and collaboration. During FY 2018, there were 10 Program Teams meetings and 16 Workgroup meetings. All except one happened during the UC ANR Statewide Conference in April 2018.

During fall of 2017, 50 full proposals for the division-wide, integrated Competitive Grants Program and the High Risk, High Rewards Program were reviewed by technical peer-review panels recruited. The technical reviewers depended on the proposals received and included external experts. After each proposal received a technical review by academics that had no conflict of interest with the proposal, the UC ANR Strategic Initiative leaders provided a consensus slate of highly ranked proposals based on the other program criteria. Then Program Council discussed the proposals in detail and made recommendations to the Vice President. In December 2017, UC ANR's Vice President announced the funding decisions to support 12 projects between the two programs.

UC ANR actively engages stakeholders in a thorough process to determine the highest priority Cooperative Extension academic positions to rebuild and strengthen the UC ANR network, given the many retirements over the past few years and to address programmatic gaps and emerging needs. The process expects consultation and discussions with internal UC ANR stakeholders and strongly encourages engaging external stakeholders, including commodity groups, cooperating programs, agency partners, community groups, and others, in the development of the position proposals. The proposals, along with information regarding current staffing and retirement projections, is considered by UC ANR Program Council in their deliberations to provide recommendations to the Vice President, who then makes the final decision. A 2018 call for CE positions was launched in January with the final announcement from the Vice President in November, to be shared in the next federal annual report.

III. Stakeholder Input

1. Actions taken to seek stakeholder input that encouraged their participation

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals
- Targeted invitation to selected individuals from general public
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey specifically with non-traditional groups
- Survey specifically with non-traditional individuals
- Survey of selected individuals from the general public

Brief explanation.

UC ANR used a variety of mechanisms to seek stakeholder input on the development of Division program priorities and use of its research, extension and education funds. In addition, CE advisors delivering programs in 58 California counties received input on local needs from their local clientele on a daily basis. All of the input received from stakeholders was used by UC ANR members in program planning and implementation at the local, regional, and statewide level.

UC ANR Strategic Planning

UC ANR continued to make significant progress toward its Strategic Vision 2025, completing the development of and implementing the 2016-2020 Strategic Plan. The stakeholder input received throughout the process helped clarify and refine the core values, strategic objectives, and goals. During FY 2018, UC ANR hosted a retreat to get diverse stakeholder feedback on year one

implementation progress and input on opportunities to improve coordination, metrics, and strategic plan communications. In addition, for Goal 5: prioritize programs and services, a poster was shared during the statewide conference poster session to get feedback on the effort (FTE) data toward the new division-wide condition changes, which were developed collaboratively by diverse program leadership. In addition, there were two division-wide webinars to get broad internal stakeholder feedback on the newly developed division-wide public value statements and respective condition changes.

Research and Extension Center System Strategic Planning

During FY 2018, UC ANR's nine Research and Extension Centers continued to implement their respective strategic plans that were each developed with critical stakeholder guidance. Stakeholder input was sought both through the diverse committees, including CE advisors, CE specialists, and AES faculty and members from external stakeholder groups, as well as through broad feedback loops conducted throughout the process, reaching additional stakeholder groups identified by the committee. The strategic planning process was collaborative, future-oriented and utilization-focused, and included assessment, strategy formation, and implementation accountability. Situational and stakeholder analysis identified key strengths and opportunities, as well as challenges to inform the development of the strategic directions, each with specific goals, intended outcomes, and key actions that include identified implementation responsibility and anticipated deliverables.

Statewide Program and Institutes Strategic Planning & Reviews

Each of the Division's eight statewide programs and two statewide institutes undergoes routine program planning and review efforts that are designed to solicit and incorporate significant input from key stakeholder groups. The strategic planning processes are highly collaborative, including a committee with representatives of diverse stakeholder interests, across UC and external groups. Those members then also outreach to additional stakeholder groups for their input. Similarly, the review committees include members from across the UC ANR network and external stakeholder representatives. As part of the review process, the committee also solicits input from additional stakeholders through interviews and web-based surveys. During FY 2018, the California Institute for Water Resources and the California 4-H Youth Development Program involved diverse stakeholder groups in their strategic planning efforts. The Informatics and GIS Statewide Program completed its 5-year review in December 2017, which found impressive results toward promoting UC ANR's use of cutting-edge geospatial tools in project planning, analysis, implementation, and communication, and the review provided directives for the program moving forward including expanding its capacity and reach with drones. Lastly, the California Naturalist Program initiated its 5-year review in January 2018; the final directives were announced December 2018 and thus will be included in the following federal annual report.

Strategic Initiative, Program Team, and Workgroup Meetings

The Strategic Initiative, Program Team, and Workgroup Meetings are the primary mechanism for accomplishing UC ANR's high priority research and extension goals through grassroots leadership. During FY 2018, the five Strategic Initiatives held regular panel meetings, and there were 10 Program Team meetings and 16 Workgroup meetings. These meetings brought together AES and CE personnel and non-UC ANR partners to work on emerging and continuing priority issues in Division program areas. Workgroups involve external stakeholders in their program planning process and Workgroup activities and projects. The involvement of external stakeholders in the Workgroups ensures that real world needs are brought to the attention of the Division as programs are planned and implemented. External stakeholders on the workgroups include individual producers, representatives from local community groups, state and federal agencies, industry groups, consumer groups, and colleagues from other higher education institutions.

Formal advisory groups

The President's Advisory Commission on Agriculture and Natural Resources meets twice annually to advise and assist UC in identifying the educational needs of the state's agricultural, natural and human resources communities and ways to meet them through science-based research, educational outreach and classroom instruction. The members represent close to 30 different business, consumer, youth, and government leaders from throughout California and meet twice a year to provide input. The UC ANR Vice President participates as a member of this Commission and brings the Commission's advice to the UC ANR Executive Council, which includes the four Deans from the UC ANR affiliated colleges/school. This leadership council then provides strategic guidance in the articulation of long-term programmatic directions division-wide, the allocation of resources across units, and the development of UC ANR policies.

Each of the three colleges at UC Berkeley, Davis, and Riverside and the School of Veterinary Medicine at Davis have external stakeholder advisory councils that met at least annually to provide feedback on their research, extension, and teaching programs. In addition, departments may have advisory boards. The Statewide Programs also have advisory groups, some mostly composed of external members, which meet regularly to review progress and offer recommendations for future program direction.

Commodity Organizations/Marketing Order Boards

Members of these organizations provided their annual input on research and extension needs for their commodities to UC ANR members through regular meetings and discussion of funding for research projects.

2(A). A brief statement of the process that was used by the recipient institution to identify individuals and groups stakeholders and to collect input from them

1. Method to identify individuals and groups

- Use Advisory Committees
- Use Internal Focus Groups
- Use External Focus Groups
- Open Listening Sessions
- Needs Assessments
- Use Surveys

Brief explanation.

Please see previous Actions to Seek discussion.

2(B). A brief statement of the process that was used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them

1. Methods for collecting Stakeholder Input

- Meeting with traditional Stakeholder groups
- Survey of traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Survey of traditional Stakeholder individuals
- Meeting with the general public (open meeting advertised to all)
- Meeting specifically with non-traditional groups
- Survey specifically with non-traditional groups

- Meeting specifically with non-traditional individuals
- Survey specifically with non-traditional individuals
- Meeting with invited selected individuals from the general public

Brief explanation.

Please see previous Actions to Seek discussion.

3. A statement of how the input will be considered

- In the Budget Process
- To Identify Emerging Issues
- Redirect Extension Programs
- Redirect Research Programs
- In the Action Plans
- To Set Priorities

Brief explanation.

Please see previous Actions to Seek discussion.

Brief Explanation of what you learned from your Stakeholders

Please see previous Actions to Seek discussion.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
{No Data Entered}	{No Data Entered}	{No Data Entered}	{No Data Entered}

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	8281482	0	6239498	0
Actual Matching	8281482	0	6239498	0
Actual All Other	100621169	0	275695562	0
Total Actual Expended	117184133	0	288174558	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	0	0

V. Planned Program Table of Content

S. No.	PROGRAM NAME
1	Sustainable Food Systems
2	Sustainable Natural Ecosystems
3	Healthy Families and Communities
4	Endemic and Invasive Pests and Diseases
5	Water Quality, Quantity and Security
6	Sustainable Energy

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Sustainable Food Systems

Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	5%		11%	
111	Conservation and Efficient Use of Water	11%		1%	
112	Watershed Protection and Management	3%		0%	
136	Conservation of Biological Diversity	0%		3%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		15%	
202	Plant Genetic Resources	0%		5%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%		6%	
204	Plant Product Quality and Utility (Preharvest)	11%		2%	
205	Plant Management Systems	16%		2%	
206	Basic Plant Biology	0%		12%	
211	Insects, Mites, and Other Arthropods Affecting Plants	14%		3%	
212	Pathogens and Nematodes Affecting Plants	14%		9%	
213	Weeds Affecting Plants	14%		0%	
215	Biological Control of Pests Affecting Plants	0%		5%	
302	Nutrient Utilization in Animals	0%		6%	
307	Animal Management Systems	12%		2%	
501	New and Improved Food Processing Technologies	0%		5%	
601	Economics of Agricultural Production and Farm Management	0%		4%	
611	Foreign Policy and Programs	0%		3%	
702	Requirements and Function of Nutrients and Other Food Components	0%		6%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	10.3	0.0	16.2	0.0
Actual Paid	14.3	0.0	18.8	0.0
Actual Volunteer	191.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
2298407	0	2451562	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
2298407	0	2451562	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
43381872	0	83750121	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

UC ANR's integrated research and extension activities will conduct research projects, workshops, education classes, demonstrations, and one-on-one interventions. In addition, the programs will use PSAs, newsletters, mass media, web sites and collaborations with other agencies and organizations to create and deliver programs.

2. Brief description of the target audience

- Food producers (e.g. farmers/ranchers and rangeland owners/operators/managers, including conventional, organic, small and large producers)
- Agricultural advising professionals (e.g. Pest Control Advisors, crop advisors, landscape professionals)
- Allied industry companies including seed and supply companies
- Food processors, handlers, retailers, and suppliers
- Public regulatory agencies and private non-profit advocacy groups
- Food consumers, members of the general public

3. How was eXtension used?

UC ANR academics used eXtension to participate in and contribute to Communities of Practice, to answer "Ask an Expert" questions, and for other networking purposes.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	295224	0	138199	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2018

Actual: 8

Patents listed

1. Monoterpene Hydrocarbons Production Using Genetically Engineered Cyanobacteria, Microalgae, or Bacteria
2. BOVINE OLIGOSACCHARIDES ARE SELECTIVELY CONSUMED BY BENEFICIAL BACTERIA AND PRODUCE EXOGENOUS SIGNALS TO THE INTESTINE
3. 'GUMDROP' PISTACHIO
4. 'FAMOSO' PISTACHIO
5. 'TEJON' PISTACHIO
6. 'VILMOS' A PROCESSING CLINGSTONE PEACH RIPENING WITH TO JUST AFTER 'ANDROSS' AND WITH FREEDOM FROM PIT FRAGMENTATION AND RED STAINING AND CAPACITY FOR-
7. PAMOIC ACID BLOCKS ETHYLENE SIGNALING
8. TOLMETIN IS AN ANTI-ETHYLENE COMPOUND

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	164	376	540

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Classes/Short Courses Conducted
Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Workshops Conducted
Not reporting on this Output for this Annual Report

Output #3

Output Measure

- Demonstrations and Field Days Conducted
Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Newsletters Produced
Not reporting on this Output for this Annual Report

Output #5

Output Measure

- Web Sites Created or Updated
Not reporting on this Output for this Annual Report

Output #6

Output Measure

- Research Projects Conducted
Not reporting on this Output for this Annual Report

Output #7

Output Measure

- Videos, Slide Sets and other A/V or Digital Media Educational Products Created
Not reporting on this Output for this Annual Report

Output #8

Output Measure

- Manuals and Other Printed Instructional Materials Produced
Not reporting on this Output for this Annual Report

Output #9

Output Measure

- Meetings Organized (includes field days, workshops, short courses, classes, and other)

Year	Actual
2018	1172

Output #10

Output Measure

- Train the Trainer

Year	Actual
2018	51

Output #11

Output Measure

- Educational Presentations

Year	Actual
2018	1125

Output #12

Output Measure

- Policy Engagement Activities

Year	Actual
2018	95

Output #13

Output Measure

- Popular Articles (non-peer-reviewed)

Year	Actual
2018	143

Output #14

Output Measure

- Website/Blog/Social Media Managed

Year	Actual
2018	133

Output #15

Output Measure

- Digital Media (includes videos, applications, software, other A/V educational products, recorded webinars)

Year	Actual
2018	59

Output #16

Output Measure

- Media Outlet Programs /Interviews

Year	Actual
2018	310

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Farm and ranch owners/managers and allied industry professionals, participating in the programs, gain knowledge of crop and varietal selection factors and research-based performance data.
2	Farm and landscaping owners/managers and allied industry professionals, participating in the programs, gain knowledge of cultural practices and other aspects of comprehensive management systems for plant production.
3	Farm and ranch owners/managers, participating in the programs, gain knowledge of business management practices and marketing strategies, including the costs and risks associated with producing specialty crops.
4	Farm and ranch owners/managers, participating in the programs, gain skills in business management practices.
5	Farm and landscaping owners/managers and allied industry professionals, participating in the programs, gain knowledge of pest and disease management for plant production.
6	Farm and landscaping owners/managers and allied industry professionals, participating in the programs, gain knowledge of irrigation management and drainage.
7	Farm and landscaping owners/managers and allied industry professionals, participating in the program, gain skills to improve comprehensive management systems for plant production.
8	Farm and ranch owners/managers and allied industry professionals, participating in food safety programs, gain knowledge on on-farm control of food contaminants and quality assurance programs.
9	Ranch owners/managers and allied industry professionals, participating in the programs, gain knowledge of aspects of comprehensive management systems for animal production.
10	Farm owners/managers and allied industry professionals, participating in the programs, are more likely to try out or adopt recommended cultural practices or other aspects of comprehensive management systems for plant production.
11	Farm and landscaping owners/managers and allied industry professionals participating in the program gain knowledge of aspects of plant nutrition management.
12	Ranch owners/managers and allied industry professionals, participating in the program, gain skills to improve comprehensive management systems for animal production.
13	Ranch owners/managers and allied industry professionals, participating in the programs, are more likely to try out or adopt recommended practices or other aspects of comprehensive management systems for animal production.
14	National priority outcome indicator: number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased, increased economic return, and/or conservation of resources.
15	Participants learned and adopted cultural practices or other aspects of comprehensive management systems for plant production.
16	Participants adopted superior varieties of crops for plant production.

17	Participants learned about farm business management practices and marketing.
18	Science-based information applied to food production policy and decision-making.
19	Participants benefit from more profitable farm businesses.
20	Participants learned and adopted recommended practices for sustainable landscaping.
21	Participants learned about and adopted practices for more productive and sustainable animal management.
22	Science-based information applied to animal production systems policy and decision-making.
23	Participants experienced changes that will improve their food system livelihood.
24	Science-based information informed labor policy and decision-making.
25	Participants adopted superior varieties of crops creating new market demand.
26	Participants learned about or were more likely to try out new market opportunities.

Outcome #1

1. Outcome Measures

Farm and ranch owners/managers and allied industry professionals, participating in the programs, gain knowledge of crop and varietal selection factors and research-based performance data.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Farm and landscaping owners/managers and allied industry professionals, participating in the programs, gain knowledge of cultural practices and other aspects of comprehensive management systems for plant production.

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Farm and ranch owners/managers, participating in the programs, gain knowledge of business management practices and marketing strategies, including the costs and risks associated with producing specialty crops.

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Farm and ranch owners/managers, participating in the programs, gain skills in business management practices.

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Farm and landscaping owners/managers and allied industry professionals, participating in the programs, gain knowledge of pest and disease management for plant production.

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Farm and landscaping owners/managers and allied industry professionals, participating in the programs, gain knowledge of irrigation management and drainage.

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Farm and landscaping owners/managers and allied industry professionals, participating in the program, gain skills to improve comprehensive management systems for plant production.

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Farm and ranch owners/managers and allied industry professionals, participating in food safety programs, gain knowledge on on-farm control of food contaminants and quality assurance programs.

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Ranch owners/managers and allied industry professionals, participating in the programs, gain knowledge of aspects of comprehensive management systems for animal production.

Not Reporting on this Outcome Measure

Outcome #10

1. Outcome Measures

Farm owners/managers and allied industry professionals, participating in the programs, are more likely to try out or adopt recommended cultural practices or other aspects of comprehensive management systems for plant production.

Not Reporting on this Outcome Measure

Outcome #11

1. Outcome Measures

Farm and landscaping owners/managers and allied industry professionals participating in the program gain knowledge of aspects of plant nutrition management.

Not Reporting on this Outcome Measure

Outcome #12

1. Outcome Measures

Ranch owners/managers and allied industry professionals, participating in the program, gain skills to improve comprehensive management systems for animal production.

Not Reporting on this Outcome Measure

Outcome #13

1. Outcome Measures

Ranch owners/managers and allied industry professionals, participating in the programs, are more likely to try out or adopt recommended practices or other aspects of comprehensive management systems for animal production.

Not Reporting on this Outcome Measure

Outcome #14

1. Outcome Measures

National priority outcome indicator: number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased, increased economic return, and/or conservation of resources.

Not Reporting on this Outcome Measure

Outcome #15

1. Outcome Measures

Participants learned and adopted cultural practices or other aspects of comprehensive management systems for plant production.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California is a national leader in agricultural production, leading the country in cash receipts for agricultural products, with farms and ranches receiving over \$50 billion for their output. The state produces over two-thirds of the country's fruits and nuts and a third of the country's vegetables. The state's farmers and ranchers must innovate and adapt to technical, social, and environmental challenges to maintain the economic vigor of California's agricultural food

production. Factors such as high input prices (e.g. labor, fertilizers, and pesticides) and regulations affect the profitability of farm and ranch businesses. These factors often more adversely affect small-scale and limited resource farmers because they often lack the skills or resources that larger farmers have.

What has been done

Research and outreach was conducted to increase plant production system efficiencies. One project focused on vineyard cultural practice optimization disseminated results through the seminar and symposia presentations and during farm calls. The Young Orchard Handbook was published and hundreds of copies were distributed from the website and by multiple Pest Control Advisor companies as part of their training materials. It was written about in two separate articles by Western Farm Press. In addition the information was extend through meetings with clientele. Research on rice was conducted to develop better fertility guidelines and explore alternative water management practices, and on diagnosing and managing weedy rice in rice cropping systems. Outreach included publications and presentations. In sorghum, applied research was augmented to support a growing industry. Seeding rates were trialed in grain sorghum to provide information that is relevant to California climatic and environmental conditions. Further North near the Oregon border, results from an organic potato study documented how cover crops and amendments influence soil and plant nitrogen helping growers increase yields, reduce input costs, and prevent nitrate losses in the environment. These studies generated interest from USDA Natural Resources Conservation Service.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that can lead to increased agricultural efficiency and profitability. Specific measured outcome indicators follow.

- Most of the growers in the production area for the Autumn King grape variety are now using different plant growth regulators to improve the fruit quality. This is one of the major late table grape varieties. It is anticipated that this will lead to an increase in vineyard productivity with high fruit quality, helping promote table grape marketing and profitability.
- Growers and managers have increased their understanding of research-based approaches to establish orchards and manage young orchards. On-farm conversations/informal interviews indicate knowledge gained based on the more advanced questions they are now asking.
- 20 growers and industry consultants improved their understanding of planting and tillage practices in rice systems as a result of the extension presentations.
- After presenting the sorghum trial results, 92% of 60 growers and industry consultants expressed a willingness to plant the low seeding rates that performed best in trials. Before the workshop most growers were planting higher seeding rates because of industry recommendations. This increased efficiency should result in good yields with lower seed inputs, and thus increased profitability.
- As a result of an organic potato study, around five of potato growers in Northeast California planted over 250 acres of cover crops on their farms and/or switched their organic amendment program to match the study recommendations.

These measured outcomes strengthened diverse California farm businesses by helping to increase their economic returns given increased yield, reduced inputs, or improved business management and marketing. These outcomes contribute to increased agricultural efficiency and profitability; and thus, the public value of promoting economic prosperity in California. In 2017, California farms and ranches increased cash receipts for their output by almost 6% compared to the previous year, collecting over \$50 billion.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
601	Economics of Agricultural Production and Farm Management

Outcome #16

1. Outcome Measures

Participants adopted superior varieties of crops for plant production.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California is a national leader in agricultural production, leading the country in cash receipts for agricultural products, with farms and ranches receiving over \$50 billion for their output. The state produces over two-thirds of the country's fruits and nuts and a third of the country's vegetables. The state's farmers and ranchers must innovate and adapt to technical, social, and environmental challenges to maintain the economic vigor of California's agricultural food production. Factors such as high input prices (e.g. labor, fertilizers, and pesticides) and regulations affect the profitability of farm and ranch businesses. These factors often more adversely affect small-scale and limited resource farmers because they often lack the skills or resources that larger farmers have.

What has been done

There were a number of ongoing variety trials to improve productivity. On the Central Coast research findings were extended to vineyard growers to inform planting decisions to improve yields and quality. In the Central Valley, one collaborative project is looking for tree rootstocks that can decrease boron toxicity, given growers are asking how to properly manage this over-supplied, naturally occurring element in soil and water. Research findings were extended through local meetings and the statewide meeting hosted by the Almond Board of California, and through an interview with an industry news outlet. Other trials evaluated the suitability of rice varieties to

various California microclimates. Further North near the Oregon border, variety trials and management trials helped growers successfully grow new potato varieties including Classic, Teton, and Canela. Lastly, findings from small grain variety trials were extended through many field-based educational efforts as well as a new interactive web-based tool that provides users with customized results to be able to select the most productive and profitable varieties.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that can lead to increased agricultural efficiency and profitability. Specific measured outcome indicators follow.

- Research and extension on almond rootstocks in high boron conditions has led to decreased planting of the least boron tolerant almond rootstock that was previously one of the most planted rootstocks in Yolo County. Sales data from two nurseries indicate a significant increase in planting the rootstocks the trial found to be superior: sales doubled over the last few years.
- Vineyard growers on the Central Coast are using planting stock with preformed trunks, given it was shown to have earlier plant development with higher initial yields and labor savings from reduced training. In addition, they are avoiding rootstocks that were shown to be most susceptible to winter cold injury.
- Growers, breeders, and other industry professionals are selecting more productive and profitable small grain varieties to grow across the diverse agroecosystems in the state. After one indoor grower meeting, 72% of the audience indicated that they were likely to use the web-based tools that help users to select superior varieties.
- Two varieties (M-210 and Calaroma-201) that were included in the trial program were released for commercial production. The variety trials results helped growers select varieties better adapted to their location. Approximately 95% of California's rice acreage is planted to varieties that have been evaluated in the variety trials, indicating very high levels of adoption of improved varieties. These varieties have allowed growers to maintain high productivity, averaging 8,500 lbs/acre in the past ten years, which is 20% higher than average yields in other US states. Good yields and quality translate into improving economic returns for the rice industry.

These measured outcomes strengthened diverse California farm businesses by helping to increase their economic returns given increased yield, reduced inputs, or improved business management and marketing. These outcomes contribute to increased agricultural efficiency and profitability; and thus, the public value of promoting economic prosperity in California. In 2017, California farms and ranches increased cash receipts for their output by almost 6% compared to the previous year, collecting over \$50 billion.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
601	Economics of Agricultural Production and Farm Management

Outcome #17

1. Outcome Measures

Participants learned about farm business management practices and marketing.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California is a national leader in agricultural production, leading the country in cash receipts for agricultural products, with farms and ranches receiving over \$50 billion for their output. The state produces over two-thirds of the country's fruits and nuts and a third of the country's vegetables. The state's farmers and ranchers must innovate and adapt to technical, social, and environmental challenges to maintain the economic vigor of California's agricultural food production. Factors such as high input prices (e.g. labor, fertilizers, and pesticides) and regulations affect the profitability of farm and ranch businesses. These factors often more adversely affect small-scale and limited resource farmers because they often lack the skills or resources that larger farmers have.

What has been done

Education and outreach for small farmers and urban agriculturists was provided through web-based resources and in-person workshops. Workshops were held that focused on building producers' skills in business management, risk management and planning, economic and market analysis, and on labor related issues. Additional efforts worked with state and local farm service agencies to reach Spanish-speaking audiences, and developed and maintain the Ag in Uncertain Times en Espanol Spanish website. Risk management tools and materials were developed and made available through the eRight Risk California website (<http://erightrisk.com/california/2014/default.htm>). Lastly, a multi-state collaboration with University of Wyoming, Colorado State and the University of Nebraska has given California farmers access to expertise, tools, resources and educational opportunities on business and risk management not previously easily available.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that can lead to increased agricultural efficiency and profitability. Specific measured outcome indicators follow.

- 90 training participants reported through a follow-up survey that they used the information after a Los Angeles area workshop on "Marketing and Business Management for Urban Farmers." 54% to develop a new or improved marketing plan. 33% to change one or more business practice. In addition, 26% to improve sales.
- As a result of one small farm economics and viability program in Sierra Foothills:
 - * 58 producers increased their knowledge of farm and ranch risks; identified key risks; and developed a risk assessment for their operation.
 - * 24 producers assessed the current profitability and determined the appropriate scale of their operations to meet the profitability benchmarks they set, and developed a plan to meet their benchmark.
 - * 20 producers developed business plans, including marketing and operations plans, cash flow and capital expenditure budgets.
 - * 14 producers conducted an in-depth economic analysis of their business; analyzing the operational components; evaluating costs of production and marketing; projecting potential sales; and assessing the profitability of each enterprise. These analyses help farmers and ranchers make better business decisions, and allow them to accurately assess the profitability of new enterprises and markets.
 - * One rancher reported that he was able, as a result of this class, to take on a new enterprise, improving the profitability and viability of his business.
 - * 20 producers developed and implemented financial analysis and recordkeeping systems, including enterprise analysis, cash flow, and profit and loss.
- As a result of the Surviving in Ag Risk Management Education Series that targeted small-scale, limited resource farmers in San Diego County. Growers have increased their understanding and ability to manage risks impacting their agricultural businesses.

These measured outcomes strengthened diverse California farm businesses by helping to increase their economic returns given increased yield, reduced inputs, or improved business management and marketing. These outcomes contribute to increased agricultural efficiency and profitability; and thus, the public value of promoting economic prosperity in California. In 2017, California farms and ranches increased cash receipts for their output by almost 6% compared to the previous year, collecting over \$50 billion.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #18

1. Outcome Measures

Science-based information applied to food production policy and decision-making.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California is a national leader in agricultural production, leading the country in cash receipts for agricultural products, with farms and ranches receiving over \$50 billion for their output. The state produces over two-thirds of the country's fruits and nuts and a third of the country's vegetables. The state's farmers and ranchers must innovate and adapt to technical, social, and environmental challenges to maintain the economic vigor of California's agricultural food production. Factors such as high input prices (e.g. labor, fertilizers, and pesticides) and regulations affect the profitability of farm and ranch businesses. These factors often more adversely affect small-scale and limited resource farmers because they often lack the skills or resources that larger farmers have.

What has been done

The UC ANR Urban Ag Collaborative team rolled out a workshop series in four of the state's largest urban communities: the San Francisco Bay Area, Los Angeles, Sacramento, and San Diego. A total of 16 one-day trainings were held reaching 581 participants. To extend the training beyond day-of-event attendees, workshop materials were made available online via UC ANR's Urban Agriculture information portal. Collaborative research on the specialty crop pomegranates focuses on improving fruit production, primarily the production and post-harvest attributes of pomegranate. The post-harvest work evaluated pomegranate juice and fruit quality and consumer preference for different cultivars grown in the two different climatic conditions.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that can lead to increased agricultural efficiency and profitability. Specific measured outcome indicators follow.

- 90 training participants reported through a follow-up survey that they used the information after the on "Legal Basics of Urban Farming" workshop in the Los Angeles area. 63% to connect with an organization they learned about at the workshop. 40% to become engaged in urban agriculture advocacy or policy work. And 33% to take steps towards participating in urban agriculture incentive zones.
- Post-harvest information on pomegranates has been used by the juice industry in determining the actual percentage of pomegranate juice in commercial juices.

These measured outcomes strengthened diverse California farm businesses by helping to

increase their economic returns given increased yield, reduced inputs, or improved business management and marketing. These outcomes contribute to increased agricultural efficiency and profitability; and thus, the public value of promoting economic prosperity in California. In 2017, California farms and ranches increased cash receipts for their output by almost 6% compared to the previous year, collecting over \$50 billion.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #19

1. Outcome Measures

Participants benefit from more profitable farm businesses.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California is a national leader in agricultural production, leading the country in cash receipts for agricultural products, with farms and ranches receiving over \$50 billion for their output. The state produces over two-thirds of the country's fruits and nuts and a third of the country's vegetables. The state's farmers and ranchers must innovate and adapt to technical, social, and environmental challenges to maintain the economic vigor of California's agricultural food production. Factors such as high input prices (e.g. labor, fertilizers, and pesticides) and regulations affect the profitability of farm and ranch businesses. These factors often more adversely affect small-scale and limited resource farmers because they often lack the skills or resources that larger farmers have.

What has been done

Research and extension was conducted to increase agricultural efficiency and profitability. For example, work continued to improve production of strawberries and vegetable growers continued along the Central Coast. In addition, there are ongoing efforts to improve farm profitability, with a number of projects focusing on helping small farmers and ranchers. For example, in the Sierras

Foothills workshops were held to build producers' skills in business management, risk management and planning, economic and market analysis, and on labor related issues.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that led to increased agricultural efficiency and profitability. Specific measured outcome indicators follow.

- From surveys over the last five years, 86% of small farm businesses in the Sierra Foothills who participated in UCCE farm business planning activities reported being profitable and paying themselves a salary. This is in contrast to the last USDA Ag Census (2012) which reported that less than 25% of farms and ranches in Placer and Nevada Counties had net gains, a measure of profitability.
- In a survey conducted between 2016 and 2018, 94% of respondents indicated adoption of recommended practices (including irrigation, nutrient, and pest and disease management) applied on over 145,000 acres, resulting in a minimum yield increase of 16.5% and at least \$2 million additional revenues.

These measured outcomes strengthened diverse California farm businesses by helping to increase their economic returns given increased yield, reduced inputs, or improved business management and marketing. These outcomes contribute to increased agricultural efficiency and profitability; and thus, the public value of promoting economic prosperity in California. In 2017, California farms and ranches increased cash receipts for their output by almost 6% compared to the previous year, collecting over \$50 billion.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #20

1. Outcome Measures

Participants learned and adopted recommended practices for sustainable landscaping.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California's growing population of over 40 million people raises environmental concerns, including decline in pollinator populations, green waste, and water-related issues, for the state's urban landscapes and urban-rural interfaces. There is opportunity to improve landscape management industry practices; for example, fertilizer and pesticide applications that can reduce negative impacts surface water contamination. There is also the need to conserve water, such as by reducing water use in turf landscapes like playing fields, golf courses, and office parks. In addition, California's Assembly Bill 341 mandates a 75 percent reduction in the amount of green waste going to landfills by the year 2020. The decomposition of green material in landfills produce methane, a greenhouse gas with global warming potential approximately 25 times higher than carbon dioxide.

What has been done

UC ANR translates research into actionable management strategies to promote increased ecological sustainability of landscapes. UC ANR partners with public, non-profit, and private groups to create and extend new knowledge about environmental horticulture.

In FY 2018, over 6,000 UC Master Gardener volunteers offered close to 400,000 volunteer hours in over 50 counties sharing research-based information on environmental horticulture to help the public more sustainably grow home, community, and school gardens. Lastly, a more specific effort worked to promote the sustainability of California's many palms, which are widely planted and increasingly common components of California landscapes. New research-based information about selection and management of palms under California's climate regimes and soil types was developed and extended. In these ways UC ANR translated research into actionable management strategies to protect our urban environments.

Another environmental horticulture effort has graduated a total of 56 Qualified Green Gardeners, with 15 during 2018, from large and small landscape companies, school districts, parks departments, Regional Conservation Corps, California State University Stanislaus, and UC Merced. Lastly, another project focuses on promoting the sustainability of California's many palms.

Results

Through UC ANR outreach and education, management of landscapes is being made more ecologically sustainable. Specific measured outcome indicators follow.

- Members of the public participating in the volunteer-led UC Master Gardener education events reported the following, through a statewide follow up survey:

- * Created and enhancing pollinator friendly gardens: For example, 70% (of 424 participants) started or improved their use of plants that attract and support pollinators, and nearly 55% started or improved the practice of providing water sources for pollinators. They also learned about creating nesting habitats. They reported applying what they learned to over 2 million square feet of pollinator habitat. This improves yields in home food gardens and supports local agriculture productivity.

- * Used recommended green waste reduction practices; for example, 68% of 719 started or improved selecting plants for size, sun, needs, water needs, and maintenance level. This reduces plant mortality and contributes to less green waste in landfills.

- * Adopted improved landscape water use efficiency practices; for example, 67% of 587 started

or improved selecting low water-use plants. In addition, participants reported removing over 135,000 square feet of turf. These practices reduce water use, helping conserve California's precious water resources.

- Adopted integrated pest management practices; for example, 54% of 632 started or improved removal of or not introducing invasive plants. This slows their spread and protects natural and managed ecosystems.

- As a result of the Qualified Green Gardeners program, 100% of participants reported, through in-course exit surveys, that they gained important knowledge in one or more areas covered and 94% reported the intention to implement all 16 sustainability practices polled.

- As a result of the palm project, clientele surveys showed 50% to 70% participants used irrigation guidelines which help to reduce landscape water use and runoff; and nutrition guidelines which emphasize applications of slow-release fertilizers that help to reduce nutrient leaching and runoff. Together these reduce landscape water use and contamination of California's groundwater resources. In addition, awareness of the South American palm weevil helps reduce tree mortality, resulting in less green waste in landfills.

Together these measured outcomes demonstrate that because of UC ANR's efforts some landscapes are more ecologically sustainable. They now better protect water quality and reduce green waste going to landfills, which helps improve air quality. In this way, UC ANR contributes to the public value of protecting California's natural resources. However, there is more work to be done ? the statewide recycling rate, which includes composting, continues to decrease.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
205	Plant Management Systems

Outcome #21

1. Outcome Measures

Participants learned about and adopted practices for more productive and sustainable animal management.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California is ranked fourth in the nation in total livestock receipts, with over \$11 billion in 2017. It remains the largest dairy-producing state providing over 18% of the nation's milk supply in 2017, and dairy is the state's top producing commodity. Ranchers and dairy producers face many management and production challenges, like drought, water and air quality regulations, and invasive species, as they strive to maintain their competitive edge. Although livestock are a high value commodity, at the ranch level it can be difficult to be profitable. In fact, ranchers or their family members often need to work off the ranch in order to make ends meet and keep the ranch running. At the same time, there is the need to improve the ecological viability of these animal production systems.

What has been done

UC ANR partnered with public, non-profit, and private groups to create and extend new knowledge about animal systems management. Livestock health was identified as a high priority for ranchers so workshops focused on this topic were conducted, including on low-stress livestock handling and specific management practices for raising sheep and goats. Another project focused on improving beef carcass quality. An annual beef carcass evaluation and contest was held for market beef cattle exhibitors at the Yolo County 4-H Spring Show and the Yolo County Fair. Ultrasound imaging provides carcass measurements that are used to evaluate and rank each exhibitor's beef carcass quality. In this way, the project provides education on the importance of carcass quality, how to understand carcass quality data, and the exhibitor's role in the beef cattle industry.

Results

As a result of UC ANR research, outreach, and education, participants made changes improve animal production systems. Specific measured outcome indicators follow.

- 100% of 48 participants in livestock health workshops said they gained useful information and 79% said they would incorporate the information into their operations within the next twenty-four months.
- 100% of the 13 who returned evaluation surveys said they would incorporate information about low-stress livestock handling into their operations within the next six months. This is a new approach to livestock handling that allows the producer to gather and place livestock in particular locations on the ranch without the need for additional fencing.
- Over the past eight years of evaluating beef cattle carcasses at Yolo County exhibitions, there has been a notable improvement in overall carcass quality and more attention is given to selecting and feeding animals for improved carcass quality. The youth exhibitors and their advisors have learned the importance of carcass quality and the genetic limitations and feeding practices that affect carcass quality.

These measured outcomes demonstrate ranch or farm level advances, which help the state's overall improvement in animal management and production. California's total livestock and livestock products cash receipts went up nearly 7% from 2016, and the cash receipts for dairy products increased slightly over 8%. In addition, because of dairy producers doing a better job at managing manure there is less impact to surface or ground waters. Thus, UC ANR contributes to the public value of promoting economic prosperity in California, as well as the ecological viability of the livestock industry.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
307	Animal Management Systems
601	Economics of Agricultural Production and Farm Management

Outcome #22

1. Outcome Measures

Science-based information applied to animal production systems policy and decision-making.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California is ranked fourth in the nation in total livestock receipts, with over \$11 billion in 2017. It remains the largest dairy-producing state providing over 18% of the nation's milk supply in 2017, and dairy is the state's top producing commodity. Ranchers and dairy producers face many management and production challenges, like drought, water and air quality regulations, and invasive species, as they strive to maintain their competitive edge. Although livestock are a high value commodity, at the ranch level it can be difficult to be profitable. In fact, ranchers or their family members often need to work off the ranch in order to make ends meet and keep the ranch running. At the same time, there is the need to improve the ecological viability of these animal production systems.

What has been done

UC ANR partnered with public, non-profit, and private groups to create and extend new knowledge about animal systems management. UC ANR conducted research and delivered educational information to dairy producers on management practices that support environmental stewardship. UC ANR continues as an important partner in the California Dairy Quality Assurance Program (CDQAP), working in collaboration with USDA Natural Resource Conservation System and others. The CDQAP partnership conducts quarterly meetings to bring industry, government agencies, and academia together to discuss concerns related to water and air quality. Technical

support was provided to dairy producers in the North Coast, San Francisco Bay, and Central Valley Regions, and to the San Joaquin Air District. A decision-making tool was created and is available online for dairy producers to use. As a result, dairy producers gained important information to better understand how water and air quality regulations fit their specific operation. In addition, work on animal protein production continued. A regional research group, with colleagues from land grant institutions and USDA Agricultural Research Service, is conducting research and developing educational products for livestock and poultry stakeholders to increase food production with social, environmental, and economic sustainability. UC ANR participated in subcommittees to inform the California Air Resources Board on non-digester technology and research needs. This included working with members from state agencies, the dairy industry, consultants, and social justice interest groups to promote alternative manure management practices.

Results

As a result of UC ANR research, outreach, and education, participants made changes improve animal production systems. Specific measured outcome indicators follow.

- During FY 2018, no dairy producers were prosecuted for off-site discharge. This is partially attributed to UC ANR's education and outreach about management practices that have led to noted changes in producers' attitudes. However, discharge was also reduced by the drought during that time.
 - In 2017, 780 dairies acquired the California Dairy Quality Assurance Program's environmental stewardship certification. This results in a 50% fee reduction for water quality fees. The actual value to producers exceeds \$2,250,000 annually.
- To advance animal protein production, an improved chopped forage sampling protocol was developed and implemented. Educational programs improved the understanding of the forage sampling protocol and the variability in nutrient accounting. Implementation of the improved protocol, and the greater accuracy in measuring nutrient uptake by harvested plants, will improve nitrogen management and reduce nitrate impacts to groundwater.

These measured outcomes demonstrate ranch or farm level advances, which help the state's overall improvement in animal management and production. California's total livestock and livestock products cash receipts went up nearly 7% from 2016, and the cash receipts for dairy products increased slightly over 8%. In addition, because of dairy producers doing a better job at managing manure there is less impact to surface or ground waters. Thus, UC ANR contributes to the public value of promoting economic prosperity in California, as well as the ecological viability of the livestock industry.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
307	Animal Management Systems
601	Economics of Agricultural Production and Farm Management

Outcome #23

1. Outcome Measures

Participants experienced changes that will improve their food system livelihood.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There are 21.6 million full- and part-time jobs related to the agricultural and food sectors ? 11% of total U.S. employment. Migrant and seasonal farm workers are a vital component of those jobs, yet they continue to live in poverty with limited access to health care services and poor health indicators. A variety of mechanisms have been used to promote social justice and improve the working conditions of farmworkers, including union organizing, policy interventions and, more recently, social certification. Social certification in agriculture is increasingly viewed as a promising mechanism to ensure ethical treatment of farmworkers on U.S.-based farms, but more information is needed.

What has been done

UC ANR continues its efforts to reach underserved groups working in California?s food system.

One collaborative project targets beginning farmers and ranchers, and specifically those who are small-scale, minority, and socially disadvantaged, to help improve their livelihoods. The long-term goal is to support the economic and ecological viability of the next generation of diverse California farmers including urban, peri-urban, and rural farmers and ranchers from diverse communities. Over the past three years, nearly 150 workshops were conducted reaching over 2,000 participants, 36% of whom were minorities/socially disadvantaged and 55% of whom were women. The project also developed over 50 culturally relevant, multimedia educational resources in four languages (English, Spanish, Hmong, and Mien).

Results

UC ANR?s research, outreach, and education is leading to changes that promote social justice in California agriculture. Specific measured outcome indicators follow.

- 87% of the diverse group of beginning farmer and rancher participants reported learning something new and 44% of workshop participants implemented at least one thing they learned after six months.
- 14 beginning farmers gained access to land and are starting to farm.

These measured outcomes demonstrate changes to improve the living and working conditions for those working in the California food system, many of whom live in poverty and have poor health. In this way, UC ANR contributes to the public value of developing an inclusive and equitable society. These efforts also benefit the farm system through workforce retention, improved safety, and improved product quality. UC ANR's involvement to advance the growing social certification movement, in particular, helps create new markets to meet consumer demand for food produced under socially sustainable conditions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #24

1. Outcome Measures

Science-based information informed labor policy and decision-making.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There are 21.6 million full- and part-time jobs related to the agricultural and food sectors ? 11% of total U.S. employment. Migrant and seasonal farm workers are a vital component of those jobs, yet they continue to live in poverty with limited access to health care services and poor health indicators. A variety of mechanisms have been used to promote social justice and improve the working conditions of farmworkers, including union organizing, policy interventions and, more recently, social certification. Social certification in agriculture is increasingly viewed as a promising

mechanism to ensure ethical treatment of farmworkers on U.S.-based farms, but more information is needed.

What has been done

UC ANR academics collaborated with the Equitable Food Initiative (EFI) to develop a business case for improved farm labor conditions. They researched the costs and benefits of providing equitable farm labor conditions. They are also working to evaluate the EFI Leadership Teams model, which is an innovative labor-management model that promotes improved channels of communication between field workers and farm management. Focus groups with agricultural workers in the United States and Mexico were conducted, as well as in-person observation of a weeklong Leadership Team training session in Mexico, and individual and group interviews with farm managers and field workers. While much of this research is still in process, two reports have been finished: 1) Making the Business Case for Improved Farm Labor Conditions: Evaluating the Equitable Food Initiative (EFI) Leadership Teams Model and 2) Making the Business Case for Positive Farm Labor Practices.

A related effort is conducting a comparative analysis of agricultural social certification in the U.S. Three principal social certification labels are being studied -- the Equitable Food Initiative (EFI), Fair Trade USA, and the Coalition of Immokalee Workers. The project is developing indicators for measuring and tracking internal costs and benefits associated with certification and improvements in farm labor conditions. In addition, the project is exploring the impact of EFI certification on health care access and health outcomes among female indigenous farmworkers.

Results

UC ANR's research, outreach, and education is leading to changes that promote social justice in California agriculture. Specific measured outcome indicators follow.

- As a result of extending the business case for improved labor conditions:

* California Labor Commissioner Julie Su would like to use the information to help advise what the state can do to promote and develop impactful labor legislation.

* The Equitable Food Initiative (EFI) was asked to present at a joint hearing of the Senate Judiciary Committee, the Senate Select Committee on Women, Work & Families, and the Legislative Women's Caucus on an alternative model of accountability in creating a harassment-free culture in California. There has been continued dialogue with the Labor Commissioner's office regarding ways to apply this model to other workplace settings, particularly with low-wage and vulnerable workers.

* The findings also informed the collaborator's (EFI) internal evaluation processes and interactions with the California legislature.

- The effectiveness of agricultural social certification programs has improved, both through internal programmatic enhancements and through informing related local, state and federal policy.

These measured outcomes demonstrate changes to improve the living and working conditions for those working in the California food system, many of whom live in poverty and have poor health. In this way, UC ANR contributes to the public value of developing an inclusive and equitable society. These efforts also benefit the farm system through workforce retention, improved safety, and improved product quality. UC ANR's involvement to advance the growing social certification movement, in particular, helps create new markets to meet consumer demand for food produced under socially sustainable conditions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #25

1. Outcome Measures

Participants adopted superior varieties of crops creating new market demand.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California is the nation's largest agricultural producer and exporter. The state's agricultural sector is vibrant and diverse, producing more than 400 commodities. For many of these specialty crops, California is often a major producer; for example, the state produces about 90 percent of the nation's avocado crop. The agricultural sector's economic viability faces uncertainty at the individual farm, industry, and global levels. Competition based on price and quality requires all commodity groups and all farmers and ranchers to continually innovate to stay abreast of market forces. Small-scale and limited resource producers are more exposed to risks and more susceptible to failure, and thus need different market opportunities.

What has been done

UC ANR developed new scientific knowledge and technological innovations that help create new food products and market opportunities. UC ANR scientists tested varieties and played key roles in introducing new varieties that are responding to food and marketing needs, ranging from forage crops for the low desert to and pistachios in the San Joaquin Valley. Information was extended locally and internationally to diverse clientele groups including growers, the food processing industry, nursery professionals, and Commodity Boards.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that help strengthen food economies and markets, local to global. Specific measured

outcome indicators follow.

- Both the Giant King grass and Rhodes grass are forage varieties that are now adopted for commercial endeavor. In particular the yield and nutritive values of the Rhodes grass as a forage crop attracted the attention of various commercial growers, from the southernmost Imperial County to the Central Valley, with a planned commodity export to the United Arab Emirates (UAE).
- The pistachio varieties Golden Hills and Lost Hills and the male pollinizer Randy gained acceptance by growers, who planted them instead of the industry standard Kerman. The earliest planted commercial acreages of these novel cultivars began bearing in 2011 and total acreage now exceeds 50,000. Significant acreage has been planted in Arizona. In addition to having superior nut quality characteristics, these earlier maturing UC cultivars are reducing the need for large expansions in huller capacity and harvesting equipment that would have been required had the industry only planted the Kerman variety. In the past two years combined, royalty and fee payments for Golden Hills alone were close to \$ 4M.

These measured outcomes helped create new market opportunities, which can expand revenue sources and thus strengthen local food systems and emerging food economies. In this way, UC ANR helps maintain the competitive edge of the California food system and the state's role as a global leader in agriculture -- contributing to the public value of promoting economic prosperity in California. In 2017, California's exports increased slightly over the year before, and almost double the amount 10 years ago.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
601	Economics of Agricultural Production and Farm Management

Outcome #26

1. Outcome Measures

Participants learned about or were more likely to try out new market opportunities.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
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2018

0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California is the nation's largest agricultural producer and exporter. The state's agricultural sector is vibrant and diverse, producing more than 400 commodities. For many of these specialty crops, California is often a major producer; for example, the state produces about 90 percent of the nation's avocado crop. The agricultural sector's economic viability faces uncertainty at the individual farm, industry, and global levels. Competition based on price and quality requires all commodity groups and all farmers and ranchers to continually innovate to stay abreast of market forces. Small-scale and limited resource producers are more exposed to risks and more susceptible to failure, and thus need different market opportunities.

What has been done

UC ANR developed new scientific knowledge and technological innovations that help create new food products and market opportunities. Work continues to help growers remain competitive. Since 1995, UCCE has collaborated with the California Avocado Commission and the California Avocado Society to develop and deliver a seminar series to provide avocado growers with science-based practices so the industry can maintain its competitive edge, especially with the increase of labor constraints and water costs. UC ANR partners with public, non-profit, and private groups to help small farmers expand their market opportunities. To help them capitalize on current market trends, one project in Southern California conducted seminars and a tour focused on agricultural tourism, value added product development, dynamics of terminal markets, value-based marketing, regulatory issues and ordinances (e.g. Cottage Food Law, Winery Ordinance, Small Brewery Ordinance). Two projects in the San Francisco Bay Area worked to help growers diversify their operations. One project customized content for unique pastured poultry systems. Another project helped the urban agriculture sector grow in the Bay Area through collaborations and educational presentations about relevant, local land use policies.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that help strengthen food economies and markets, local to global. Specific measured outcome indicators follow.

- Participants gained understanding about issues and challenges related to agri-tourism, value added product development, and wholesale and specialty product marketing opportunities. In addition, these seminar participants and local organizations are recognizing agritourism and value added products as legitimate business activities. This project expands value-added market opportunities for local growers.
- 73% of the attendees reported gaining knowledge from the Avocado Educational Grower Seminar Series on topics they requested to help them remain competitive, including economics, labor, pest management, water quality and usage, soil science, pruning techniques, biocontrol, salinity, and harvesting.
- To help support diversified farming, 71 farmers, ranchers, and agriculture supporters celebrated the Marin County agricultural community's accomplishments over the last 40 years and envisioned the future. 88% of evaluation respondents indicated they will use what they learned in their work.
- Similarly, 21 current and prospective poultry producers learned science-based information for small-scale pastured poultry production, an opportunity for diversified farming operations. 90% of evaluation respondents indicated that they will use what they learned in their work.

- As a result of efforts to increase market opportunities for farmers in Southern California, participants identified solid leads and/or product ideas to diversify their farms, and four market tour participants established market connections for their products.

- In the urban Bay Area, policy makers and the public increased their understanding of local municipal and state land use and urban agriculture production policies. This helps provide a practical land access pathway for small urban growers.

These measured outcomes helped create new market opportunities, which can expand revenue sources and thus strengthen local food systems and emerging food economies. In this way, UC ANR helps maintain the competitive edge of the California food system and the state's role as a global leader in agriculture -- contributing to the public value of promoting economic prosperity in California. In 2017, California's exports increased slightly over the year before, and almost double the amount 10 years ago.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

During FFY 2018, California experienced catastrophic wildfires across the state from the North to the South. Thousands of fires burned over one million acres, including five of the most destructive wildland-urban interface fires in the state's history to date. Wildfires affected UC ANR's research and program delivery focus, with dedicated attention going from immediate response to fostering resilience. UC ANR is committing more effort to convening stakeholders across many fields including science, emergency response, community planning, public health, and policy. More attention is being put on the need to expand understanding of California's fire problem and provide an opportunity to build connectivity, interaction, and integration across disciplines and better understand the complexity of and find solutions to California's wildfire challenge.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

UC ANR's notable outcomes measured through program evaluation efforts are reported under the State Defined Outcomes section.

Key Items of Evaluation

The Report Overview's Federal Planned Program summary of accomplishments highlights UC ANR's most notable research and the significant extension outcomes from FFY 2018. In addition, under the Federal Planned Programs State Defined Outcomes section, the significant outcomes are highlighted in the impact stories.

V(A). Planned Program (Summary)**Program # 2****1. Name of the Planned Program**

Sustainable Natural Ecosystems

 Reporting on this Program**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
101	Appraisal of Soil Resources	0%		4%	
102	Soil, Plant, Water, Nutrient Relationships	20%		10%	
112	Watershed Protection and Management	20%		2%	
121	Management of Range Resources	20%		3%	
123	Management and Sustainability of Forest Resources	20%		3%	
131	Alternative Uses of Land	0%		3%	
132	Weather and Climate	0%		4%	
133	Pollution Prevention and Mitigation	0%		6%	
135	Aquatic and Terrestrial Wildlife	0%		9%	
136	Conservation of Biological Diversity	20%		11%	
141	Air Resource Protection and Management	0%		5%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		4%	
206	Basic Plant Biology	0%		7%	
211	Insects, Mites, and Other Arthropods Affecting Plants	0%		3%	
311	Animal Diseases	0%		6%	
511	New and Improved Non-Food Products and Processes	0%		4%	
603	Market Economics	0%		2%	
605	Natural Resource and Environmental Economics	0%		8%	
610	Domestic Policy Analysis	0%		4%	
723	Hazards to Human Health and Safety	0%		2%	
	Total	100%		100%	

V(C). Planned Program (Inputs)**1. Actual amount of FTE/SYs expended this Program**

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	9.6	0.0	9.6	0.0
Actual Paid	8.2	0.0	7.7	0.0
Actual Volunteer	20.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
1868731	0	1383125	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
1868731	0	1383125	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
9620471	0	71527521	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

UC ANR's integrated research and extension activities will conduct research projects, workshops, education classes, demonstrations, and one-on-one interventions. In addition, the programs will use PSAs, newsletters, mass media, web sites and collaborations with other agencies and organizations to create and deliver programs.

2. Brief description of the target audience

- Farmers
- Ranchers
- Inland fishery owners/operators
- Governmental agencies
- Agricultural and fishing organizations
- Owners/managers of private and public rangeland, forest and wildlands
- Community organizations
- Resource managers

3. How was eXtension used?

UC ANR academics used eXtension to participate in and contribute to Communities of Practice, to answer "Ask an Expert" questions, and for other networking purposes.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	8692	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2018

Actual: 2

Patents listed

1. Microbial Metabolism of Chlorine Oxyanions As a Control of Biogenic Hydrogen Sulfide Production in Oil Reservoirs
2. A TRANSPOSON VECTOR FROM AEDES AEGYPTI FOR USE IN VERTEBRATE AND INVERTEBRATE GENE TRANSFER

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	90	397	487

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Classes/Short Courses Conducted
Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Workshops Conducted
Not reporting on this Output for this Annual Report

Output #3

Output Measure

- Demonstrations and Field Days Conducted
Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Newsletters Produced
Not reporting on this Output for this Annual Report

Output #5

Output Measure

- Web Sites Created or Updated
Not reporting on this Output for this Annual Report

Output #6

Output Measure

- Research Projects Conducted
Not reporting on this Output for this Annual Report

Output #7

Output Measure

- Videos, Slide Sets and Other AV or Digital Media Educational Products Created
Not reporting on this Output for this Annual Report

Output #8

Output Measure

- Manuals and Other Printed Instructional Materials Produced
Not reporting on this Output for this Annual Report

Output #9

Output Measure

- Meetings Organized includes field days, workshops, short courses, classes, and other)

Year	Actual
2018	190

Output #10

Output Measure

- Train the Trainer

Year	Actual
2018	38

Output #11

Output Measure

- Educational Presentations

Year	Actual
2018	211

Output #12

Output Measure

- Policy Engagement Activities

Year	Actual
2018	82

Output #13

Output Measure

- Popular Articles (non-peer-reviewed)

Year	Actual
2018	50

Output #14

Output Measure

- Website/Blog/Social Media Managed

Year	Actual
2018	72

Output #15

Output Measure

- Digital Media (includes videos, applications, software, other A/V educational products, recorded webinars)

Year	Actual
2018	9

Output #16

Output Measure

- Media Outlet Programs/Interviews

Year	Actual
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2018

160

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Farm, ranch, private and public forest and wildland owners/mangers, participating in natural resource management programs, gain knowledge of strategies and techniques for sustainable use of natural resources.
2	Fire protection and land management agencies, land and home owners, community organizations, and landscape professionals, participating in wildland fire education programs, gain knowledge on how to increase fire resistance of homes and landscaping.
3	Farm, ranch, and landscape owners/managers and allied industry professionals and governmental agency representatives, participating in air quality education programs, gain knowledge of the atmospheric system and/or how policies, products, plants, and practices can help improve air quality.
4	Ranch and private and public rangeland owners/managers, participating in rangeland management programs, gain knowledge of recommended techniques for rangeland monitoring and management, and grazing and browsing.
5	Ranch and private and public rangeland owners/managers, participating in the programs, adopt recommended techniques for rangeland monitoring and management, and grazing and browsing.
6	Farm owners/managers and allied industry professionals participating in soil quality education programs, gain knowledge of soil conditions and management practices to improve soil health.
7	Forest landowners and agency personnel gain knowledge of management and sustainability for forest resources.
8	Owners/managers of private and public lands, participating in sustainable natural ecosystem education programs, will adopt recommended strategies and techniques for sustainable use of natural resources.
9	Participants adopted recommended pest management practices that contribute improved air quality.
10	Science-based information was applied to air quality policy and decision-making.
11	Participants learned about or adopted recommended soil and water management practices.
12	Landowners adopted recommended strategies and techniques for sustainable use of range, forest and wildland resources.
13	Science-based information was applied to forestland policy and decision-making.
14	Participants learned about or adopted techniques for rangeland management, grazing and browsing.
15	Participants learned about or adopted strategies and techniques for sustainable use of range, forest and wildland natural resources.
16	Science-based information was applied to public land policy and decision-making.

17	Participants learned how to manage their properties or adopted strategies to recover from and prevent future wildfire and drought damage.
18	Science-based information was applied to fire resiliency policy and decision making.

Outcome #1

1. Outcome Measures

Farm, ranch, private and public forest and wildland owners/mangers, participating in natural resource management programs, gain knowledge of strategies and techniques for sustainable use of natural resources.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Fire protection and land management agencies, land and home owners, community organizations, and landscape professionals, participating in wildland fire education programs, gain knowledge on how to increase fire resistance of homes and landscaping.

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Farm, ranch, and landscape owners/managers and allied industry professionals and governmental agency representatives, participating in air quality education programs, gain knowledge of the atmospheric system and/or how policies, products, plants, and practices can help improve air quality.

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Ranch and private and public rangeland owners/managers, participating in rangeland management programs, gain knowledge of recommended techniques for rangeland monitoring and management, and grazing and browsing.

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Ranch and private and public rangeland owners/managers, participating in the programs, adopt recommended techniques for rangeland monitoring and management, and grazing and browsing.

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Farm owners/managers and allied industry professionals participating in soil quality education programs, gain knowledge of soil conditions and management practices to improve soil health.

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Forest landowners and agency personnel gain knowledge of management and sustainability for forest resources.

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Owners/managers of private and public lands, participating in sustainable natural ecosystem education programs, will adopt recommended strategies and techniques for sustainable use of natural resources.

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Participants adopted recommended pest management practices that contribute improved air quality.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Ozone and air pollution can harm people and crops, among other things. San Joaquin Valley, home to 10% of California's population, has some of the most polluted air in the United States. This pollution causes 1,300 premature deaths per year, as well as asthma attacks, emergency room visits, and lost school and work days costing valley residents \$11 billion each year. California has been at the forefront of developing ways to mitigate air pollutant concentrations and the impacts of existing air pollution. Projects have provided information to growers, producers, and regulators regarding impacts and sources of air pollutants related to agricultural productivity.

What has been done

UC ANR partners with public, governmental, and private groups to extend new knowledge and develop agricultural management practices to improve air quality. UC ANR scientists have collaboratively conducted numerous fungicide efficacy trials for powdery mildew control in tomatoes, beginning with sulfur. Educational programs for growers and pest control advisers (PCAs) have outlined the best management practices for sulfur use to guide the behavior of growers and PCAs. In particular, UC ANR researchers recommended the application of sulfur by ground equipment rather than airplane or helicopter, which should lead to less off-target movement of pesticides and thus improved air quality.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that lead to improved air quality. For example:

- Data analysis that was just completed indicated that there was a 26% greater use of dust versus sprayable sulfur and greater use of ground application versus air, from 18% of acres treated by ground in 2006 to 58% of acres treated by ground by 2015 ? 203,105 more acres were treated by air application to ground application.

These measured outcomes demonstrate the state's ability to preserve natural ecosystems alongside increases in agricultural productivity. Thus, while in 1967, there were 239 Stage 1 and 2 smog alerts, in 2016 there were zero Stage 1 and 2 smog alerts. In these ways, UC ANR contributes to improved air quality and the public value of promoting healthy communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management
723	Hazards to Human Health and Safety

Outcome #10

1. Outcome Measures

Science-based information was applied to air quality policy and decision-making.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Ozone and air pollution can harm people and crops, among other things. San Joaquin Valley, home to 10% of California's population, has some of the most polluted air in the United States. This pollution causes 1,300 premature deaths per year, as well as asthma attacks, emergency room visits, and lost school and work days costing valley residents \$11 billion each year. California has been at the forefront of developing ways to mitigate air pollutant concentrations and the impacts of existing air pollution. Projects have provided information to growers, producers, and regulators regarding impacts and sources of air pollutants related to agricultural productivity.

What has been done

UC ANR partners with public, governmental, and private groups to extend new knowledge and develop agricultural management practices to improve air quality. Research has been focused on understanding the impact that air pollution from particulate matter has on plants. Recent projects have shown that particulate matter pollution increases plant water loss and reduces the plant's ability to regulate water loss. Additionally, the studies demonstrated that some invasive weeds are much more resistant to ozone and drought than the crops with which they compete. Another study focused on measuring greenhouse gas emission estimates on dairies. Specifically, academics measured precursors to greenhouse gases and identified primary housing and manure storage /treatment systems that are essential to include in greenhouse gas dairy sector

emissions estimates.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that lead to improved air quality. Specific measured outcome indicators follow.

- The work on the impacts of particulate matter on plants has been incorporated into US Environmental Protection Agency (EPA) supporting documents for the process of developing a secondary welfare standard for both ozone and for particulate matter. For context, EPA secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. The EPA has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" air pollutants.
- Information on greenhouse gas estimates for dairies has been relayed to the Air Resources Board of California via progress reports and the results will assist in their work to regulate greenhouse gas emissions moving forward.

These measured outcomes demonstrate the state's ability to preserve natural ecosystems alongside increases in agricultural productivity. Thus, while in 1967, there were 239 Stage 1 and 2 smog alerts, in 2016 there were zero Stage 1 and 2 smog alerts. In these ways, UC ANR contributes to improved air quality and the public value of promoting healthy communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management
723	Hazards to Human Health and Safety

Outcome #11

1. Outcome Measures

Participants learned about or adopted recommended soil and water management practices.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
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2018

0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Soil health is essential for productive agriculture lands. Critical issues that require solutions in California include addressing salinity and nutrients in the soil. More than half of California's irrigated cropland is affected by salinization. Salinity can challenge growers' ability to grow crops, especially under conditions of reduced water flows during droughts. In recent years, 88,000 acres of farmland have been retired in two central valley counties because the soil is too saline to grow food. Additionally, nitrogen fertilizer use can lead to excess nitrogen in the soil and further leach into water supplies. When soil is healthy, nitrogen leaching is reduced and more nutrients can be used by crops again. Proper understanding and care of soil is essential for a healthy and abundant food supply for Californians.

What has been done

UC ANR develops research projects and extends information throughout the state to better monitor and understand soil composition, impacts from agricultural uses, and improved management strategies to conserve soil. Three salinity projects, spanning three years, focused on intensive soil and water sampling to gain knowledge on leaching fractions in alfalfa soils in the Sacramento Delta region and to better understand how surface water quality and rainfall were affecting leaching fractions. This applied research led to newsletters, blog articles, and presentations and included information for growers on the impact conversion to drip irrigation has on water use and soil salinity. Another set of collaborative projects studied the levels of nitrate in tile drainage water in Monterey County. UC ANR research has shown what levels of nitrogen (N) fertilizer reductions are possible with different levels of nitrate-N in the water. Trials consisted of farm-scale projects evaluating the use of nitrate-N in irrigation water for crop production, increase nitrate retention in soils, determining nitrogen uptake by vegetable crops, and evaluating nitrate immobilization in winter-fallow beds.

Other projects have focused on improving or maintaining interactive online soil survey applications. This work includes a package of interactive Web-Apps called SoilWeb, including SoilWeb GMap, SoilWeb Earth, California Soil Properties App, Soil Series Extent Explorer, and the Soil Data Explorer. These apps continue to receive an average of 500 to 1,000 visits per day. In addition to the applications, decision support tools have been repackaged to include soil survey models. These interactive tools help stakeholders characterize water resource challenges and apply mitigating management practices. Specifically, one tool predicts annual soil loss for rangelands, nitrate leaching hazard ratings for all agricultural soils, and characterization of water resources in soils to identify water saving opportunities.

Results

Specific measured outcome indicators follow.

- Forty-one percent of meeting participants gained knowledge on effective salinity management. Outreach occurred at the peak of a drought, when winter rainfall was too low to provide leaching, and it was valuable for growers to understand how they could augment leaching by leveraging rainfall with irrigation.
- Several growers have begun using controlled release fertilizers to improve nitrogen use efficiency and a new nitrification inhibitor is being registered for use on leafy vegetables.
- Growers' interest has increased in organic soil amendments with high carbon content as a

means to sequester nitrate in the soil during the winter fallow period to help reduce nitrate leaching with rain.

- The SoilWeb app has been adopted as a practice to learn about soil management for a variety of land use applications, including open water, wetlands, rangelands, grasslands, forest, urban land, and crop land. Thousands of people are using the survey apps each year to better understand data available on soils.

These measured outcomes demonstrate growers learned and adopted practices that improve soil quality and conservation. California launched the Healthy Soils Program in 2017, for which UC ANR is a partner, and has resulted in grants awarded to 84 farms for improved on-farm soil fertility. An improved understanding of salinity and nitrate management will help to protect and conserve soil quality. Thus, UC ANR contributes to the public values of protecting California's natural resources.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships

Outcome #12

1. Outcome Measures

Landowners adopted recommended strategies and techniques for sustainable use of range, forest and wildland resources.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Nearly 33 percent of California's landscapes are covered by forest and rangeland covers an additional 57 percent of the state. These landscapes provide clean air, carbon sequestration, clean water, and habitat for plants and wildlife. There is a critical need for land owners and managers to understand the effects of different management practices including restoration and

conservation to these services. Identifying methods for ecosystem restoration and ecosystem management practices will ensure that California's plants, wildlife, and other natural resources can continue to thrive.

What has been done

UC ANR leads collaborative research and extension efforts and provides support to develop new policies in an effort to increase ecological sustainability of forests and rangelands. UC ANR activities in 2018 included research on rangelands, development of new technological tools, and extension of new policies and regulations. Advisors have worked with the East Bay Municipal Utility District (EBMUD) staff and rangeland permittees to develop a monitoring program for the EBMUD managed Mokelumne Watershed. This work included developing an online platform to collect data in the field and creating a web-based resource guide and map of Bay Area rangeland. Projects like this are supported by resources and technology from UC ANR's Informatics and Geographic Information Systems Program which has delivered 52 workshops across California since July 2015 and reached nearly 800 people. These include workshops included GIS for Forestry, GIS for Agriculture, Drone Technology, WebGIS, Mobile Data Collection, and other topics. At the request of CalFire, one academic extended information about reforestation after bark beetle infestations at three workshops reaching 82 landowners and partners. Workshop topics included effective reforestation, planting needs at different scales, procuring seedlings, mortality in plantations, technical and financial assistance. In 2018, with information based on UC ANR research, California Senate Bill 901 allowed landowners to use a permit process to carry out forest harvests in an effort to preserve or restore oak woodlands. UC ANR's research provided the much-needed evidence for the policy changes. Additionally, to support the new permit process and facilitate understanding, UC ANR provided outreach, presentations, field tours, and data to interested stakeholders, Board of Forestry members, foresters, landowners, and legislative representatives. Finally, UC ANR provided oversight on a collaborative project focused on the restoration and management of deciduous oak woodlands.

Results

Specific outcome indicator follow.

- The changes to the watershed monitoring program were adopted by the EBMUD staff and have been well-received by staff and permittees. The GIS platform developed greatly reduces the time to create maps in the office after field collection of data.
- Workshop participants increased their understanding of tree mortality and reforestation (98% knew how to approach tree mortality and replanting, compared to 24% at the start of the workshops).
- Seven new permits that enable landowners to restore oak forests were utilized in 2018 and three more are currently in development as a result of this outreach.

As the aforementioned measured outcomes demonstrate, UC ANR supports the implementation of forest and rangeland restoration practices, policy and regulation. Increased ecological sustainability of range and forest landscapes helps California realize the many benefits of the state's rich and diverse natural resources. Thus, UC ANR contributes to the public value of protecting California's natural resources.

Extension about oak restoration has led to planning and contracting several projects covering 300 acres. In 2018, 212 acres of oak woodland have been successfully restored. Additionally, with support from UC ANR, the Natural Resources Conservation Service now has a legal permitting pathway for their oak restoration programs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
136	Conservation of Biological Diversity

Outcome #13

1. Outcome Measures

Science-based information was applied to forestland policy and decision-making.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Nearly 33 percent of California’s landscapes are covered by forest and rangeland covers an additional 57 percent of the state. These landscapes provide clean air, carbon sequestration, clean water, and habitat for plants and wildlife. There is a critical need for land owners and managers to understand the effects of different management practices including restoration and conservation to these services. Identifying methods for ecosystem restoration and ecosystem management practices will ensure that California’s plants, wildlife, and other natural resources can continue to thrive.

What has been done

UC ANR leads collaborative research and extension efforts and provides support to develop new policies in an effort to increase ecological sustainability of forests and rangelands. Research projects provided support to policy development to protect forest and stream health. One project focused on developing tools that help landowners and managers rapidly assess forest health. Specifically, researchers evaluated seasonal timing and spatial patterns of tree stress and insect attacks to identify the optimal biological window in which to conduct unmanned aerial system (UAS) detection flights. In partnership with private and public forest managers GIS tools were developed to support management strategies that minimize tree stress and mortality from bark beetle infestations. This work led to two policy oriented publications that identified how to use existing tools to overcome barriers to forest management, and how forest management plans can

help establish healthy resilient forests. Researchers are also studying how water use for cannabis cultivation may impact stream flows needed for the health and survival of endangered and other aquatic organisms. Other cannabis cultivation related research includes understanding the impacts on wildlife interactions and movement. The Berkeley Cannabis Research Center has been founded at UC Berkeley and researchers have focused on a variety of scientific methods to research the ecosystem impacts of cannabis, including remote sensing, spatial econometric techniques, and surveys to gather scientific data. Outreach to grower organizations, local and state government agencies, and non-profits is helping facilitate research and sharing of results.

Results

Specific measured outcome indicators follow.

Science-based research supported the development and adoption of state bills, AB 616 (The California Forest Carbon Plan) and SB 901 (Wildfires), which is a "...a comprehensive forest health bill aimed at reducing future wildfire risk and improving the condition of California's forests and wildlands", and SB- 462 (Forestland Restoration Workforce Program).

- Science-based research has also provided support to the Board of Forestry by informing changes to reforestation practices outlined in the California Forest Practice Rules.
- Research on the impacts of cannabis has been used directly by several water quality control boards, planning departments, and boards of supervisors for decisions regarding where and how much cannabis to allow.

As the aforementioned measured outcomes demonstrate, UC ANR supports the implementation of forest and rangeland restoration practices, policy and regulation. Increased ecological sustainability of range and forest landscapes helps California realize the many benefits of the state's rich and diverse natural resources. Thus, UC ANR contributes to the public value of protecting California's natural resources.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
211	Insects, Mites, and Other Arthropods Affecting Plants
610	Domestic Policy Analysis

Outcome #14

1. Outcome Measures

Participants learned about or adopted techniques for rangeland management, grazing and browsing.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California must innovate and adapt to maintain its economic resilience. One contribution to California’s economy is the 40 million acres of actively grazed rangeland. These rangelands provide a critical economic foundation for California’s livestock production with an annual gross value of cattle and sheep production exceeding \$3 billion. Rangelands represent one type of working landscape in California, and along with cropland and timberlands, provide a basis of economic activity that supports millions of Californians. These lands also play a vital role in providing food, fiber, wildlife habitat, recreation, energy, and ecosystem services. Science-based information is needed for land owners, managers, and policy makers to develop practices and policies that sustain economic vitality while protecting environmental quality.

What has been done

UC ANR projects identify opportunities and address needs to reduce cost and increase profitability for ranchers and land owners. Projects addressed livestock production, native grass restoration and incentives for ecosystem services to increase profitability. Several UC ANR academics worked with the Alameda County Resource Conservation District to conduct a needs assessment of the demand for local meat processing, assess resource concerns with regional hog operations, and develop a resource guide on outdoor hog production. Additionally, a Beef Cattle Cost Study was conducted to document the cost associated with cow-calf grazing that would support conservation on public lands. Additional research focused on grazing for biological conservation and was used to inform the development of local conservation plans. Rangeland restoration can be important to provide quality forage for livestock as well as to protect an ecosystem, yet restoration costs can exceed \$350 per acre. Two long-term ongoing restoration projects are testing the seeding of native and introduced perennial grasses following weed control applications. Restoration treatments that include introduced perennial grass species have been more effective at preventing weed re-infestation, but had less overall plant species diversity compared to treatments of pure native perennial grasses and annual grass species. The information from these projects will help evaluate potential success and the value of ecosystem services provided from both high-cost restoration options with native species and low-cost options with introduced species. One project is creating case studies, based on surveys from landowners with large parcels, that will include quantitative analysis of the services that occur on working lands throughout California. An additional component of the work was to gather feedback on whether land owners with conservation easements prefer one-time or ongoing payments for ecosystem services they provide. These findings were shared at the California Economic

Summit. Another academic provided programming and workshops for succession planning, business development, and regulatory compliance.

Results

Specific measured outcome indicators follow.

- Projects have contributed to at least four public agencies managing over 149,000 acres of grazing land, re-evaluating their lease arrangements to improve rancher sustainability.
- The outdoor hog resource guide provided the information necessary to maintain a hog operation on public land and an opportunity for producers to access Environmental Quality Incentives Program funding from the USDA for implementing conservation practices on their operations.
- Science-based information led to significant improvements and cost savings associated with the Santa Clara Valley Habitat Conservation Plan and East Alameda County Conservation Strategy.
- The rancher who hosted a Napa County research project was sufficiently convinced of one treatment to invest in a range seeding drill and has since seeded an additional 80 acres, an investment of approximately \$40,000. Another livestock producer seeded a 40 acre field to perennial grass species after seeing early results at a field day.
- Survey results have led to increased interest in new methodologies for paying landowners for ecosystem services provided from rangelands, and could lead to payments for ecosystem services.
- The Working Landscapes subgroup from the California Economic Summit has met with a Senator and sought funding for ecosystem service pilots that incentivize landowners for bundled services. Monetary credits will be quantified with support of scientific research.
- Through succession planning workshops, ten families successfully complete succession planning.
- As a result of business development workshops, four agriculturalists received loans that they were previously unaware of to benefit their operations.

These aforementioned measured outcomes demonstrate improved knowledge and adoption of practices to improve the profitability of working landscapes while conserving resources. Improved practices enable managers to reduce inputs and costs leading to more economically sustainable management. In this way, UC ANR contributes to the public value of promoting economic prosperity in California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
121	Management of Range Resources
605	Natural Resource and Environmental Economics

Outcome #15

1. Outcome Measures

Participants learned about or adopted strategies and techniques for sustainable use of range, forest and wildland natural resources.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Public and private land in California is managed for a wide variety of uses, and one of the most significant challenges in the state is serving areas where land uses are changing. Challenges include addressing sprawl, loss of productive working landscapes, the growing urban/rural/wildland interface, human and wildlife conflicts, protecting water quality and better understanding ecosystem services. Research and extension are needed to help land managers and owners create plans that balance the social, economic, and ecological benefits of these landscapes. Land management decisions at the local level will be increasingly important to the health of our natural environment and communities.

What has been done

UC ANR activities focus on management strategies with regard to livestock, wildlife and land maintenance. Field data collection and extension addressed issues with livestock, wildlife, and road maintenance. One researcher collected local data for a statewide project to determine erosion capability from rangelands. This data came from the long-term forage production project of measuring biomass as it relates to bare ground and was compiled to model erosion statewide. Further efforts focused on collaboration with a Resource Conservation District and the Society of American Foresters to design and implement a road design and maintenance workshop. Another research project examined the impact of wild horses on private land and rangeland grazing allotments. Research-based information was shared with range managers and the public through briefing papers, tours, interviews, popular press articles, presentations and social media reaching over 10,000 people.

Results

Specific measured outcome indicators follow.

- Surveys for the road maintenance workshop indicated that 100% gained useful information. Also, 60% will implement what they learned within 6 months, while 25% will within 12 months, and 15% within 24 months.
- Due to the extension efforts to improve the understanding of wild horses on rangeland, in 2018 nearly 1,000 wild horses were gathered from rangelands and adopted. The project received the National Rangeland Management Award from the US Forest Service.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
121	Management of Range Resources
135	Aquatic and Terrestrial Wildlife

Outcome #16

1. Outcome Measures

Science-based information was applied to public land policy and decision-making.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Public and private land in California is managed for a wide variety of uses, and one of the most significant challenges in the state is serving areas where land uses are changing. Challenges include addressing sprawl, loss of productive working landscapes, the growing urban/rural/wildland interface, human and wildlife conflicts, protecting water quality and better understanding ecosystem services. Research and extension are needed to help land managers and owners create plans that balance the social, economic, and ecological benefits of these landscapes. Land management decisions at the local level will be increasingly important to the health of our natural environment and communities.

What has been done

UC ANR activities focus on management strategies with regard to livestock, wildlife and land maintenance. One academic surveyed ranchers to understand their familiarity with non-lethal control methods for wildlife and their experience of success or failure with those methods. Reports including the survey results were prepared for a local Board of Supervisors. Another project conducted research in response to suggestions from local groups to eliminate grazing access in Sierra National Forest given the concern that it posed a threat to water quality. However, the test demonstrated that E. coli levels were safely below the EPA threshold.

Results

Specific measured outcome indicators follow.

- A Board of Supervisors used science-based information to make decisions about continuing a contract with professional wildlife control agents once they understood the science behind non-lethal tools as a form of wildlife control.
- Water quality testing validated the USFS grazing standards, in response to claims of livestock-related pollution. By continuing to allow livestock to graze, local livestock producers have access to high-quality forage in the summer and the forest ecosystem benefits from grazing to keep meadows open and reduce brush encroachment.

The aforementioned measured outcomes demonstrate improved knowledge and adoption of land management practices. UC ANR has contributed to improvements in land use policies and land management practices that can help maximize the benefits that managed lands provide. Thus UC ANR contributes to the public value of protecting California's natural resources.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
121	Management of Range Resources
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity

Outcome #17

1. Outcome Measures

Participants learned how to manage their properties or adopted strategies to recover from and prevent future wildfire and drought damage.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The associated effects of climate change are increasing the risk of extreme weather events that negatively impact California's ecosystems. For example, cyclical droughts are expected to worsen with climate change. Because of our changing climate, rangelands and forests are experiencing the effects of intense wildfires and persistent droughts. Land managers and land owners need effective response and adaptation strategies to best manage the land so they are better prepared to deal with the growing risks. Communities need to be better prepared to deal with the growing risks of hazards from fires and droughts.

What has been done

UC ANR collaborates with agencies and land owners that have been impacted by catastrophic fires and droughts and provides science-based information to aid in recovery and prevention efforts and develop improved practices. After the catastrophic fires, academics extended knowledge about fire recovery, fire preparation and prevention, and climate change. Academics organized forest stewardship workshops, including Living with Fire at Sonoma State University, and the North Coast Fire Resiliency Workshop to inform citizens of the coastal areas north of the Russian River about how to deal with fire. Several academics around the state organized meetings for nearly 40 ranchers affected by the Waverly, Thomas, Tubbs and Camp Fires. Information was presented on management practices that can safeguard resources, how to prevent soil erosion, as well as an overview of how to estimate the cost of replacing forage losses on annual rangelands. Additionally, UC ANR academics hosted seven workshops in Northern California on fire resiliency and recovery reaching 550 people. Another academic gave over 20 presentations to more than 300 people on fire resistant homes and defensible space reaching fire safe councils, UC Master Gardener events, garden clubs, and the general public. Other academics collaborated to organized nine prescribed burns and successfully demonstrated using fire to treat over 700 acres across the state.

Projects also focused on impacts related to drought. One project resulted because drought conditions were not being accurately depicted on the US Drought Monitor (USDM), which is the nationwide geospatial tool that tracks drought conditions and determines federal insurance payouts to agriculturalists. As a result, UC ANR advisors worked with authors of USDM and the California Cattleman's Association and identified the need to connect authors with rangeland professionals. The advisors developed procedures for range managers to relay conditions on the ground to the USDM authors and UC ANR livestock advisors statewide now provide monthly feedback regarding their local drought conditions to the USDM.

Results

Specific measured outcome indicators follow.

- 30% of Living with Fire workshop participants increased their knowledge on fire recovery practices.
- 89% of ranchers that participated in loss claim workshops were able to use the information to prepare a loss claim from the wildfire that impacted their forage land.
- Workshops and live-fire trainings in other counties have spurred the creation of six other prescribed burn associations across the state.
- After attending the prescribed fire workshops, trained participants extended training in two communities.
- Three property owners applied the knowledge gained to apply for grants with the Natural Resources Conservation Service to put in fire lines.
- 90% of workshops participants that didn't understand fire resistant structures prior to workshops, left with a nuanced perspective and an action plan to prepare their properties for wildfire.

- USDM utilized information from UC ANR academics to update the drought severity listing on California rangelands. This project has also resulted in partnership between UCCE, the USDA Climate Hub (Davis, CA), the National Drought Mitigation Center, and the National Oceanic and Atmospheric Administration.

The aforementioned measured outcomes demonstrate that participants learned about and developed new management paradigms to address the challenges that come with a changing climate. Policy informed by science-based research will help increase forest and rangeland resiliency and decrease the risk of catastrophic fires and droughts. In this way, UC ANR is contributing to the public value of building climate resilient communities and ecosystems.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate

Outcome #18

1. Outcome Measures

Science-based information was applied to fire resiliency policy and decision making.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The associated effects of climate change are increasing the risk of extreme weather events that negatively impact California's ecosystems. For example, cyclical droughts are expected to worsen with climate change. Because of our changing climate, rangelands and forests are experiencing the effects of intense wildfires and persistent droughts. Land managers and land owners need effective response and adaptation strategies to best manage the land so they are better prepared to deal with the growing risks. Communities need to be better prepared to deal with the growing risks of hazards from fires and droughts.

What has been done

UC ANR collaborates with agencies and land owners that have been impacted by catastrophic fires and droughts and provides science-based information to aid in recovery and prevention efforts and develop improved practices. A wide variety of research and extension led to opportunities to inform policy related to fire resiliency. The North Coast Fire Resiliency workshop was used to collect feedback on what residents were most interested in learning. Fire probability maps have been developed or updated to model extreme fire hazard conditions, fire spread under different future climate scenarios, and to predict future fire frequencies. Fire knowledge has been shared with local, national, and international media and through numerous educational events and interactions with policy makers. Another academic conducted a field survey of the aquatic habitat in Matilija Creek after 90 percent of the watershed burned in the Thomas Fire. The creek had been a primary spawning area for steelhead trout, but a few months post fire there was no sign of fish presence. The academic made presentations to 220 people about erosion control and how to recover their landscapes to prepare for future fire events. One academic worked with local livestock producers and USFS personnel on dealing with post fire grazing and worked with a local municipal utility district to develop a Range Health Conditions Assessment and Monitoring Program. For example, after the King fire in El Dorado County burned 97,000 acres, UC ANR helped livestock producers begin grazing a year earlier than the current policy allowed.

Other projects informed policy related to drought and climate change resiliency. One project produced a detailed review paper on Climate Change Trends and Impacts on California Agriculture, which garnered significant international, national, and state attention. In collaboration with UC ANR advisors, campus academics, ranchers, and rangeland managers, an academic examined on-ranch management decision-making and social-ecological resilience to drought. This work, draws on more than 600 surveys and interviews of California ranchers. Another collaborative effort, has built an online framework, Cal-Adapt.org, for data sharing in the interest of understanding a changing climate in California.

Results

Specific measured outcome indicators follow.

- Information gathered at the fire resiliency workshop helped shape Sonoma County's fire planning.
- Fire hazard research has directly contributed to more sophisticated modeling of fire hazards and have been incorporated directly into CAL FIRE's evaluation protocol for proposed fuel treatment projects, grounding their program in the most current scientific understanding of climate/fire interactions at broad scales.
- Information to policy-makers, informed SB 901 which is about improving fire resiliency.
- The city of Mill Valley used UC ANR science-based information to help create a new defensible space ordinance.
- A collaborative group of resource agencies, public works agencies, non-profits, and other stakeholder groups, used science-based information from UC ANR research to develop a published Strategic Plan for the recovery of watersheds after fires and debris flows.
- One rancher said "without UCCE we would no longer be ranching". US Forest Service policy decisions is being guided by UC ANR research regarding the return interval for grazing, post-fire and what on-the-ground practices ranchers need to implement. The research is helping understand what factors are the most critical for evaluating return intervals and will be a model for other areas across California.
- The California Climate and Agriculture Network (CalCAN) has used the paper, Climate Change Trends and Impacts on California Agriculture, to pursue legislation to fund the development of farm-level, science-based agricultural climate adaptation decision support and planning tools.
- The study on rangeland resilience to drought has informed USDA climate vulnerability

assessments.

- Cal-Adapt has been used by several companies and agencies as a planning tool:

* three electric and gas utility companies in California used Cal Adapt to support climate-resilient design of compressor stations and substations, and to explore intensity and duration of projected mid-century heat waves.

* the USDA Forest Service used it for planning a fuel treatment with future climate conditions.

* and the Caltrans? Transportation Adaptation Planning Grant Program (which distributes \$20M to local and regional agencies for adaptation planning) used it as a tool to support applicants.

- Cal Adapt has also been used by the California Department of Public Health to generate county-level reports of climate-related risks to public health.

- The California Governor?s Office of Planning and Research released guidance for Planning and Investing for a Resilient California (pursuant to B-30-15), and directs state agencies to use Cal-Adapt.org as a source for peer-reviewed, state-sanctioned data depicting projected climate risks and for map overlays to facilitate planning and investment.

The aforementioned measured outcomes demonstrate that participants learned about and developed new management paradigms to address the challenges that come with a changing climate. Policy informed by science-based research will help increase forest and rangeland resiliency and decrease the risk of catastrophic fires and droughts. In this way, UC ANR is contributing to the public value of building climate resilient communities and ecosystems.

4. Associated Knowledge Areas

KA Code	Knowledge Area
121	Management of Range Resources
132	Weather and Climate

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

During FFY 2018, California experienced catastrophic wildfires across the state from the North to the South. Thousands of fires burned over one million acres, including five of the most destructive wildland-urban interface fires in the state's history to date. Wildfires affected UC ANR's research and program delivery focus, with dedicated attention going from immediate response to fostering resilience. UC ANR is committing more effort to convening stakeholders across many fields including science, emergency response, community planning, public health, and policy. More attention is being put on the need to expand understanding of California's fire problem and provide an opportunity to build

connectivity, interaction, and integration across disciplines and better understand the complexity of and find solutions to California's wildfire challenge.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

UC ANR's notable outcomes measured through program evaluation efforts are reported under the State Defined Outcomes section.

Key Items of Evaluation

The Report Overview's Federal Planned Program summary of accomplishments highlights UC ANR's most notable research and the significant extension outcomes from FFY 2018. In addition, under the Federal Planned Programs State Defined Outcomes section, the significant outcomes are highlighted in the impact stories.

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Healthy Families and Communities

Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
133	Pollution Prevention and Mitigation	0%		1%	
301	Reproductive Performance of Animals	0%		2%	
305	Animal Physiological Processes	0%		7%	
306	Environmental Stress in Animals	0%		2%	
502	New and Improved Food Products	0%		3%	
603	Market Economics	0%		2%	
604	Marketing and Distribution Practices	0%		2%	
606	International Trade and Development	0%		3%	
608	Community Resource Planning and Development	0%		3%	
610	Domestic Policy Analysis	0%		2%	
611	Foreign Policy and Programs	0%		1%	
702	Requirements and Function of Nutrients and Other Food Components	0%		36%	
703	Nutrition Education and Behavior	17%		7%	
704	Nutrition and Hunger in the Population	0%		6%	
723	Hazards to Human Health and Safety	0%		2%	
724	Healthy Lifestyle	11%		3%	
802	Human Development and Family Well-Being	0%		7%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	0%		7%	
806	Youth Development	21%		3%	
903	Communication, Education, and Information Delivery	51%		1%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	13.0	0.0	4.4	0.0
Actual Paid	18.3	0.0	3.0	0.0
Actual Volunteer	873.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
2741992	0	595354	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
2741992	0	595354	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
25332452	0	36740122	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

UC ANR's integrated research and extension activities will conduct research projects, workshops, education classes, demonstrations, and one-on-one interventions. In addition, the programs will use PSAs, newsletters, mass media, web sites and collaborations with other agencies and organizations to create and deliver programs.

2. Brief description of the target audience

- Adults, children, youth, and families in general
- Children in general
- Low and moderate income adults, children, youth and families
- Adults and children at-risk for nutrition-related health problems, including individuals living in poverty, recent immigrants, and African-American, Native American, and Hispanic populations
- Nutrition and healthcare professionals
- Preschool, primary, and secondary school teachers and administrators
- Professional childcare providers
- Public agencies and private organizations concerned with food, nutrition, and health

3. How was eXtension used?

UC ANR academics used eXtension to participate in and contribute to Communities of Practice, to answer "Ask an Expert" questions, and for other networking purposes.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	34882	0	268704	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2018
 Actual: 2

Patents listed

1. Molecular Flux Rates Through Critical Pathways Measured by Stable Isotope Labeling In Vivo, as Targets and Biomarkers of Drug Action
2. CHEMICALLY ACTIVATABLE NANOCAPSID FUNCTIONALIZED FOR CANCER TARGETING

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	81	132	213

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Classes/Short Courses Conducted
- Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Workshops Conducted

Not reporting on this Output for this Annual Report

Output #3

Output Measure

- Demonstrations and Field Days Conducted
Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Newsletters Produced
Not reporting on this Output for this Annual Report

Output #5

Output Measure

- Web Sites Created or Updated
Not reporting on this Output for this Annual Report

Output #6

Output Measure

- Research Projects Conducted
Not reporting on this Output for this Annual Report

Output #7

Output Measure

- Videos, Slide Sets, and other AV or Digital Media Educational Products Created
Not reporting on this Output for this Annual Report

Output #8

Output Measure

- Manuals and Other Printed Instructional Materials Produced
Not reporting on this Output for this Annual Report

Output #9

Output Measure

- Meetings Organized (includes field days, workshops, short courses, classes, and other)

Year	Actual
2018	44064

Output #10

Output Measure

- Train the Trainer

Year	Actual
2018	33

Output #11

Output Measure

- Educational Presentations

Year	Actual
2018	254

Output #12

Output Measure

- Policy Engagement Activities

Year	Actual
2018	437

Output #13

Output Measure

- Popular Articles (non-peer-reviewed)

Year	Actual
2018	34

Output #14

Output Measure

- Website/Blog/Social Media Managed

Year	Actual
2018	52

Output #15

Output Measure

- Digital Media (includes videos, applications, software, other A/V educational products, recorded webinars)

Year	Actual
2018	25

Output #16

Output Measure

- Media Outlet Programs/Interviews

Year	Actual
2018	42

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Low-income individuals and families, participating in nutrition and consumer education programs, gain knowledge of food resource management techniques.
2	Low-moderate income individuals and families, participating in nutrition and consumer education programs, adopt recommended food resource management techniques.
3	Children and youth, participating in-school and afterschool educational programs, increase their level of science, agricultural and environmental literacy.
4	Youth educators and child resource specialists, participating in youth development education programs, gain knowledge of youth development practices.
5	Children and youth, participating in nutrition education programs, gain knowledge of nutrition.
6	Adults, participating in nutrition education programs, adopt recommended dietary practices.
7	Individuals, participating in nutrition education programs, adopt safe food handling and preparation techniques.
8	Youth educators and child resource specialists, participating in youth development education programs, adopt recommended youth development practices.
9	Youth educators and program extenders, participating in the programs, including 4-H and SET, gain knowledge of best practices to extend science, engineering, and technology education and opportunities.
10	Teachers, participating in health and nutrition programs, adopt recommended practices to prevent childhood obesity and foster a school environment that reinforces nutrition education.
11	Community garden managers, non-profit agency personnel, small business owners, and low-income members of the public, participating in Master Gardener and other urban horticulture programs, gain knowledge about sustainable gardening practices.
12	Individuals participating in food safety education, gain knowledge of safe food handling, preparation, and preservation techniques.
13	Percentage of 4-H youth (4th- 12th graders) make positive choices.
14	Percentage of 4-H youth (4th- 12th graders) effectively communicate.
15	Percentage of 4-H youth (4th- 12th graders) build connections.
16	Percentage of 4-H youth (4th- 12th graders) apply content knowledge and skills in health, citizenship and science to contribute to the health, growth, and well-being of self, family, community, nation, and the world.
17	Percentage of 4-H youth (4th- 12th graders) express interest and engage in science.

18	Percentage of 4-H youth (4th- 12th graders) express positive attitudes and aspirations toward science.
19	Percentage of 4-H youth (4th- 12th graders) develop science skills and abilities.
20	Percentage of 4-H youth (8th-12th graders) apply learning, and make a contribution through science.
21	Percentage of 4-H youth (4th- 12th graders) appreciate cultural diversity.
22	Percentage of 4-H youth (4th- 12th graders) engage in community and community issues.
23	Percentage of 4-H youth (4th- 12th graders) have understanding of the democratic process.
24	Percentage of 4-H youth (8th-12th graders) have awareness of community and community issues.
25	Percentage of 4-H youth (4th- 12th graders) choose food consistent with Dietary Guidelines.
26	Percentage of 4-H youth (4th- 12th graders) improve physical activity practices.
27	Percentage of 4-H youth (4th- 12th graders) avoid and prevent negative risk behaviors.
28	Participants learned information or gained skills to prepare them for college.
29	Participants learned about science to prepare them for college and careers.
30	Participants learned about and improved food resource management practices.
31	Science-based information applied to food security policy and decision-making.
32	Participants learned healthy lifestyle and decision-making practices.
33	Participants changed attitudes toward and adopted healthy eating practices.
34	Participants adopted edible gardening practices and spent more time outdoors.
35	Participants improved individual health.
36	Science-based information applied to healthy food policy and decision-making.
37	Participants learned about and adopted civically engagement behaviors.

38	Participants learned about and adopted financial management practices.
39	Participants learned and adopted home food safety practices.
40	Participants adopted farm food safety behaviors.
41	Participants learned leadership skills and extended evidence-based information to their peers and decision-makers.
42	Participants learned about and changed attitudes about the environment.
43	Participants improved access to green spaces and the outdoors for youth.
44	Participants learned promising food policy council practices.
45	Participants adopted community-level changes to prevent overweight and obesity.
46	Participants applied practices that improve overall community wellness.
47	Participants increased access to fresh produce.
48	Science-based information applied to community health and wellness policy and decision-making at the local and state levels.
49	Science-based information applied to community health and wellness policy and decision-making at the federal and national levels.
50	Participants learned about and applied new evidence-based information in youth education programs.
51	Participants learned skills in landscapes and agricultural production.
52	Participants applied program planning and evaluation skills to requirements for federal and state nutrition programs.
53	UC ANR better engages underserved communities.
54	Science-based information applied to community engagement policy and decision-making.
55	UC ANR academics, staff, and volunteers learned skills to better engage diverse audiences.

Outcome #1

1. Outcome Measures

Low-income individuals and families, participating in nutrition and consumer education programs, gain knowledge of food resource management techniques.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Low-moderate income individuals and families, participating in nutrition and consumer education programs, adopt recommended food resource management techniques.

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Children and youth, participating in-school and afterschool educational programs, increase their level of science, agricultural and environmental literacy.

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Youth educators and child resource specialists, participating in youth development education programs, gain knowledge of youth development practices.

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Children and youth, participating in nutrition education programs, gain knowledge of nutrition.

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Adults, participating in nutrition education programs, adopt recommended dietary practices.

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Individuals, participating in nutrition education programs, adopt safe food handling and preparation techniques.

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Youth educators and child resource specialists, participating in youth development education programs, adopt recommended youth development practices.

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Youth educators and program extenders, participating in the programs, including 4-H and SET, gain knowledge of best practices to extend science, engineering, and technology education and opportunities.

Not Reporting on this Outcome Measure

Outcome #10

1. Outcome Measures

Teachers, participating in health and nutrition programs, adopt recommended practices to prevent childhood obesity and foster a school environment that reinforces nutrition education.

Not Reporting on this Outcome Measure

Outcome #11

1. Outcome Measures

Community garden managers, non-profit agency personnel, small business owners, and low-income members of the public, participating in Master Gardener and other urban horticulture programs, gain knowledge about sustainable gardening practices.

Not Reporting on this Outcome Measure

Outcome #12

1. Outcome Measures

Individuals participating in food safety education, gain knowledge of safe food handling, preparation, and preservation techniques.

Not Reporting on this Outcome Measure

Outcome #13

1. Outcome Measures

Percentage of 4-H youth (4th- 12th graders) make positive choices.

Not Reporting on this Outcome Measure

Outcome #14

1. Outcome Measures

Percentage of 4-H youth (4th- 12th graders) effectively communicate.

Not Reporting on this Outcome Measure

Outcome #15

1. Outcome Measures

Percentage of 4-H youth (4th- 12th graders) build connections.

Not Reporting on this Outcome Measure

Outcome #16

1. Outcome Measures

Percentage of 4-H youth (4th- 12th graders) apply content knowledge and skills in health, citizenship and science to contribute to the health, growth, and well-being of self, family, community, nation, and the world.

Not Reporting on this Outcome Measure

Outcome #17

1. Outcome Measures

Percentage of 4-H youth (4th- 12th graders) express interest and engage in science.

Not Reporting on this Outcome Measure

Outcome #18

1. Outcome Measures

Percentage of 4-H youth (4th- 12th graders) express positive attitudes and aspirations toward science.

Not Reporting on this Outcome Measure

Outcome #19

1. Outcome Measures

Percentage of 4-H youth (4th- 12th graders) develop science skills and abilities.

Not Reporting on this Outcome Measure

Outcome #20

1. Outcome Measures

Percentage of 4-H youth (8th-12th graders) apply learning, and make a contribution through science.

Not Reporting on this Outcome Measure

Outcome #21

1. Outcome Measures

Percentage of 4-H youth (4th- 12th graders) appreciate cultural diversity.

Not Reporting on this Outcome Measure

Outcome #22

1. Outcome Measures

Percentage of 4-H youth (4th- 12th graders) engage in community and community issues.

Not Reporting on this Outcome Measure

Outcome #23

1. Outcome Measures

Percentage of 4-H youth (4th- 12th graders) have understanding of the democratic process.

Not Reporting on this Outcome Measure

Outcome #24

1. Outcome Measures

Percentage of 4-H youth (8th-12th graders) have awareness of community and community issues.

Not Reporting on this Outcome Measure

Outcome #25

1. Outcome Measures

Percentage of 4-H youth (4th- 12th graders) choose food consistent with Dietary Guidelines.

Not Reporting on this Outcome Measure

Outcome #26

1. Outcome Measures

Percentage of 4-H youth (4th- 12th graders) improve physical activity practices.

Not Reporting on this Outcome Measure

Outcome #27

1. Outcome Measures

Percentage of 4-H youth (4th- 12th graders) avoid and prevent negative risk behaviors.

Not Reporting on this Outcome Measure

Outcome #28

1. Outcome Measures

Participants learned information or gained skills to prepare them for college.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California requires a highly skilled workforce to remain a competitive, prosperous, and an innovative global leader. California is ranked 42nd in the nation for 2016 performance and has a high school graduation rate of 83%, which is slightly lower than the national average of 85%. Improved college readiness and access can contribute the development of a qualified workforce for California and a robust and thriving state economy.

What has been done

UC ANR's youth and community development programs equip the next generation for college and successful careers. UC ANR academics provide oversight, leadership, and guidance for the statewide implementation of UC 4-H Youth Development Program (UC 4-H). UC ANR academics advance the field of youth development by conducting research and extending new knowledge to UC 4-H staff and volunteers and other youth development professionals. UC 4-H reached over 142,000 youth- an increase of 30% from the previous year- participating in clubs, afterschool programs, and camps. Almost 20,000 adult volunteers contributed over 1,700,000 hours, estimated at almost \$50 million in value.

Results

Over 200 California youth responded to the college & career readiness common measures survey about what they may have learned at 4-H.

- Youth reported learning information to prepare them for college and a career:
 - * 90% of youth reported when choosing a career, it is important to be passionate about the work they do
 - * 80% of youth report that for the type of career they want, it is important to go to college
 - * 87% have thought a little or a lot about how to pay for college
 - * 59% of youth have an idea of what they would like to major in
- Youth reported intrapersonal professionalism skills such as it being important to arrive on time for work (100%), be trusted by an employer (99%), do their job well (100%), show respect for others (100%) and have a professional image on social media (90%).

These measured outcomes demonstrated knowledge and skills learned and positive attitudes related to science, college, and careers, which are the pathway to entering the workforce. In this way, UC ANR contributes to the public value of developing a qualified workforce for California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #29

1. Outcome Measures

Participants learned about science to prepare them for college and careers.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California requires a highly skilled workforce to remain a competitive, prosperous, and an innovative global leader. California is ranked 42nd in the nation for 2016 performance and has a high school graduation rate of 83%, which is slightly lower than the national average of 85%. Improved college readiness and access can contribute the development of a qualified workforce for California and a robust and thriving state economy.

What has been done

UC ANR's youth and community development programs equip the next generation for college and successful careers. UC ANR academics provide oversight, leadership, and guidance for the statewide implementation of UC 4-H Youth Development Program (UC 4-H). UC ANR academics advance the field of youth development by conducting research and extending new knowledge to UC 4-H staff and volunteers and other youth development professionals. UC 4-H provided hands-on, experiential learning opportunities in science, engineering, and technology to almost 170,000 youth. UC ANR academics provided training to teen teachers to deliver science programs to younger children, such as the Youth Experiences in Science program delivered by 21 teens to 276 younger children in Sacramento County. UC 4-H delivered training to school teachers; for example, in Kern County, the Avian Embryology school enrichment program was implemented in three elementary schools and reached a total of 804 students, of which 789 were Latino. UC 4-H also sent teens to represent California at the National Youth Summit on Agri-Science.

Results

As a result of UC ANR research, outreach, and education, youth participants learned skills and reported positive aspirations that can lead to increased college readiness. Specific measured outcome indicators follow.

- Over 1,000 4-H youth responded to the science common measures survey about what they may have learned in the 4-H program.
- Youth reported science skills and abilities such as asking questions about how things work (88%), trying new things to see how they will work (87%), looking at how things are the same or different (83%), and comparing how different things work (77%).
- Youth grades 8 to 12 reported positive attitudes and aspirations towards science such as liking science (83%), liking a job that involves using science (72%), and studying science after high school (70%).
- In Santa Clara County, over 70 4-H youth responded to a survey about their experiences and reported learning new things about computer science (93%), interest in a job in computer science (77%), and interest in learning about engineering (76%).
- Teen teachers in Sacramento County reported an increase in their understanding of the science process in teaching youth (91%) and how inquiry relates to science (87%).
- Program evaluations from the Kern County Avian Embryology program indicated that the students showed increased levels of knowledge of food sources.
- National Youth Summit on Agri-Science indicated that all 13 teens increased their knowledge of agricultural science, agricultural career options, and the role of technology and science in

agriculture.

These measured outcomes demonstrated knowledge and skills learned and positive attitudes related to science, college, and careers, which are the pathway to entering the workforce. In this way, UC ANR contributes to the public value of developing a qualified workforce for California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #30

1. Outcome Measures

Participants learned about and improved food resource management practices.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

One out of every eight Californians does not know where their next meal will come from. Of the 4.6 million Californians facing food insecurity, 1.7 million are children. Food insecurity for youth increases school absences and behavioral problems, and reduces children's concentration and academic achievement.

What has been done

UC ANR's research creates practical solutions and delivers educational programs promoting improvement in individual and household food budget practices. UC ANR academics provided academic oversight, leadership, and guidance for the statewide implementation of the Expanded Food Nutrition and Education Program (EFNEP), UC CalFresh Nutrition Education Program (UC CalFresh), and the UC Master Gardener Program, which delivered direct education to participants related to food security. UC ANR piloted new programs and methods to reach new communities that are potentially food insecure. For example, EFNEP piloted a program at a public library in Riverside County as a method to improve low participation rates of SNAP-eligible, potentially food

insecure families in the federally funded summer meals program. Feedback from the families confirmed that providing educational enrichment activities in conjunction with the meals is an effective strategy for improving participation. UC ANR academics developed relationships with communities to develop new curricula and deliver culturally relevant educational programs. For example, one UC ANR academic collaborated with the Karuk, Yurok, and Klamath tribes in delivering workshops and seasonal food camps focused on understanding, finding, gathering, and processing edible native foods and fibers as well as other subsistence skills (butchering, canning, bread baking etc.) as part of the Tribal Food Security Project.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that lead to improved food security. Specific measured outcome indicators follow.

- EFNEP participants responded to surveys about their participation in a nutrition education program and 47% of over 4,000 EFNEP participants showed improvement in one or more food security indicators (i.e., not eating less than you wanted so there was more food for your family or having enough money to get food for your family).
- Over 1,200 UC CalFresh participants responded to a survey about their experiences with the Plan, Shop, Save and Cook curriculum, designed to help adult participants stretch food dollars by learning shopping strategies and meal planning.
 - * Participants adopted resource management behavior changes such as planning meals more often (42%), shopping with a list more often (45%), and comparing unit prices more often (44%).
 - * Participants reported improved food security by running out of food less often (36%).
- Over 800 participants of Master Gardener volunteer-led public education events responded to a survey about their food gardening practices related to food security. Participants reported applying gardening practices that reduced food loss (45%) as well as donating produce to community programs that distribute food to individuals in need of food assistance (13%).
- EFNEP participants of the pilot program in Riverside County completed surveys which show that over 85% of children improved in at least one core area: diet quality, food safety, and physical activity. As a result of this nutrition education program, families utilized the summer meals program, even though they were not intending to.
- The Tribal Food Security Project reached approximately 1450 participants in its final year. Program evaluations indicate that between 80-100% of participants learned something new at each camp, and between 63 ? 100% of participants wanted to learn more or implement their new learning, which can contribute to food security.

These measured outcomes demonstrated learning and behaviors changes related food resource management and informed decision-making that can lead to food policy changes at the state and local levels. According to the USDA Economic Research Service, the estimated percentage of food-insecure households in 2013-2015 was 12.6%, which decreased by 3% from 2010-2012 estimates. UC ANR's efforts contribute to the public value of safeguarding sufficient, safe, and healthy food for all Californians.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
703	Nutrition Education and Behavior

Outcome #31

1. Outcome Measures

Science-based information applied to food security policy and decision-making.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

One out of every eight Californians does not know where their next meal will come from. Of the 4.6 million Californians facing food insecurity, 1.7 million are children. Food insecurity for youth increases school absences and behavioral problems, and reduces children's concentration and academic achievement.

What has been done

UC ANR conducted policy engagement activities, including providing evidence-based, participating in networks, developing relationships, and facilitating information transfer. UC ANR academics? work informed decision-makers at the state level, such as the California Department of Health, and at the local level, such as the Marin County agencies and food policy councils.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that lead to improved food security. Policy engagement activities contributed to knowledge gain and science-based decision making. Specific measured outcome indicators follow.

- As a result of UC ANR Nutrition Policy Institutes? collaboration with the California Department of Public Health in research-to-policy efforts, counties utilized profiles developed to communicate the need for SNAP-Ed work, and help them target specific areas of need during their Integrated Work Plan planning process to achieve better food security and health outcomes for individuals reached by the program.
- UC ANR?s local policy engagement activities in Marin County led to increased awareness of the issues among the food policy council board of supervisors; greater interdepartmental collaboration between UC Cooperative Extension, Health and Human Services, and the

Community Development Agency; and increased alignment and an elevated urgency around two pressing policy priorities: low rates of CalFresh participation and lack of a grocery store in Marin City. Subsequently, these efforts informed the resurgence of county-wide taskforces on Healthy Eating Active Living.

These measured outcomes demonstrated learning and behaviors changes related food resource management and informed decision-making that can lead to food policy changes at the state and local levels. According to the USDA Economic Research Service, the estimated percentage of food-insecure households in 2013-2015 was 12.6%, which decreased by 3% from 2010-2012 estimates. UC ANR's efforts contribute to the public value of safeguarding sufficient, safe, and healthy food for all Californians.

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices
703	Nutrition Education and Behavior

Outcome #32

1. Outcome Measures

Participants learned healthy lifestyle and decision-making practices.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California's rapid population growth increases pressure on community resources, presenting numerous challenges to health and safety. Adult and childhood obesity is a public health crisis for the state and nation, resulting in a range of negative health consequences. Nearly 30% of California's youth in grades 9-12 and over 60% of California's adults are overweight or obese, according to the Center for Disease Control and Prevention. California spends over \$52 billion annually in healthcare costs associated with obesity.

What has been done

UC ANR produces tools, programs, and policy-relevant research that result in healthy living for individuals. UC ANR academics provided oversight, leadership, and guidance for the statewide implementation of the UC 4-H Youth Development Program. UC 4-H provided hands-on, experiential learning opportunities about healthy lifestyles to almost 25,000 youth.

Results

Over 1,000 4-H youth responded to the healthy living and positive youth development common measures survey about what they may have learned at 4-H.

- Youth reported healthy behaviors such as getting 8 hours or more of sleep per night (75%) and paying attention to how active they are - 74% of youth reported having a growth mindset related to health and being healthy.
- 93% of youth reported social and emotional skills (e.g., character, growth mindset, persistence, decision-making and ethics) necessary for academic or workplace success.
- Youth report that it is not okay or usually not okay for others to engage in risky behaviors such as texting and driving (96%), riding a bike without a helmet (78%), not wearing a seatbelt (96%), and someone their age drinking alcohol (97%), smoking (98%), or taking drugs (99%).

These measured outcomes lead to and demonstrate improved health for Californians where they learn, work, and play. Collectively these efforts contribute to the public value of promoting healthy people and communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle
806	Youth Development

Outcome #33

1. Outcome Measures

Participants changed attitudes toward and adopted healthy eating practices.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
------	--------

2018

0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California's rapid population growth increases pressure on community resources, presenting numerous challenges to health and safety. Adult and childhood obesity is a public health crisis for the state and nation, resulting in a range of negative health consequences. Nearly 30% of California's youth in grades 9-12 and over 60% of California's adults are overweight or obese, according to the Center for Disease Control and Prevention. California spends over \$52 billion annually in healthcare costs associated with obesity.

What has been done

UC ANR academics provided oversight, leadership, and guidance for the statewide implementation of the UC CalFresh Nutrition Education Program (UC CalFresh), Expanded Food Nutrition and Education Program (EFNEP), and UC 4-H Youth Development Program. EFNEP and UC CalFresh delivered nutrition education programs to over 138,000 youth as well as policy, systems, and environmental change strategies to prevent overweight and obesity. For example, Butte County Cluster's EFNEP and UC CalFresh Nutrition Education Program collaborated to deliver a dual series-based presentation of curricula over an 8-week period. The participants were families (specifically mothers and their children) living at the Migrant Farm Housing. EFNEP staff facilitated adult lessons using the Eating Smart, Being Active curriculum and UC CalFresh Nutrition Education Program staff facilitated the youth lessons using the Happy Healthy Me curriculum. The two programs collaborated to make it their goal during lesson delivery for both the parent and the child to be introduced to the same terminology and concepts so that they could have a common language at home. UC 4-H provided hands-on, experiential learning opportunities about healthy lifestyles to almost 25,000 youth. UC 4-H delivered teens as teachers programs such as Cooking Academy, a collaborative project with the UC CalFresh in Sutter and Yuba Counties. Twelve teens learned culinary techniques, behavior guidance strategies, and how to prepare each recipe featured in the curriculum. The teens then delivered seven weeks of cooking and food safety instruction where younger youth.

Results

As a result of UC ANR extension efforts, participants learned about healthier lifestyles. Specific measure outcome indicators follow.

- EFNEP received survey responses from over 4,000 adult participants and over 5,700 youth participants about their participation in a nutrition education program.
 - * Adult participants showed improvement in one or more diet quality indicators (95%) and in one or more physical activity behaviors (86%).
 - * 81% of youth improved their abilities to choose foods according to federal dietary recommendations or gain knowledge.
- Over 800 UC CalFresh adult participants responded to Food Behavior Checklist pre/post surveys after participating in a nutrition education program.
 - * Participants reported eating more than one kind of fruit (44%) and more than one vegetable (44%) each day more often.
 - * Participants increased the amount of fruit and vegetables eaten in cups (68%).
- 97% of 700 UC CalFresh trained teachers reported on behalf of their 17,099 students that students are now able to identify healthy food choices.
- UC CalFresh implemented over 4,000 healthy food tastings with over 89,700 students. Youth participants indicated that they were willing to eat the food again at school (67%) and willing to

ask for this food at home (63%).

- Migrant farm workers in Butte County Cluster made healthier food choices as a result of their nutrition education such as eating more fruits (78%) and eating more vegetables (22%).

- Over 1,000 4-H youth responded to the healthy living common measures survey about what they may have learned at 4-H. Youth reported healthy habits such as never or only some days eating fast food (95%), eating breakfast (83%), eating a meal with their family most or every day (85%), and paying attention to how much water they drink each day (72%).

- In Sutter and Yuba Counties, teens who were trained as teachers increased their overall self-confidence, ability to act as mentors, and ability to speak before a group. Almost 70% of the teens reported that they eat more fruits and vegetables, drink less soda, and consume more water. Additionally, the younger youth reported an increase by 28% in their willingness to try new foods increased as a result of participating in the Cooking Academy.

These measured outcomes lead to and demonstrate improved health for Californians where they learn, work, and play. Collectively these efforts contribute to the public value of promoting healthy people and communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle

Outcome #34

1. Outcome Measures

Participants adopted edible gardening practices and spent more time outdoors.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California's rapid population growth increases pressure on community resources, presenting

numerous challenges to health and safety. Adult and childhood obesity is a public health crisis for the state and nation, resulting in a range of negative health consequences. Nearly 30% of California's youth in grades 9-12 and over 60% of California's adults are overweight or obese, according to the Center for Disease Control and Prevention. California spends over \$52 billion annually in healthcare costs associated with obesity.

What has been done

UC ANR academics provided oversight, leadership, and guidance for the statewide implementation of the UC Master Gardener Program. Volunteers delivered public education workshops and participants responded to a survey about any changes made as a result of attending.

Results

Specific measured outcome indicators related to health and well-being follow.

- 68% of 841 respondents started or improved growing edible plant(s) and 56% expanded varieties of edible plant(s) grown. These behaviors are correlated with increasing consumption of fruits and vegetables.
- Respondents applied knowledge gained on 1,378,985 square feet of food gardens, potentially increasing their access to produce.
- 71% of 1,505 respondents spent more time gardening and outdoors, which is associated with improved individual emotional and physical health.

These measured outcomes lead to and demonstrate improved health for Californians where they learn, work, and play -- contributing to the public value of promoting healthy people and communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle

Outcome #35

1. Outcome Measures

Participants improved individual health.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California’s rapid population growth increases pressure on community resources, presenting numerous challenges to health and safety. Adult and childhood obesity is a public health crisis for the state and nation, resulting in a range of negative health consequences. Nearly 30% of California’s youth in grades 9-12 and over 60% of California’s adults are overweight or obese, according to the Center for Disease Control and Prevention. California spends over \$52 billion annually in healthcare costs associated with obesity.

What has been done

UC ANR academics provided oversight, leadership, and guidance for the statewide implementation of the UC CalFresh Nutrition Education Program (UC CalFresh). In San Luis Obispo County, the UC CalFresh Shaping Healthy Choices program reached 138 students in five schools that have predominantly Latino youth population and youth who qualify for free or reduced cost meals. Additionally, UC ANR academics conducted research on the efficacy of healthy lifestyle interventions and participant outcomes. For example, UC ANR academics collaborated on a 5 year Agriculture and Food Research Institute (AFRI) USDA-funded obesity project, which involved delivering evidence-based curriculum as well as family and community level interventions, to Mexican origin families in Central California.

Results

Specific measured outcome indicators follow.

- Evaluation findings from San Luis Obispo County indicate a statistically significant decrease in Body Mass Index percentile in youth participants.
- 392 children received an intensive, multi-faceted, childhood obesity intervention including nutrition education over several years. Children had greater improvement over two years in skin carotenoid intensity scores than those in a comparison community. Increased skin carotenoid scores indicate an increase in fruit and vegetable consumption as a result of this intervention.

These measured outcomes demonstrate improved health for Californians where they learn, work, and play. Collectively these efforts contribute to the public value of promoting healthy people and communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
724	Healthy Lifestyle

Outcome #36

1. Outcome Measures

Science-based information applied to healthy food policy and decision-making.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California's rapid population growth increases pressure on community resources, presenting numerous challenges to health and safety. Adult and childhood obesity is a public health crisis for the state and nation, resulting in a range of negative health consequences. Nearly 30% of California's youth in grades 9-12 and over 60% of California's adults are overweight or obese, according to the Center for Disease Control and Prevention. California spends over \$52 billion annually in healthcare costs associated with obesity.

What has been done

UC ANR academics provided evidence-based information to state-level decisions makers, such as the California Department of Public Health regarding the curricula, strategies, and program guidance for the implementation of Supplemental Nutrition Assistance Program ? Education (SNAP-Ed) in California.

Results

Evidence-based recommendations to the California Department of Public Health regarding SNAP-Ed nutrition education curricula and program guidance has led to the adoption of at least two new curricula, ?My Plate. My Way. Everyday!? and ?Cooking for Healthy Academic,? and the adoption of new requirements for local health departments in their implementation of SNAP-Ed. Agencies must now utilize multiple strategies from a menu of evidence-based nutrition education curricula and obesity prevention approaches. The adoption of these new curricula and program guidance will lead to stronger, more focused SNAP-Ed interventions and ultimately, better health outcomes for individuals reached by the program.

This measured outcome leads to improved health for Californians, contributing to the public value of promoting healthy people and communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
610	Domestic Policy Analysis

Outcome #37

1. Outcome Measures

Participants learned about and adopted civically engagement behaviors.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California requires a highly skilled workforce to remain a competitive, prosperous, and an innovative global leader. Volunteering and civic engagement can develop skills and confidence that make individuals employable as well as create attachment to communities that encourages people to invest, spend, and hire. Increased civic engagement can contribute the development of a qualified workforce for California and a robust and thriving state economy.

What has been done

UC ANR delivers educational programs that increase civic engagement. The UC 4-H Youth Development Program reached over 142,000 youth- an increase of 30% from the previous year- participating in clubs, afterschool programs, and camps, who were involved in projects around civic engagement, healthy lifestyles, and science, engineering & technology. Civic engagement projects included four focus areas: community engagement, service, civic education, and personal development. Teens as teachers programs created opportunities for teens to learn skills and contribute to their communities by delivering education to younger children. Almost 20,000 adult volunteers contributed over 1,700,000 hours, estimated at almost \$50 million in value. As a result of UC ANR outreach and evidence-based educational programs, participants learned and adopted civic engagement skills and attitudes. Outcomes with specific indicators follow.

Results

Almost 800 4-H youth responded to the Civic Engagement common measures survey about what

they may have learned at 4-H.

- Youth reported that they like to help people in their community (99%) and feel a responsibility to help their community (93%).
- 76% of youth report having critical teamwork skills related to diversity. These are skills that become increasingly important as the population in California and the U.S. are becoming increasingly racially and ethnically diverse.
- Youth reported they have done a community service project (83%) and look for ways to help when they learn about a problem in the community (85%).
- 4-H teen teachers in Sacramento County delivered the semester-long Youth Experiences in Science program to 276 children and 97% of 21 teens agreed that they made an important contribution to their community.

These measured outcomes demonstrated learning gain and behavior change related to civic engagement. Research shows civic engagement outcomes can lead to employability, emotional connection to communities, and a more qualified workforce. California’s unemployment rate was 4.1% in December 2018, which is down from 4.4% the previous year. UC ANR’s youth development programs equip the next generation to be active participants in their communities, which can contribute to a robust and thriving state economy.

4. Associated Knowledge Areas

KA Code	Knowledge Area
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

Outcome #38

1. Outcome Measures

Participants learned about and adopted financial management practices.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California's vibrant, diverse economy is the sixth largest in world. To maintain its competitive edge, California must overcome technical, social, and environmental challenges. Consumer spending contributes a majority of overall economic growth other and while California experienced historic low unemployment rates in 2018, other issues related to financial stability continue to rise such as lack of housing, inflation, and cost of living.

What has been done

UC ANR conducts research and delivered education leading to improvements in individual and household financial management practices. UC ANR academics delivered the Money Talks program to 240 teens and young adults about financial literacy and housing security. UC ANR academics provided oversight, leadership, and guidance for the statewide implementation of the UC CalFresh Nutrition Education Program (UC CalFresh) and Expanded Food Nutrition and Education Program (EFNEP) statewide programs. Curricula such as Making Every Dollar Count are designed to help UC CalFresh adult participants gain the tools needed to take control of their money and which teaches families food buying/budgeting skills and food and resources management techniques. As a result of UC ANR outreach and education, participants learned and adopted financial management practices. Outcomes with specific indicators follow.

Results

Specific measured outcome indicators follow.

- Money Talks program participants were observed applied new knowledge learned from the program in discussions and group activities about available housing resources in their communities. Participants also reported learning information that applies to real life and can see themselves utilizing resources and becoming more civically engaged
- About 1,000 UC CalFresh participants completed a retrospective survey about their participation in the Making Every Dollar Count program. The majority reported improvement in their knowledge about the topics covered such as knowing easy ways to save money on food (83%) and understanding food ads (83%).
- Over 4,000 EFNEP participants responded to a survey about their educational program experiences and 82% of participants showed improvement in one or more food resource management practices. EFNEP adult graduates reported an average monthly food cost savings of \$38.20, which collectively saved California EFNEP families \$2,916,340.

These measured outcomes demonstrated improved knowledge and skills related to individual and household resource management. In this way, UC ANR contributes to the public value of promoting economic prosperity in California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being

Outcome #39

1. Outcome Measures

Participants learned and adopted home food safety practices.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California is a national and global leader in food production and agricultural export. The state faces social, regulatory, economic, and environmental challenges that affect our agricultural and food systems, our communities, and our public health. The Center for Disease Control and Prevention estimates that 1 in 6 people get sick from foodborne diseases each year, including 128,000 hospitalizations.

What has been done

UC ANR academics provided research-based information and programmatic oversight to statewide program extenders, such as UC Master Food Preserver (UC MFP) volunteers, who were then able to provide information to the public. UC MFP was delivered in 17 California counties by over 400 volunteers, who donated over 19,000 volunteer hours. In San Luis Obispo and Santa Barbara Counties, almost 900 low-income residents, the majority of whom are Spanish-speaking, received safe food preservation information and tools such as ice cube trays for implementing new practices. Other statewide programs that extended food safety information included the UC 4-H Youth Development Program, UC CalFresh Nutrition Education Program (UC CalFresh), and Expanded Food and Nutrition Education Program (EFNEP).

Results

As a result, participants learned about and adopted individual and household food safety behaviors. Specific measured outcome indicators follow.

- Over 600 participants in San Luis Obispo and Santa Barbara Counties responded to surveys about their experience with the UC Master Food Preserver program and reported increases in knowledge of food safety and/or safe food preservation techniques (99%).

- Over 1,000 4-H youth responded to the Healthy Living common measures survey about what they may have learned at 4-H and 75% of youth report knowing how to keep a cooking area clean to stop spreading of germs.
- EFNEP surveyed over 4,000 participants and over 5,700 youth participants about behavior changes as a result of participating in the program.
 - * 83% of adult participants showed improvement in one or more food safety practices, such as washing hands before preparing food or using a meat thermometer).
 - * 50% of youth participants used safe food handling practices more often or gain knowledge such as washing fruit and vegetables before eating or putting foods back in the refrigerator within 2 hours.

These measured outcomes demonstrate improved knowledge and skills around individual and household food safety practices. In this way, UC ANR contributes to the public value of safeguarding sufficient, safe, and healthy food for all Californians.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
723	Hazards to Human Health and Safety
724	Healthy Lifestyle

Outcome #40

1. Outcome Measures

Participants adopted farm food safety behaviors.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California is a national and global leader in food production and agricultural export. The state faces social, regulatory, economic, and environmental challenges that affect our agricultural and

food systems, our communities, and our public health. The Center for Disease Control and Prevention estimates that 1 in 6 people get sick from foodborne diseases each year, including 128,000 hospitalizations.

What has been done

UC ANR academics delivered both online and in-person farm food safety workshops; in-person workshops enable peer-to-peer sharing of knowledge and experiences which can lead to earlier adoption of new practices. Almost 600 urban farmers throughout California attended online and in-person workshops about food safety basics. Specialty Crop producers in Placer and Nevada Counties participated in on-farm workshops about food safety and managing risks. In Mendocino and Sonoma Counties, 71 small-scale produce farmers attended workshops about farm food safety workshops.

Results

As a result, participants learned about and adopted on-farm food safety behaviors. Specific measured outcome indicators follow.

- 90 urban farmers responded to a survey after completing online food safety workshops and reported the following behavior changes.
 - * 68% of respondents identified food safety risks on their farm.
 - * 53% of respondents developed and implemented a food safety plan for their farm.
- 35% of respondents kept records of date and type of food sold/donation.
- Specialty crop producers in Placer and Nevada Counties identified key food safety risks and developed a plan to manage those risks on their farms after attending on-farm workshops.
- Small-scale produce farmers in Mendocino and Sonoma Counties increased their food safety knowledge, enhanced their ability to comply with regulations, and improved wholesale readiness in the region.

These measured outcomes demonstrate improved knowledge and skills around farm food safety practices. In this way, UC ANR contributes to the public value of safeguarding sufficient, safe, and healthy food for all Californians.

4. Associated Knowledge Areas

KA Code	Knowledge Area
723	Hazards to Human Health and Safety

Outcome #41

1. Outcome Measures

Participants learned leadership skills and extended evidence-based information to their peers and decision-makers.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In the last ten years, 37-56% of U.S. adults approved of the U.S. president's job performance and 48-74% were confident that the U.S. president would do the right thing in world affairs. Furthermore, only 64% of U.S. adults say the overall quality of candidates running for congress in their districts was good. These 2018 public opinion studies conducted by the Pew Research Center indicate a continued need for increased effective and responsive public leaders.

What has been done

UC ANR's extensive network and youth development programs equip the next generation of public leaders. UC ANR developed, evaluated, and delivered evidence-based educational programs that provided youth with leadership skills. UC ANR academics provided oversight, leadership, and guidance for the statewide implementation of the UC CalFresh Nutrition Education Program (UC CalFresh) and the UC 4-H Youth Development Program. Youth participants in these programs were empowered to take on leadership roles in research, teaching, and service-learning projects to improve their communities.

Results

As a result of UC ANR educational programs, youth participants learned and applied scientific methods, leadership, presentation, and advocacy skills. In some cases, youth participants engaged in environmental change or policy engagement activities that led to decision-makers adopting evidence-based recommendations. Outcomes with specific indicators follow.

- Over 1,000 4-H youth responded to the universal positive youth development common measures survey about what they may have learned at 4-H and 87% of youth report social and leadership skills, including the ability to communicate through multiple methods and value and respect for other cultures.
- In testing new science literacy curricula, 4-H youth increased their understanding of scientific concepts, including county fair bio-security practices and animal husbandry practices to help mitigate predator and livestock interactions. Youth applied leadership skills by extending evidence-based information to their peers and community members through videos and outreach.
- In Contra Costa County, six 4-H teens learned about and utilized research skills to understand water consumption and water access at their school, then delivered evidence-based recommendations to their peers, school site staff, and school board members, advocating for water filling stations for their school. As a result, the board members approved added a water filling stations in the schools' renovation plans. Over 300 students at the school completed post

surveys and reported a 19% increase in choosing water as their first choice of beverage and a 15% increase in selecting water from the first floor, the location of the a new water refilling station, thereby demonstrating increased access to safe and good-tasting water can influence students' beverage choices.

- As part of the Healthy School Farmer's Market initiative of UC CalFresh nutrition education program in Tulare County, 20 4-H youth selected to be Nutrition Ambassadors applied new knowledge and skills in delivering evidence-based healthy food information and resources to their peers and families.

- In Yolo County, seven UC CalFresh participants became teens as teachers and taught nutrition education, food preparation, and cooking lessons to 77, 5th & 6th-grade student chefs. After the intervention, 100% of the leaders felt that they could successfully work with younger youth. One school expanded their efforts by developing a Student Nutrition Advisory Council, which led a health education campaign focused on increasing water consumption and decreasing sugar-sweetened beverages on campus.

- Youth who participated in UC CalFresh's pilot Youth Engagement Initiative applied research and presentation skills, resulting in the following school-level policy changes:

* Youth in San Mateo County applied research skills by surveying their peers and then advocated to add smoothies to the lunch menus. After presentations to school and district officials and their peers, their recommendations were implemented.

* Youth in Imperial County applied research skills by surveying their peers and analyzing physical fitness and obesity data to advocate for new physical activity equipment and approval of a playground stencil project. After presentations to school and district officials as well as their peers, their recommendations were approved.

These measured outcomes demonstrated that leadership skills were learned and applied for the benefit of local California communities. In this way, UC ANR contributes to the public value of developing a qualified workforce for California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
806	Youth Development

Outcome #42

1. Outcome Measures

Participants learned about and changed attitudes about the environment.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There are documented health benefits of spending time in nature, yet children in the U.S. spend a daily average of 7.5 hours in front of a screen. Furthermore, 30% of Californian youth do not have parks, sidewalks, and community centers in their neighborhood and 30% of adults do not meet physical activity guidelines. Adult and childhood obesity is a public health crisis for the state and nation, resulting in a range of negative health consequences.

What has been done

UC ANR delivers educational programs and policy, system, and environment (PSE) interventions to youth with the goal of improving access to positive built and natural environments. UC ANR academics provided oversight, leadership, and guidance in the statewide implementation of the UC 4-H Youth Development Program. One academic piloted a new program that provides outdoor experiential learning opportunities titled, ¡Descubre Outside! Discover Afuera!

Results

As a result of UC ANR educational and PSE activities, participants learned about the environment and increased access to positive built environments. For example:

- Forty-three, mostly Latino youth, participated in ¡Descubre Outside! Discover Afuera! and participated in a pre-post evaluation about their experiences. All of the participants noted that they now enjoy spending time outdoors. Youth expressed that they care about the environment (97%) and said this program has helped them to learn about environmental issues (80%).

This measured outcome demonstrates individual learning gains related to the environment and improved access to green spaces and the outdoors -- contributing to the public value of promoting healthy people and communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle
903	Communication, Education, and Information Delivery

Outcome #43

1. Outcome Measures

Participants improved access to green spaces and the outdoors for youth.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There are documented health benefits of spending time in nature, yet children in the U.S. spend a daily average of 7.5 hours in front of a screen. Furthermore, 30% of Californian youth do not have parks, sidewalks, and community centers in their neighborhood and 30% of adults do not meet physical activity guidelines. Adult and childhood obesity is a public health crisis for the state and nation, resulting in a range of negative health consequences.

What has been done

UC ANR academics delivered educational programs and policy, system, environment (PSE) activities that increased access to green spaces, improved outdoor physical activity, and increased appreciation of the environment. UC ANR academics provided oversight, leadership, and guidance in the statewide implementation of the UC CalFresh Nutrition Education Program (UC CalFresh) and UC Master Gardener Program.

Results

As a result of UC ANR educational and PSE activities, participants increased access to positive built environments. Specific measured outcome indicators follow.

- Thirty UC CalFresh program sites across the state newly adopted or continued adoption of playground stencils. Combined with teacher training and delivery of evidence-based physical activity lessons, the stencils provided outdoor, engaging, and structured physical activity.
- Two schools participating in the UC CalFresh Shaping Healthy Choice Programs in Riverside County implemented gardening during physical education class. One of these schools implemented a school garden for the first time. The hands-on gardening activities enhanced student interest in learning about healthy food choices. The pre/post student evaluation showed a significant increase in nutrition knowledge.
- As a result of participating in collaborative programming between UC Master Gardener and UC CalFresh in Fresno County, one community-serving rehabilitation organization revitalized its garden. Five garden beds were planted by residents and their children, who continued to regularly spend time in the garden.
- The Imperial County school district's participation in the UC CalFresh Smarter Lunchrooms Movement resulted in the adoption of comprehensive strategies to prevent child overweight and obesity, while at the same time, created opportunities for children to spend time outdoors. The district adopted stencils, which created opportunities for outdoor physical activity for 488 students. Eight teachers adopted garden-enhanced nutrition education, among other physical and nutrition

education activities.

- As a result of participating in the UC Master Gardeners pilot gardening program for incarcerated youth in Tulare and Kings Counties, one juvenile center created opportunities for youth to learn technical skills and belonging while spending time outdoors. Detention facility staff reported a clear uptick in interest and pride in the garden by the youth, as well as pride in donating produce to the local food pantry and filling a critical community need. Gardeners observed youth taking great pride in sharing their landscaping efforts with visiting family members, connecting their efforts to an improved physical environment.

These measured outcomes demonstrate PSE changes that created more opportunities to spend time in gardens and outdoors. In this way, UC ANR improves access to green spaces and the outdoors for people and communities where they live, learn, work, and play. Collectively these efforts contribute to the public value of promoting healthy people and communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle
903	Communication, Education, and Information Delivery

Outcome #44

1. Outcome Measures

Participants learned promising food policy council practices.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California's rapid population growth increases pressure on community resources, presenting numerous challenges to health and safety. Adult and childhood obesity is a public health crisis for the state and nation, resulting in a range of negative health consequences. Nearly 30% of California's youth in grades 9-12 and over 60% of California's adults are overweight or obese,

according to the Center for Disease Control and Prevention.

What has been done

UC ANR conducted research about and shared findings with California food policy councils. Findings from this study of 31 of the 33 known food policy councils indicate that significant policy change can be achieved through small sub-groups and that information-sharing is seen as the most valuable food policy council activity. Food policy councils are uniquely positioned to engage with agricultural, economic, environmental, and social issues in California.

Results

As a result of UC ANR research, policy engagement, outreach, and education, participants learned about and adopted strategies to improve community health and wellness. For example:

- Over 80% of participants reported they will use what they gained at the event in their work, such as expanded use of promising practices and continuing to build relationships across food policy councils and with UC ANR, which may contribute to increasing their overall effectiveness.

This measured outcome demonstrates learning that can lead to improved community health and wellness -- contributing to the public value of promoting healthy people and communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices

Outcome #45

1. Outcome Measures

Participants adopted community-level changes to prevent overweight and obesity.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California's rapid population growth increases pressure on community resources, presenting numerous challenges to health and safety. Adult and childhood obesity is a public health crisis for the state and nation, resulting in a range of negative health consequences. Nearly 30% of California's youth in grades 9-12 and over 60% of California's adults are overweight or obese, according to the Center for Disease Control and Prevention.

What has been done

UC ANR academics provided oversight, leadership, and guidance in educational programs and policy, systems, and environmental (PSE) interventions delivered through the UC CalFresh Nutrition Education Program (UC CalFresh). UC CalFresh provided training and technical assistance to low-income communities on evidence-based programs and strategies for participating sites to increase consumption of health foods, improve physical activity opportunities, and implement or update wellness policies.

Results

As a result of UC ANR research, policy engagement, outreach, and education, participants learned about and adopted strategies to improve community health and wellness. Specific measured outcome indicators follow.

- UC CalFresh reported PSE changes at 350 SNAP-Ed locales, contributing to improved community health and wellness for more than 140,000 people.
- Over 180 UC CalFresh program sites in 27 counties made at least one physical activity-related PSE change, reaching over 80,000 individuals. About half of the sites changed the quality of structured physical activity.
- The Smarter Lunchrooms Movement was utilized by 102 UC CalFresh program sites to encourage the selection of healthy options in cafeterias. Twenty-one sites with more than one scorecard increased cafeteria assessment scores by 5.9 points over the school year due to adopting evidence-based, low-cost/no-cost cafeteria makeover strategies.
- 13 UC CalFresh county programs adopted youth engagement strategies after receiving training and technical assistance. As a result, 189 young people provided direct and indirect nutrition education and PSE strategies that contribute to improved community health and wellness.
- Behavior changes in Kings County include 113 teachers enrolling to implement nutrition lessons in the classroom and one teacher aligning nutrition lessons with common core standards for English Language Arts and Health Education. The effective partnership and program led to changes to the district's school wellness policy to improve healthy eating.

These measured outcomes demonstrated learning, action, and policy changes that can lead to improved community health and wellness. Collectively these efforts contribute to the public value of promoting healthy people and communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle

Outcome #46

1. Outcome Measures

Participants applied practices that improve overall community wellness.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California's rapid population growth increases pressure on community resources, presenting numerous challenges to health and safety. Adult and childhood obesity is a public health crisis for the state and nation, resulting in a range of negative health consequences. Nearly 30% of California's youth in grades 9-12 and over 60% of California's adults are overweight or obese, according to the Center for Disease Control and Prevention.

What has been done

UC ANR academics provided oversight, leadership, and guidance in educational programs and policy, systems, and environmental (PSE) interventions delivered through the UC CalFresh Nutrition Education Program (UC CalFresh). UC ANR academics also provide oversight, leadership, and guidance to the UC Master Gardener Program, who then extend research-based information and technical assistance to members of the public. In addition, ANR founded the Oakland Food Web, which encourages and facilitates knowledge-sharing about school gardens and healthy foods.

Results

As a result of UC ANR research, policy engagement, outreach, and education, participants learned about and adopted strategies to improve community health and wellness. Specific measured outcome indicators follow.

- UC CalFresh evaluated program delivery by surveying teachers in 22 of the 32 counties served. In total, 724 teachers reported on behalf of their 17,099 students. Over 50% of teachers reported more frequently encouraging students to be physically active and to eat breakfast and 97% indicated that more students are now able to identify healthy food choices
- Participants of UC Master Gardener volunteer-led educational programs started or improved

practices on over 2,700,000 square feet of home gardens in California. This is important because a 2016 study found that living near greenery may help you live longer.

- As a result of participating in the Oakland Food Web and focused work on recycling and composting, three middle school sites experienced waste reduction.

These measured outcomes demonstrated learning, action, and policy changes that can lead to improved community health and wellness. Collectively these efforts contribute to the public value of promoting healthy people and communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle

Outcome #47

1. Outcome Measures

Participants increased access to fresh produce.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California's rapid population growth increases pressure on community resources, presenting numerous challenges to health and safety. Adult and childhood obesity is a public health crisis for the state and nation, resulting in a range of negative health consequences. Nearly 30% of California's youth in grades 9-12 and over 60% of California's adults are overweight or obese, according to the Center for Disease Control and Prevention.

What has been done

UC ANR academics provided oversight, leadership, and guidance in educational programs and policy, systems, and environmental (PSE) interventions delivered through the UC CalFresh Nutrition Education Program (UC CalFresh).

Results

As a result of UC ANR research, policy engagement, outreach, and education, participants learned about and adopted strategies to improve community health and wellness. Specific measured outcome indicators follow.

- 136 UC CalFresh sites implemented edible gardens where participants eat, work, and learn.
- 30 UC CalFresh sites adopted or continued to improve their Farm-to-School/Fork initiatives, providing increased access to healthy foods.
- In San Mateo and Santa Clara County school districts, UC CalFresh sites adopted cafeteria promotion, farm-to-school, and school garden strategies to introduce 36 local produce items.
- Student selection, consumption, and interest in new produce items increased.
- One school food service director aligned the produce served in the cafeteria to what is grown in the school garden.
- Parents shared the desire to purchase new produce items because their children tried and liked them at school.
- As a result of participating in UC CalFresh, two elementary school communities in Tulare County have increased access to fresh fruits and vegetables due to a partnership with a local food bank. The produce is available to nearly 500 students and community residents at no cost.

These measured outcomes demonstrated learning, action, and policy changes that can lead to improved community health and wellness. Collectively these efforts contribute to the public value of promoting healthy people and communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices
703	Nutrition Education and Behavior

Outcome #48

1. Outcome Measures

Science-based information applied to community health and wellness policy and decision-making at the local and state levels.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California's rapid population growth increases pressure on community resources, presenting numerous challenges to health and safety. Adult and childhood obesity is a public health crisis for the state and nation, resulting in a range of negative health consequences. Nearly 30% of California's youth in grades 9-12 and over 60% of California's adults are overweight or obese, according to the Center for Disease Control and Prevention.

What has been done

UC ANR academics conducted research on nutrition policies, participation levels in nutrition assistance programs like the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), obesity prevention, and food hubs. Findings from this research as well as other evidence-based recommendations were shared by academics with decision-makers at local and state levels through policy engagement activities.

Results

The following outcome indicators are related to efforts of UC ANR's Nutrition Policy Institute that impact the local and state levels.

- As a result of UC ANR academics' policy engagement activities (meeting with decision-makers, providing resources and recommendations), California state government provided funding for a new project to assess satisfaction with WIC services and the WIC food shopping experience before the state transitions from paper to electronic benefit cards, as well as possible updates to the WIC food packages. This project will enable future assessments of and improvements to WIC participation, contributing to greater food security and nutrition among low-income families with young children.
- Evaluation findings of a new campus vending policy, developed by UC ANR and colleagues, confirmed increased access to healthy foods for university students. UC Berkeley vending audits show that 44% of snack vending machines were compliant with the policy, an improvement from 31% the year before, and about 1/3 of the top selling snacks are healthy. Furthermore, at least two other campuses implemented similar nutrition standards in vendor specifications.
- As a result of UC ANR research, Mandela Marketplace in Oakland has increased understanding of their effectiveness as a food hub in reaching their target clientele of community residents of color. They report intent to use the findings in fundraising efforts and identifying strategies for financial sustainability.
- UC ANR's collaboration and leadership in California's inaugural Food Waste Prevention Week led to multiple state agencies engaging in food waste prevention efforts beyond their participation in the week-long messaging campaign, which resulted in multiple agencies across sectors circulating shared messages on a critical social, environmental, and health issues.
- As a result of UC ANR providing evidence-based information and resources, the California Department of Public Health adopted a new SNAP-Ed theme, "drink water, not sugar-sweetened beverages," which will be required of every SNAP-Ed Local Implementing Agency in California.

These measured outcomes demonstrated learning, action, and policy changes that can lead to improved community health and wellness, including improved access to healthy foods and safe

drinking water. Collectively these efforts contribute to the public value of promoting healthy people and communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
604	Marketing and Distribution Practices
610	Domestic Policy Analysis

Outcome #49

1. Outcome Measures

Science-based information applied to community health and wellness policy and decision-making at the federal and national levels.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California's rapid population growth increases pressure on community resources, presenting numerous challenges to health and safety. Adult and childhood obesity is a public health crisis for the state and nation, resulting in a range of negative health consequences. Nearly 30% of California's youth in grades 9-12 and over 60% of California's adults are overweight or obese, according to the Center for Disease Control and Prevention.

What has been done

UC ANR academics conducted research and policy engagement activities on child and adult care nutrition, participation levels in nutrition assistance programs like Women, Infants, and Children (WIC), obesity prevention, and testing for lead in water in schools and child care settings. Decision-makers at federal and national levels were engaged through activities such as organizing policy convenings, participating in briefings, testifying at hearings, and participating in briefings and network

Results

The following outcome indicators are related to efforts of UC ANR's Nutrition Policy Institute academics that impact the federal and national levels.

- Several policy convenings were led by a UC ANR academic to share childcare research findings, which informed nutrition policy at both federal and state levels, informing revisions to the federal Child and Adult Care Food Program nutrition standards. Additionally, the academic shared study findings indicating the readiness of childcare providers to adopt the new requirements, demonstrating the feasibility of policy implementation.
- UC ANR conducted a study on WIC infant and toddler feeding practices and why eligible participants leave the program. Findings were shared at a USDA briefing, which informed ongoing federal and state efforts, ensuring that more young children who need the nutrition and education provided by WIC remain on the program.
- National research conducted by UC ANR and collaborators confirmed that successful nutrition and obesity prevention efforts of communities require sustained implementation over 4-6 years and strategies of greater intensity, such as changing food environments and focusing on behaviors not to do as well as behaviors to do. The findings align with SNAP-Ed's newer requirements for agencies to deliver more than one policy, system, and environment strategy in addition to nutrition education.
- Evidence shared from a UC ANR research study assessing Body Mass Index in schoolchildren provided support for the introduction of a new federal school nutrition wellness bill by Ohio Congressman Tim Ryan.
- Through policy engagement activities and providing academic expertise about the current status and considerations in drinking water lead testing programs, UC ANR contributed to the following.
 - * The Environmental Protection Agency's development of a new grant program for states to test for lead in school and childcare drinking water.
 - * Renewed and new authorizations related to eliminating lead exposure in school and childcare drinking water in America's Water Infrastructure Act of 2018.
 - * 2018 budget Omnibus appropriations for programs to reduce lead in school and childcare drinking water.
 - * The passage of California legislation (AB2370), which will require lead testing in childcare facilities and allocates state budget funds for implementation and remediation of any lead contamination.

These measured outcomes demonstrated learning, action, and policy changes that can lead to improved community health and wellness, including improved access to healthy foods and safe drinking water. Collectively these efforts contribute to the public value of promoting healthy people and communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
610	Domestic Policy Analysis
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #50

1. Outcome Measures

Participants learned about and applied new evidence-based information in youth education programs.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California requires a highly skilled workforce to remain a competitive, prosperous, and an innovative global leader. A Pew Research Center study projects that U.S. job growth will increase as it has in the past 35 years in occupations that require higher levels of education, training, and experience. A qualified workforce is needed especially in youth education and obesity prevention, two areas in which California ranks among the worst in the country. Additionally, California is the largest agricultural producer in the U.S., thus education and training must be provided to enhance agricultural productivity and capacity to innovate.

What has been done

UC ANR academics affiliated with Expanded Food and Nutrition Education Program (EFNEP) and the UC 4-H Youth Development Program (UC 4-H) provided professional development opportunities to school teachers and staff, who then deliver evidence-based curricula to youth. EFNEP partnered with school districts, such as Hayward Unified, and provided two years of nutrition education training and curriculum materials. UC 4-H trained after school enrichment staff in projects. In Sacramento County, 20 after school staff were trained in and delivered 4-H Water Wizards to 488 students and animal agricultural production. In Kern County, school enrichment staff received 4-H Avian Embryology project training and supplies for implementing the project with youth. Furthermore, UC ANR academics and multi-state collaborators conducted research on the application of ?lesson study,? an iterative and educator-centered approach to professional development, in youth development settings. Findings from this research revealed the potential for ?lesson study? to improve data-driven decision-making, content knowledge, lesson planning, and implementation among Cooperative Extension educators, adult 4-H volunteers, and 4-H teens.

Results

As a result of UC ANR research, outreach, and education, participants learned about and adopted strategies to improve workforce retention and competency. Specific measured outcome indicators follow.

- Thirty after school staff members applied food and fitness knowledge in delivering six lessons to 1,400 students in Hayward Unified School District, in addition to adopting food and fitness behavior changes in their own lives.
- Staff implemented pre and post evaluations to find that 72% of students improved skills in choosing foods consistent with federal dietary guidelines and 47% improved their food safety practices.
- Program evaluations of 4-H Water Wizards program in Sacramento County revealed that after school staff were confident in delivering their projects, while youth increased their knowledge about water. Furthermore, 77% of 20 after school program staff indicated they better understood how inquiry relates to science.
- In Kern County, 4-H Avian Embryology project trainings improved abilities of after-school instructors as 87% of those trained reported a significant increase in knowledge and confidence in delivering the project. All teachers reported increased student engagement and a desire to learn in class.
- As a result of findings from the new research on "lesson study" in youth development settings, one land grant institution adopted lesson study as a professional development for all new and early-career 4-H agents.

These measured outcomes demonstrated changes in learning and improvements in how they work to UC ANR's extension of evidence-based information. Youth development professionals, nutrition educators, decision-makers, growers, and land managers learned cutting edge skills that increase workforce competency and advance innovation. In this way, UC ANR contributes to the public value of developing a qualified workforce for California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
903	Communication, Education, and Information Delivery

Outcome #51

1. Outcome Measures

Participants learned skills in landscapes and agricultural production.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California requires a highly skilled workforce to remain a competitive, prosperous, and an innovative global leader. A Pew Research Center study projects that U.S. job growth will increase as it has in the past 35 years in occupations that require higher levels of education, training, and experience. A qualified workforce is needed especially in youth education and obesity prevention, two areas in which California ranks among the worst in the country. Additionally, California is the largest agricultural producer in the U.S., thus education and training must be provided to enhance agricultural productivity and capacity to innovate.

What has been done

UC ANR academics developed curricula and delivered professional development opportunities for individuals who work in agricultural production and landscape management. UC ANR delivered continuing education classes in Spanish and in English for individuals to renew their California Department of Pesticide Regulation Maintenance Gardener licenses. A UC ANR academic in Monterey County co-developed eight curricula in Spanish for growers, including owners, managers, supervisors, and foremen. This effort reached over 5,000 Hispanic growers in the state using several methods, including developing a new contact and distribution lists to increase the reach of Hispanic and potential growers. Almost 90 hours of training was completed through 17 workshops, 12 of which were in Spanish. Furthermore, one UC ANR academic in the San Francisco Bay Area delivered 35 workshops to clientele about soil quality, attended by 653 participants.

Results

As a result of UC ANR outreach and education, participants learned skills to improve workforce competency and retention. Specific measured outcome indicators follow.

- All 29 respondents that participated in the continuing education classes to renew their gardener licenses indicated that they gained useful pest management information.
- Post-pre surveys indicate an average of 25% increase in learning for growers who attended workshops delivered by the UC ANR academic based in Monterey County.
- Over 70% of participants in the San Francisco Bay Area reported increased knowledge of soil management skills and improved food safety practices.

These measured outcomes demonstrate changes in learning and improvements in how they work. Growers and landscapers cutting-edge skills increase workforce competency. In addition, developing a more qualified landscape management and agricultural production workforce contributes to poverty reduction for smallholders and other marginalized groups, which then also facilitates interaction with commercial markets. In this way, UC ANR contributes to the public value of developing a qualified workforce for California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
723	Hazards to Human Health and Safety
903	Communication, Education, and Information Delivery

Outcome #52

1. Outcome Measures

Participants applied program planning and evaluation skills to requirements for federal and state nutrition programs.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California requires a highly skilled workforce to remain a competitive, prosperous, and an innovative global leader. A Pew Research Center study projects that U.S. job growth will increase as it has in the past 35 years in occupations that require higher levels of education, training, and experience. A qualified workforce is needed especially in youth education and obesity prevention, two areas in which California ranks among the worst in the country.

What has been done

UC ANR academics provided training and technical assistance to local health departments in their implementation of Supplemental Nutrition Assistance Program ? Education (SNAP-Ed). Several webinars and an in-person workshop were delivered about evaluation, reporting, and communications. Additionally, UC ANR hosted and managed an information-sharing platform that includes an online discussion forum as well as evaluation tools, templates, and protocols for its 133 registered users.

Results

Specific measured outcome indicators follow.

- Over 70% of almost 40 webinar participants and over 70 in-person workshop participants

reported that they were able to apply what they had learned in their SNAP-Ed needs assessment and evaluation work. Furthermore, 97% of 29 respondents that attended the "PEARS Points" webinar series indicated that they were able to apply what they learned to effectively report their programs.

- Adoption of the information-sharing platform was observed as local health departments and resulted in more dialogue around SNAP-Ed local evaluation work, strategies, troubleshooting, and requests for technical assistance to complete nutrition program implementation requirements.

These measured outcomes demonstrate changes in learning and improvements in how they work. Nutrition education professionals learned program planning and evaluation skills which increase workforce competency. In this way, UC ANR contributes to the public value of developing a qualified workforce for California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
903	Communication, Education, and Information Delivery

Outcome #53

1. Outcome Measures

UC ANR better engages underserved communities.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California is the most diverse state in the nation by many standards, including race/ethnicity, languages, and socio-economics. It is a minority-majority state, where no single ethnic group forms a majority of the population. However, more than half of the children in California are Latino. The median annual income for Latino, Native American, and African American households in California are well below the state median income. This income gap correlates to opportunity gaps, in critical areas like access to high-quality youth development programs and early preparation for college. California continues to be challenged by social, health, and economic

inequities.

What has been done

UC ANR builds cultural competency skills, implements community-centered programs, and develops proactive policies to increase diversity and inclusiveness. UC ANR engages in intentional efforts to ensure that all members of the public have equitable access to the resources we provide. UC ANR academics live and work in communities building trust and credibility to solve local problems together through research, outreach, and education. As a result of UC ANR's multipronged efforts to better reach underserved audiences, the internal audience gained cultural competency skills and it increased engagement with Latino and tribal communities.

The UC ANR 4-H Youth Development Program continued the UC 4-H Latino Initiative, a three year pilot to develop culturally relevant and responsive programs to welcome Latino youth, families, and volunteers to 4-H in seven counties. Local programs developed partnerships with other organizations serving Latinos and identified the needs of the California Latino community. The program is testing new delivery modes, ways to remove barriers to participation, and recruiting volunteers from under-represented groups. Programming introduces 4-H projects to Latino youth through schools, building trusting relationships over time and developing programming relationships with key volunteers in influential leadership positions in Latino communities. A cultural awareness training for 4-H staff and volunteers was developed and conducted. Peer-reviewed publications, including three journal articles, and popular press articles were developed that extend best practices and lessons learned from this effort. The UC program now leads the largest 4-H effort to serve Latino youth in the nation, and chairs the National 4-H Council Latino Advisory Committee. It is also an adviser on 4-H in Mexico.

Results

As a result of UC ANR's multipronged efforts to better reach underserved audiences, the internal audience gained cultural competency skills and it increased engagement with Latino and tribal communities. Research and activities resulted in internal organizational outcomes that then led to increased engagement with underserved groups. Specific measured indicators follow.

- In 2017 there was a 34% annual increase in Latino participation (45,528 Latino children), and a 52% annual increase in Latino adult volunteer participation (2,259 Latino adult volunteers).
- The Latino Initiative's local 4-H Career Pathways programming grew, with an almost 50% increase in Latino youth participation over the last year. In FFY 2018, 7,549 youth and 29 peer educators were engaged. Survey results showed that 95.3% of participants "think science will be important in their future," with 96.8% of youth "reporting they are now good at science." These youth members also reported that they feel they can "weigh the pros and cons of future college options." National research findings indicate the 4-H Career Pathways initiative "shows promise for empowering youth to achieve the attitudes, aspirations, and skills needed for successful STEM careers." The effort also produced a number of best practices for STEM education, career exploration, and engagement of girls and underrepresented youth.
- 45 Latino 4-H youth recruited through the UC ANR 4-H Latino Initiative attended the California 4-H Youth Summit and reported feeling a sense of belonging among participants "an important inclusion indicator. Bilingual and bicultural Latino chaperones also participated. They accompanied the youth during the experience to help them feel confident and welcome.
- UC ANR established a partnership with Segorea Te Land Trust, an urban Indigenous women-led community organization in the San Francisco Bay Area. Cultural food plants have been established on an Agricultural Experiment Station urban farm and there have been associated educational events.

These measured outcomes demonstrate how UC ANR has strengthened its internal capacity to do effective outreach to diverse audiences, and as a result expanded and sustained important partnerships with both the Latino and tribal communities. UC ANR increased access to opportunities and created environments where different kinds of people can thrive and succeed. In this way, UC ANR contributes to the public value of developing an inclusive and equitable society. The UC Berkeley Hass Institute of Fair and Equitable Society listed California as the fourth most inclusive state in the nation based on their inclusiveness ranking system in 2017. Nevertheless, there is still a lot of work to do.

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

Outcome #54

1. Outcome Measures

Science-based information applied to community engagement policy and decision-making.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California is the most diverse state in the nation by many standards, including race/ethnicity, languages, and socio-economics. It is a minority-majority state, where no single ethnic group forms a majority of the population. However, more than half of the children in California are Latino. The median annual income for Latino, Native American, and African American households in California are well below the state median income. This income gap correlates to opportunity

gaps, in critical areas like access to high-quality youth development programs and early preparation for college. California continues to be challenged by social, health, and economic inequities.

What has been done

The findings from the UC 4-H study that identified promising practices of Latinx youth serving organizations was provided to 4-H academics and staff from 10 counties, the statewide program office, and the 4-H Foundation. Information was shared on recruiting, engaging, and sustaining the participation of Latinx youth in youth programs. In addition, The Karuk-UC Berkeley Collaborative, which is a partnership between the Karuk Tribe and UC Berkeley, developed a guiding policy to inform the work with their allies to enhance the "eco-cultural revitalization" of the people and landscapes within Karuk ancestral lands.

Results

As a result of UC ANR's multipronged efforts to better reach underserved audiences, the internal audience gained cultural competency skills and it increased engagement with Latino and tribal communities. Research and activities resulted in internal organizational outcomes that then led to increased engagement with underserved groups. Specific measured indicators follow.

- New knowledge about how to better engage Latino audiences in 4-H youth development work was integrated into 4-H programming. For example, bilingual staff teach Spanish speaking youth and families, all programs and leadership conferences are free, and free transportation is offered.
- The Karuk Tribe is using the new guiding policy as the basis for agreements with all researchers and project leaders who propose collaborative projects with the Karuk Tribe that affect the Karuk people, culture, traditions, and/or Karuk ancestral lands and territory. This document is part of an adaptive process whereby they revise the guidelines to fit the evolving needs of the Karuk Tribe.

These measured outcomes demonstrate how UC ANR has strengthened its internal capacity to do effective outreach to diverse audiences, and as a result expanded and sustained important partnerships with both the Latino and tribal communities. UC ANR increased access to opportunities and created environments where different kinds of people can thrive and succeed. In this way, UC ANR contributes to the public value of developing an inclusive and equitable society. The UC Berkeley Hass Institute of Fair and Equitable Society listed California as the fourth most inclusive state in the nation based on their inclusiveness ranking system in 2017. Nevertheless, there is still a lot of work to do.

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

Outcome #55

1. Outcome Measures

UC ANR academics, staff, and volunteers learned skills to better engage diverse audiences.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California is the most diverse state in the nation by many standards, including race/ethnicity, languages, and socio-economics. It is a minority-majority state, where no single ethnic group forms a majority of the population. However, more than half of the children in California are Latino. The median annual income for Latino, Native American, and African American households in California are well below the state median income. This income gap correlates to opportunity gaps, in critical areas like access to high-quality youth development programs and early preparation for college. California continues to be challenged by social, health, and economic inequities.

What has been done

UC ANR builds cultural competency skills, implements community-centered programs, and develops proactive policies to increase diversity and inclusiveness. UC ANR engages in intentional efforts to ensure that all members of the public have equitable access to the resources we provide. UC ANR academics live and work in communities building trust and credibility to solve local problems together through research, outreach, and education. UC ANR continues effort to build successful relationships with tribes. A new work group on Native American Community Partnerships was formed. They organized two professional development workshops for the UC ANR internal audience, which included collaborative and participatory agenda setting and deep listening to communities of color and other under-represented groups. There were 114 participants. Additional materials and resources are under development. A UC 4-H Youth Development qualitative study identified promising practices of Latinx youth serving organizations, in regards to recruiting, engaging, and sustaining Latinx youth participation in youth programs. It conducted interviews with youth-serving professionals and youth served by 13 youth organizations in California. The preliminary findings were extended in California to 4-H academics and staff from 10 counties, the statewide program office, and the 4-H Foundation. This

information also was provided to national audiences using an asset-based community mapping process and tools, through two webinars, a poster presentation, and three journal articles.

Results

As a result of UC ANR's multipronged efforts to better reach underserved audiences, the internal audience gained cultural competency skills and it increased engagement with Latino and tribal communities. Research and activities resulted in internal organizational outcomes that then led to increased engagement with underserved groups. Specific measured indicators follow.

- 88% of the 40 evaluation respondents felt increased confidence in their ability to reach out to tribes.
- 35 Extension professionals, 30 4-H volunteers and nine 4-H youth learned new practices to engage Latino populations as evidenced by tests.

These measured outcomes demonstrate how UC ANR has strengthened its internal capacity to do effective outreach to diverse audiences, and as a result expanded and sustained important partnerships with both the Latino and tribal communities. UC ANR increased access to opportunities and created environments where different kinds of people can thrive and succeed. In this way, UC ANR contributes to the public value of developing an inclusive and equitable society. The UC Berkeley Hass Institute of Fair and Equitable Society listed California as the fourth most inclusive state in the nation based on their inclusiveness ranking system in 2017. Nevertheless, there is still a lot of work to do.

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

During FFY 2018, California experienced catastrophic wildfires across the state from the North to the South. Thousands of fires burned over one million acres, including five of the most destructive wildland-urban interface fires in the state's history to date. Wildfires affected UC ANR's research and program delivery focus, with dedicated attention going from immediate response to fostering resilience. UC ANR is committing more effort to

convening stakeholders across many fields including science, emergency response, community planning, public health, and policy. More attention is being put on the need to expand understanding of California's fire problem and provide an opportunity to build connectivity, interaction, and integration across disciplines and better understand the complexity of and find solutions to California's wildfire challenge.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

UC ANR's notable outcomes measured through program evaluation efforts are reported under the State Defined Outcomes section.

Key Items of Evaluation

The Report Overview's Federal Planned Program summary of accomplishments highlights UC ANR's most notable research and the significant extension outcomes from FFY 2018. In addition, under the Federal Planned Programs State Defined Outcomes section, the significant outcomes are highlighted in the impact stories.

V(A). Planned Program (Summary)**Program # 4****1. Name of the Planned Program**

Endemic and Invasive Pests and Diseases

 Reporting on this Program**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
101	Appraisal of Soil Resources	0%		1%	
111	Conservation and Efficient Use of Water	3%		1%	
121	Management of Range Resources	23%		0%	
135	Aquatic and Terrestrial Wildlife	0%		2%	
136	Conservation of Biological Diversity	3%		1%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		3%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%		1%	
205	Plant Management Systems	0%		1%	
206	Basic Plant Biology	0%		2%	
211	Insects, Mites, and Other Arthropods Affecting Plants	24%		16%	
212	Pathogens and Nematodes Affecting Plants	24%		30%	
213	Weeds Affecting Plants	0%		1%	
215	Biological Control of Pests Affecting Plants	0%		16%	
216	Integrated Pest Management Systems	23%		11%	
305	Animal Physiological Processes	0%		2%	
311	Animal Diseases	0%		3%	
312	External Parasites and Pests of Animals	0%		2%	
313	Internal Parasites in Animals	0%		1%	
721	Insects and Other Pests Affecting Humans	0%		5%	
722	Zoonotic Diseases and Parasites Affecting Humans	0%		1%	
	Total	100%		100%	

V(C). Planned Program (Inputs)**1. Actual amount of FTE/SYs expended this Program**

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	7.7	0.0	12.1	0.0
Actual Paid	6.7	0.0	14.7	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
1158332	0	1424994	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
1158332	0	1424994	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
18495756	0	61546937	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

UC ANR's integrated research and extension activities will conduct research projects, workshops, education classes, demonstrations, and one-on-one interventions. In addition, the programs will use PSAs, newsletters, mass media, web sites and collaborations with other agencies and organizations to create and deliver programs

2. Brief description of the target audience

- Farmers
- Ranchers
- Rangeland owners/managers
- Landscaping professionals
- Owners/operators of allied agricultural industries
- General public
- Crop and pest consultants

3. How was eXtension used?

UC ANR academics used eXtension to participate in and contribute to Communities of Practice, to answer "Ask an Expert" questions, and for other networking purposes.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	14725	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)
Patent Applications Submitted

Year: 2018
 Actual: 5

Patents listed

1. TREATING NEUROPATHIC PAIN WITH sEH INHIBITORS
2. ELECTRICAL SENSOR PLATFORM TO DETECT FOOD-BORNE BACTERIA AND PLANT VIRUSES
- NANO-MOLECULAR ELECTRONIC DETECTION OF SINGLE MOLECULE RNA BASED
3. HARD RED SPRING WHEAT VARIETY "YUOK" PREVIOUSLY KNOWN AS "UC1745"
4. INSECT LURES AND REPELLANTS
5. RECEPTOR FOR IDENTIFICATION OF ARTHROPOD REPELLENTS

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	121	258	379

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Classes/Short Courses Conducted
 Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Workshops Conducted
 Not reporting on this Output for this Annual Report

Output #3

Output Measure

- Demonstrations and Field Days Conducted
 Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Newsletters Produced
Not reporting on this Output for this Annual Report

Output #5

Output Measure

- Web Sites Created or Updated
Not reporting on this Output for this Annual Report

Output #6

Output Measure

- Research Projects Conducted
Not reporting on this Output for this Annual Report

Output #7

Output Measure

- Videos, Slide Sets and Other AV or Digital Media Educational Products Created
Not reporting on this Output for this Annual Report

Output #8

Output Measure

- Manuals and Other Printed Instructional Materials Produced
Not reporting on this Output for this Annual Report

Output #9

Output Measure

- Meetings Organized includes field days, workshops, short courses, classes, and other)

Year	Actual
2018	219

Output #10

Output Measure

- Train the Trainer

Year	Actual
2018	48

Output #11

Output Measure

- Educational Presentations

Year	Actual
2018	595

Output #12

Output Measure

- Policy Engagement Activities

Year	Actual
2018	43

Output #13

Output Measure

- Popular Articles (non-peer-reviewed)

Year	Actual
2018	92

Output #14

Output Measure

- Website/Blog/Social Media Managed

Year	Actual
2018	74

Output #15

Output Measure

- Digital Media (includes videos, applications, software, other A/V educational products, recorded webinars)

Year	Actual
2018	27

Output #16

Output Measure

- Media Outlet Programs/Interviews

Year	Actual
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2018

142

V(G). State Defined Outcomes**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Farm, ranch, rangeland, and landscaping owner/operators and managers and allied industry professionals, participating in the programs, gain knowledge of pest management techniques, including Integrated Pest Management strategies.
2	Farm, ranch, rangeland, and landscaping owner/operators and managers and allied industry professionals, participating in the programs, adopt recommended prevention, detection and monitoring, and treatment practices for pest management, including Integrated Pest Management strategies.
3	Farm, ranch, rangeland, and landscaping owner/operators and managers and allied industry professionals, participating in the programs, realize lower costs for pest prevention and management.
4	Farm, ranch, rangeland, landscaping, and boat owner/operators and managers, allied industry professionals, and members of the public participating in the programs, gain knowledge of prevention, detection, and treatment strategies and techniques for management of invasive species.
5	Decreased incidence of endemic and invasive pests and diseases.
6	Farm and landscaping owner/operators and managers, and other allied industry professionals, participating in the programs, gain skills to detect, monitor, and treat endemic and invasive pests and diseases.
7	Participants learned or adopted pest management techniques, including Integrated Pest Management strategies.
8	Participants learned or adopted recommended treatment practices for invasive species.
9	Participants adopted pesticide and pharmaceutical efficacy and optimal use practices for ecological sustainability.
10	Participants used recommended pest and disease management practices for ecological sustainability, which resulted in reduced crop losses and thus more economic gain.
11	Participants adopted recommended pest management practices, including Integrated Pest Management strategies.
12	Participants adopted recommended treatment practices for invasive species.
13	Participants adopted pesticide and pharmaceutical efficacy and optimal use practices for efficiency and profitability.
14	Participants used recommended pest and disease management practices for efficiency and profitability, which resulted in reduced crop losses and thus more economic gain.

Outcome #1

1. Outcome Measures

Farm, ranch, rangeland, and landscaping owner/operators and managers and allied industry professionals, participating in the programs, gain knowledge of pest management techniques, including Integrated Pest Management strategies.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Farm, ranch, rangeland, and landscaping owner/operators and managers and allied industry professionals, participating in the programs, adopt recommended prevention, detection and monitoring, and treatment practices for pest management, including Integrated Pest Management strategies.

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Farm, ranch, rangeland, and landscaping owner/operators and managers and allied industry professionals, participating in the programs, realize lower costs for pest prevention and management.

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Farm, ranch, rangeland, landscaping, and boat owner/operators and managers, allied industry professionals, and members of the public participating in the programs, gain knowledge of prevention, detection, and treatment strategies and techniques for management of invasive species.

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Decreased incidence of endemic and invasive pests and diseases.

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Farm and landscaping owner/operators and managers, and other allied industry professionals, participating in the programs, gain skills to detect, monitor, and treat endemic and invasive pests and diseases.

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Participants learned or adopted pest management techniques, including Integrated Pest Management strategies.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Endemic and invasive pests and diseases cause widespread damage to agriculture, landscapes, and forests. The spread of invasive pests has increased in recent decades, linked to global travel, produce trade, and climate change. According to the USDA, invasive species are responsible for \$137 billion per year in economic losses in the United States. In 2016, the California Department of Pesticide Regulation notes that California used over 208,000,000 pounds of pesticide.

Pesticide often used to control weeds, insects, and other pests, when used incorrectly, can cause environmental problems. Growers, land managers, and forestry experts need pest management tools and strategies that minimize impact on natural pest enemies and pollinators, potential for water quality problems, impact on aquatic invertebrates, and endangered species.

What has been done

UC ANR partners with public, governmental, and private groups to develop and extend new knowledge about integrated pest management (IPM) for growers and land managers. One project conducted field trials on tomatoes to evaluate the impact of varying spray intervals and chemical groups on powdery mildew disease. For strawberry crops, another UC ANR scientist conducted

field studies identifying solar-light traps as effective against pests; effective botanical and microbial fungicides on fruit diseases; and fungi that can promote fruit yield. To slow the loss of oaks to Goldspotted oak borer (GSOB), UC ANR researchers developed best management practices (BMPs), integrated pest management (IPM) strategies, and mapped the extent, intensity and history of the spread of Goldspotted oak borer. Additionally, IPM research focused on managing white rot and maggots in garlic and onions. One UC ANR academic coordinated a webinar series for California Invasive Species Awareness Week that had over 100 viewers, covering topics like tree pests, aquatic invasive species, and the interaction between invasive plants and fire. For UC ANR's Healthy Garden ? Healthy Home Program, UC Master Gardeners provided education about least-toxic pest management methods, reducing runoff, and other related issues for 103 community events around San Diego County, reaching approximately 27,500 individuals.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that led to increased ecological sustainability of agriculture, landscapes, and forestry. Research and activities that resulted in outcomes with specific measured indicators follow.

- New knowledge about mildew has been used by chemical manufacturers, growers, and pest control advisers (PCAs) on 120,000 acres working to manage this disease and minimize fungicide resistance development.
- For the strawberry and vegetable IPM program, online post-surveys of meetings indicated that 100% of 58 respondents gained useful information and 85% would use information. Feedback for related eJournal articles showed that 98% of 291 respondents found the information useful and 91% have used/will use information on strawberry and vegetable IPM.
- In pre- and post-tests of pest management, water quality, and runoff knowledge for the Healthy Garden ? Healthy Home Program, 98% of 103 respondents indicated that they learned 2 or more least-toxic pest management methods, techniques or ideas that they would use in the future and 93% indicated that that they learned 3 or more methods, techniques or ideas that they would use in the future.
- For white rot and maggots in onions and garlic, nearly all growers in Tulalake, several growers from the Central Valley, and many growers from outside California have adopted recommendations resulting in improved management of one or all these pests.
- 40 participants of California Invasive Species Awareness Week who completed a short survey all felt they learned something, nearly half planned to share the information, 31% planned to look for signs of pest infestation, and 42% planned to undertake activities to prevent the spread of invasive pests, like not moving firewood or draining and cleaning gear that went in the water.
- In efforts to protect California oaks from Goldspotted oak borer, there are now 14,800 acres of treated demonstration woodlands involving over 100 cooperators 11 locations. GSOB maps have been used by the California Department of Forestry (CDF) to develop and amend the zone of infestation for GSOB. The maps have also been used to identify communities at risk for importation of GSOB-infested firewood, to calculate the rate of spread for GSOB, and to show the impact of UCCE outreach to slow human-transportation of GSOB to new locations.

These measured outcomes can create, improve, and enrich the state's ability to prevent, control, and mitigate pests and diseases. In these ways, UC ANR contributes to the increased ecological sustainability of agriculture, forestry, and urban landscapes and the public value of protecting California's natural resources, helping California realize the many benefits of the state's rich and diverse natural resources. However, there is more work to be done, as the agricultural sector contributes to 8% of greenhouse gas emissions in California, one of the indicators of climate change.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems

Outcome #8

1. Outcome Measures

Participants learned or adopted recommended treatment practices for invasive species.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Endemic and invasive pests and diseases cause widespread damage to agriculture, landscapes, and forests. The spread of invasive pests has increased in recent decades, linked to global travel, produce trade, and climate change. According to the USDA, invasive species are responsible for \$137 billion per year in economic losses in the United States. In 2016, the California Department of Pesticide Regulation notes that California used over 208,000,000 pounds of pesticide.

Pesticide often used to control weeds, insects, and other pests, when used incorrectly, can cause environmental problems. Growers, land managers, and forestry experts need pest management tools and strategies that minimize impact on natural pest enemies and pollinators, potential for water quality problems, impact on aquatic invertebrates, and endangered species.

What has been done

UC ANR partners with public, governmental, and private groups to develop and extend new knowledge about integrated pest management (IPM) for growers and land managers. One project conducted brown marmorated stink bug (BMSB) sampling in peach and almond orchards, finding BMSB adults in peach, which was the first report of the BMSB invasion in California agriculture, and subsequently discovering BMSB infestation in almonds, the first report of BMSB infestation in almonds in California and elsewhere; this information has been extended to the Almond Board.

For Asian citrus psyllid, a serious pest of citrus native to the Indian subcontinent that spreads a citrus-killing bacterium, UC ANR researchers have employed biological control, importing its natural enemies, mass rearing, and releasing them to establish, spread, and impact the target pest populations. Another project promoted the use of Aphytis wasps to control California red scale by facilitating releases with growers.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that led to increased ecological sustainability of agriculture, landscapes, and forestry. Research and activities that resulted in outcomes with specific measured indicators follow.

- 86% of 42 farmer and landscaper participants in an invasive pest management seminar were able to correctly identify key fruit tree and vine pests discussed, 85% were able to identify damage or impacts of key pests, and 95% were able to identify appropriate actions to manage those key pests.
- The almond industry has gained awareness of BMSB as a new pest in almonds. Several growers and PCAs are now using the new trap for brown marmorated stink bug (BMSB) detection and UC ANR's feeding damage pictures have been used by trade magazines and other farm advisors in their educational programs.
- With respect to Asian citrus psyllid, more than 10 million natural parasitoid enemies have been mass reared and released in California in cooperation with the California Department of Food and Agriculture (CDFA). Establishment has been confirmed at 95% of release sites, parasitoids have spread up to eight miles without human assistance, and pest populations have declined on average by about 70%.

These measured outcomes can create, improve, and enrich the state's ability to prevent, control, and mitigate pests and diseases. In these ways, UC ANR contributes to the increased ecological sustainability of agriculture, forestry, and urban landscapes and the public value of protecting California's natural resources, helping California realize the many benefits of the state's rich and diverse natural resources. However, there is more work to be done, as the agricultural sector contributes to 8% of greenhouse gas emissions in California, one of the indicators of climate change.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

Outcome #9

1. Outcome Measures

Participants adopted pesticide and pharmaceutical efficacy and optimal use practices for ecological sustainability.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Endemic and invasive pests and diseases cause widespread damage to agriculture, landscapes, and forests. The spread of invasive pests has increased in recent decades, linked to global travel, produce trade, and climate change. According to the USDA, invasive species are responsible for \$137 billion per year in economic losses in the United States. In 2016, the California Department of Pesticide Regulation notes that California used over 208,000,000 pounds of pesticide. Pesticide often used to control weeds, insects, and other pests, when used incorrectly, can cause environmental problems. Growers, land managers, and forestry experts need pest management tools and strategies that minimize impact on natural pest enemies and pollinators, potential for water quality problems, impact on aquatic invertebrates, and endangered species.

What has been done

UC ANR partners with public, governmental, and private groups to develop and extend new knowledge about integrated pest management (IPM) for growers and land managers. UC ANR academics investigated chemical and non-chemical alternatives to the now banned methyl bromide pre-plant fumigant for strawberries and caneberries through hand-in-hand coordination with the Santa Cruz County Agricultural Commissioner. In pesticides, one project conducted field trials and monitoring the control of medusahead, an invasive weed, which allowed the return of perennial grasses. Another project organized and conducted educational presentations to a total of 469 attendees explaining pest management for sorghum and general IPM principles of controlling pests in dairy forage crops. Field tests of new nematicides have been conducted for control of Columbia Root-knot nematode in potatoes to collect local data for California registration of several new low-risk nematicides labeled in other states. UC ANR scientists conducted fumigant studies in strawberry grower fields, disseminating in-progress information and final results during field days and meetings, online, and through publications. Another led field trials on tomatoes to evaluate the impact of varying spray intervals and chemical groups on powdery mildew disease. Another project promoted the use of Aphytis wasps to control California red scale by facilitating releases with growers.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that led to increased ecological sustainability of agriculture, landscapes, and forestry. Research and activities that resulted in outcomes with specific measured indicators follow.

- Commercial field trials on fungicides helped the vegetable industry obtain new registrations,

including Vivando, Luna Sensation, Rhyme, and Orondis Ultra.

- Data generated from the study of Indaziflam to control medusahead on rangelands has helped the manufacturer submit to the EPA for a grazing label and will be utilized for Indaziflam labeling in California.
- Metam potassium (KPAM) crop termination is being used as an alternative to standard fumigant use on the Central Coast.
- Ventura County phased out methyl bromide fumigant for strawberries and adopted fumigant application technologies identified and shared by UC ANR scientists, including tarps that reduce emissions and allow reduction in fumigant application rates.
- For pest management in potatoes, the nematicide trial provided necessary data to allow for the California registration of Velum Prime and Nimitz to control Columbia root knot nematode.
- Five years of UC ANR research made possible the temporary registration of Sulfoxaflor, an insecticide mainly for Lygus bugs in strawberry with an attractive environmental profile.
- Data from UC ANR research supported the registration of several insecticide labels in California for the management of Sugarcane Aphid in sorghum as well as the registration of a novel use of an existing insecticide for the same purpose which will improve efficacy of the insecticide while reducing risk to workers, non-target organisms, and the environment. As a result, these researchers observed a reduction in the use of unnecessary insecticide applications -- reduced number of less-effective insecticide applications and reduced number of insecticide applications by improved early season control and pest monitoring methods.
- 41% of citrus orchards in Placer County now use Aphytis wasps rather than spraying.

These measured outcomes can create, improve, and enrich the state's ability to prevent, control, and mitigate pests and diseases. In these ways, UC ANR contributes to the increased ecological sustainability of agriculture, forestry, and urban landscapes and the public value of protecting California's natural resources, helping California realize the many benefits of the state's rich and diverse natural resources. However, there is more work to be done, as the agricultural sector contributes to 8% of greenhouse gas emissions in California, one of the indicators of climate change.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems

Outcome #10

1. Outcome Measures

Participants used recommended pest and disease management practices for ecological sustainability, which resulted in reduced crop losses and thus more economic gain.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Endemic and invasive pests and diseases cause widespread damage to agriculture, landscapes, and forests. The spread of invasive pests has increased in recent decades, linked to global travel, produce trade, and climate change. According to the USDA, invasive species are responsible for \$137 billion per year in economic losses in the United States. In 2016, the California Department of Pesticide Regulation notes that California used over 208,000,000 pounds of pesticide. Pesticide often used to control weeds, insects, and other pests, when used incorrectly, can cause environmental problems. Growers, land managers, and forestry experts need pest management tools and strategies that minimize impact on natural pest enemies and pollinators, potential for water quality problems, impact on aquatic invertebrates, and endangered species.

What has been done

UC ANR partners with public, governmental, and private groups to develop and extend new knowledge about integrated pest management (IPM) for growers and land managers. One UC ANR scientist presented the results of strawberry and vegetable studies at various extension meetings, in trade and extension articles, and added through an IPMinfo app.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that led to increased ecological sustainability of agriculture, landscapes, and forestry.

- Survey of strawberry and vegetable growers indicated that new IPM practices were applied on 6,305 acres with a 100% change in behavior contributing to 15% of yield increase valued at \$550,000.

Such a measured outcome can create, improve, and enrich the state's ability to prevent, control, and mitigate pests and diseases. In this way, UC ANR contributes to the increased ecological sustainability of agriculture, forestry, and urban landscapes and the public value of protecting California's natural resources, helping California realize the many benefits of the state's rich and diverse natural resources. However, there is more work to be done, as the agricultural sector contributes to 8% of greenhouse gas emissions in California, one of the indicators of climate change.

4. Associated Knowledge Areas

KA Code **Knowledge Area**
216 Integrated Pest Management Systems

Outcome #11

1. Outcome Measures

Participants adopted recommended pest management practices, including Integrated Pest Management strategies.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Pests and diseases decrease California's agriculture and forestry efficiency and profitability. In agricultural systems, pests reduce yields, render crops unmarketable, and make rangeland unfavorable to livestock. Just one species can be detrimental to crop production and revenues. The invasion of spotted-wing drosophila, for example, caused conventional raspberry growers in California to lose \$36.4 million in revenue between 2009 and 2014, and was on track to reduce California raspberry yields by as much as 50 percent. As the global, state, and local population increases, however, crop production must increase to meet the greater food demands.

What has been done

UC ANR partnered with public, governmental, and private groups to extend new knowledge and develop integrated pest management plans to increase agriculture and forestry efficiency and profitability. UC ANR academics addressed pests that affect grapes grown in the central coast, conducting research and extension programs to address new and existing pest concerns of wine grapes on the Central Coast. In another project, applied research and trials were conducted to develop key integrated pest management plans. UC ANR's Citrus Clonal Protection Program (CCPP) tested nearly 2,000 tree sources representing 400+ citrus varieties for budwood distribution, and then distributed citrus material to more than 2,000 users who ordered over 80,000 buds from 300+ citrus varieties.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that led to increased agriculture and forestry efficiency and profitability. Research and

activities that resulted in outcomes with specific measured indicators follow.
 ?140 grape growers in the Salinas Valley adopted management practices and formed a cooperative pest control district and local neighborhood groups to share mealybug trap catch lessons learned and coordinate control practices between all growers in the county ? particularly between adjacent vineyard properties ? to reduce the impact of mealybug spread of leafroll virus.
 ?At UC ANR-directed CCPP, a record number of users ordered a record number of citrus buds. Five years ago, just under 350 people were using CCPP produced budwood. Today, over 2,100 are ordering budwood for varieties that typically are not produced commercially in California. Therefore, not only has UC ANR achieved a measurable change in behavior ? a 600% increase in the use of pathogen-tested citrus propagative materials ? but has also reduced the risk of people smuggling desirable citrus varieties in to California.

These measured outcomes can create, improve, and enrich the state?s ability to prevent, control, and mitigate pests and diseases. In 2017, California farms and ranches increased cash receipts for their output by almost 6% compared to the previous year, collecting over \$50 billion. In these ways, UC ANR contributes to increased agriculture and forestry efficiency and profitability and the public value of promoting economic prosperity in California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems

Outcome #12

1. Outcome Measures

Participants adopted recommended treatment practices for invasive species.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Pests and diseases decrease California's agriculture and forestry efficiency and profitability. In agricultural systems, pests reduce yields, render crops unmarketable, and make rangeland unfavorable to livestock. Just one species can be detrimental to crop production and revenues. The invasion of spotted-wing drosophila, for example, caused conventional raspberry growers in California to lose \$36.4 million in revenue between 2009 and 2014, and was on track to reduce California raspberry yields by as much as 50 percent. As the global, state, and local population increases, however, crop production must increase to meet the greater food demands.

What has been done

UC ANR partnered with public, governmental, and private groups to extend new knowledge and develop integrated pest management plans to increase agriculture and forestry efficiency and profitability. UCCE's Rice Team developed a set of Best Management Practices (BMPs) on weedy rice, conducted a series of hands-on trainings, field days, and workshops for growers and PCAs, and launched a new website, <http://www.caweedyrice.com/>.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that led to increased agriculture and forestry efficiency and profitability. UC ANR's work on invasive weedy rice helped to change the California state seed laws concerning certification of rice seed. The laws went into effect in the spring of 2018, after extensive work from the California Rice Commission Seed Certification Committee. Recommendations for the certification committee came directly from the Best Management Practices developed by the UCCE Rice Team. As of 2019, rice growers in California can no longer save seed produced by the Rice Experiment Station, even for their own use. A new Quality Assurance Program was developed for those rice varieties that cannot be patented. It is administered by the California Crop Improvement Association (CCIA) and it ensures that seed of those varieties will also be weedy rice free.

These measured outcomes can create, improve, and enrich the state's ability to prevent, control, and mitigate pests and diseases. In 2017, California farms and ranches increased cash receipts for their output by almost 6% compared to the previous year, collecting over \$50 billion. In these ways, UC ANR contributes to increased agriculture and forestry efficiency and profitability and the public value of promoting economic prosperity in California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
213	Weeds Affecting Plants

Outcome #13

1. Outcome Measures

Participants adopted pesticide and pharmaceutical efficacy and optimal use practices for efficiency and profitability.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Pests and diseases decrease California’s agriculture and forestry efficiency and profitability. In agricultural systems, pests reduce yields, render crops unmarketable, and make rangeland unfavorable to livestock. Just one species can be detrimental to crop production and revenues. The invasion of spotted-wing drosophila, for example, caused conventional raspberry growers in California to lose \$36.4 million in revenue between 2009 and 2014, and was on track to reduce California raspberry yields by as much as 50 percent. As the global, state, and local population increases, however, crop production must increase to meet the greater food demands.

What has been done

UC ANR partnered with public, governmental, and private groups to extend new knowledge and develop integrated pest management plans to increase agriculture and forestry efficiency and profitability. UC ANR scientists diagnosed production issues of large scale vegetable crop growers in California’s Central Valley, including Beet curly top virus (BCTV) in tomatoes which avoided losses approaching \$100 million and providing for garlic and onion growers with GPS maps of white rot infested areas within fields to improve planting decisions. Another UC ANR scientist conducted field trials on weed control in mixed alfalfa orchardgrass hay throughout the Intermountain Region, extending research through newsletter articles, online reports, and an Alfalfa Symposium.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that led to increased agriculture and forestry efficiency and profitability. Research and activities that resulted in outcomes with specific measured indicators follow.

- Four very large tomato growers reduced the acreage treated with the pesticide Verimark, which is effective but costs more than \$100 per acre. Due to low disease incidence present in 2018, this expense would have been unnecessarily applied to more than 20,000 acres, at a cost of more than \$2 million. Additionally, one of the major processors of garlic is now treating fields at planting with fungicide, which is reducing risk of white rot and saving a substantial percentage of the crop. Damage in replicated studies has been reduced by as much as 68% with the use of a fungicide, making the savings to the garlic industry in Fresno County as high as \$5 million per year in garlic.

- Data generated by the project on mixed alfalfa grass was used by the chemical manufacturer of the herbicide Saflufenacil, not currently registered in mixed alfalfa grass production in California,

to submit for a California label change.

These measured outcomes can create, improve, and enrich the state's ability to prevent, control, and mitigate pests and diseases. In 2017, California farms and ranches increased cash receipts for their output by almost 6% compared to the previous year, collecting over \$50 billion. In these ways, UC ANR contributes to increased agriculture and forestry efficiency and profitability and the public value of promoting economic prosperity in California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
216	Integrated Pest Management Systems

Outcome #14

1. Outcome Measures

Participants used recommended pest and disease management practices for efficiency and profitability, which resulted in reduced crop losses and thus more economic gain.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Pests and diseases decrease California's agriculture and forestry efficiency and profitability. In agricultural systems, pests reduce yields, render crops unmarketable, and make rangeland unfavorable to livestock. Just one species can be detrimental to crop production and revenues. The invasion of spotted-wing drosophila, for example, caused conventional raspberry growers in California to lose \$36.4 million in revenue between 2009 and 2014, and was on track to reduce California raspberry yields by as much as 50 percent. As the global, state, and local population increases, however, crop production must increase to meet the greater food demands.

What has been done

UC ANR partnered with public, governmental, and private groups to extend new knowledge and develop integrated pest management plans to increase agriculture and forestry efficiency and profitability. UC ANR scientists diagnosed production issues of large scale vegetable crop growers in California's Central Valley, including Beet curly top virus (BCTV) in tomatoes which avoided losses approaching \$100 million and providing for garlic and onion growers with GPS maps of white rot infested areas within fields to improve planting decisions. Another UC ANR scientist conducted field trials on weed control in mixed alfalfa orchardgrass hay throughout the Intermountain Region, extending research through newsletter articles, online reports, and an Alfalfa Symposium. Partnering with the rice industry, UC ANR scientists have also maintained a monitoring network for armyworms, created an email alert system to share results weekly with clientele, and conducted outreach to educate rice growers about monitoring and managing armyworms.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that led to increased agriculture and forestry efficiency and profitability. Research and activities that resulted in outcomes with specific measured indicators follow.

- Due to the rapid diagnosis of late blight in tomatoes, removal of the symptomatic plants, and treatment of all houses, growers have saved over \$1.2 million.
- In conversations with alfalfa growers, approximately 40% of them were able to utilize the information from UC ANR's research to prevent yield loss.
- UC ANR's research on armyworm, another pest of rice, was fundamental to securing an emergency registration of an effective insecticide. This insecticide was used in 30,000 acres in 2018, resulting in armyworm control, and avoiding yield losses that can be as high as 20%.

These measured outcomes can create, improve, and enrich the state's ability to prevent, control, and mitigate pests and diseases. In 2017, California farms and ranches increased cash receipts for their output by almost 6% compared to the previous year, collecting over \$50 billion. In these ways, UC ANR contributes to increased agriculture and forestry efficiency and profitability and the public value of promoting economic prosperity in California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

During FFY 2018, California experienced catastrophic wildfires across the state from the North to the South. Thousands of fires burned over one million acres, including five of the most destructive wildland-urban interface fires in the state's history to date. Wildfires affected UC ANR's research and program delivery focus, with dedicated attention going from immediate response to fostering resilience. UC ANR is committing more effort to convening stakeholders across many fields including science, emergency response, community planning, public health, and policy. More attention is being put on the need to expand understanding of California's fire problem and provide an opportunity to build connectivity, interaction, and integration across disciplines and better understand the complexity of and find solutions to California's wildfire challenge.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

UC ANR's notable outcomes measured through program evaluation efforts are reported under the State Defined Outcomes section.

Key Items of Evaluation

The Report Overview's Federal Planned Program summary of accomplishments highlights UC ANR's most notable research and the significant extension outcomes from FFY 2018. In addition, under the Federal Planned Programs State Defined Outcomes section, the significant outcomes are highlighted in the impact stories.

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Water Quality, Quantity and Security

Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	0%		21%	
103	Management of Saline and Sodic Soils and Salinity	0%		1%	
104	Protect Soil from Harmful Effects of Natural Elements	0%		1%	
111	Conservation and Efficient Use of Water	50%		25%	
112	Watershed Protection and Management	50%		12%	
122	Management and Control of Forest and Range Fires	0%		1%	
124	Urban Forestry	0%		1%	
131	Alternative Uses of Land	0%		1%	
132	Weather and Climate	0%		14%	
133	Pollution Prevention and Mitigation	0%		6%	
135	Aquatic and Terrestrial Wildlife	0%		2%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		3%	
202	Plant Genetic Resources	0%		2%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%		1%	
204	Plant Product Quality and Utility (Preharvest)	0%		1%	
205	Plant Management Systems	0%		1%	
206	Basic Plant Biology	0%		2%	
215	Biological Control of Pests Affecting Plants	0%		1%	
404	Instrumentation and Control Systems	0%		2%	
605	Natural Resource and Environmental Economics	0%		2%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	2.3	0.0	1.5	0.0
Actual Paid	0.9	0.0	1.8	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
214020	0	384463	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
214020	0	384463	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
3790618	0	22130861	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

UC ANR's integrated research and extension activities will conduct research projects, workshops, education classes, demonstrations, and one-on-one interventions. In addition, the programs will use PSAs, newsletters, mass media, web sites and collaborations with other agencies and organizations to create and deliver programs.

2. Brief description of the target audience

- Governmental agencies
- Water managers
- UC campus-based water centers
- The general public
- Farmers
- Ranchers
- Agricultural organizations
- Owners/managers of private and public rangeland, forest, and wildlands

3. How was eXtension used?

UC ANR academics used eXtension to participate in and contribute to Communities of Practice, to answer "Ask an Expert" questions, and for other networking purposes.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	8992	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)
Patent Applications Submitted

Year: 2018
 Actual: 1

Patents listed

1. BIOMIMETIC SOLID SEPARATOR

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	34	89	123

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Classes/Short Courses Conducted
 Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Workshops Conducted
 Not reporting on this Output for this Annual Report

Output #3

Output Measure

- Demonstrations and Field Days Conducted
 Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Newsletters Produced

Not reporting on this Output for this Annual Report

Output #5

Output Measure

- Web Sites Created or Updated

Not reporting on this Output for this Annual Report

Output #6

Output Measure

- Research Projects Conducted

Not reporting on this Output for this Annual Report

Output #7

Output Measure

- Videos, Slide Sets and Other AV or Digital Media Educational Products Created

Not reporting on this Output for this Annual Report

Output #8

Output Measure

- Manuals and Other Printed Instructional Materials Produced

Not reporting on this Output for this Annual Report

Output #9

Output Measure

- Meetings Organized includes field days, workshops, short courses, classes, and other)

Year	Actual
2018	155

Output #10

Output Measure

- Train the Trainer

Year	Actual
2018	23

Output #11

Output Measure

- Educational Presentations

Year	Actual
2018	110

Output #12

Output Measure

- Policy Engagement Activities

Year	Actual
2018	28

Output #13

Output Measure

- Popular Articles (non-peer-reviewed)

Year	Actual
2018	21

Output #14

Output Measure

- Website/Blog/Social Media Managed

Year	Actual
2018	22

Output #15

Output Measure

- Digital Media (includes videos, applications, software, other A/V educational products, recorded webinars)

Year	Actual
2018	3

Output #16

Output Measure

- Media Outlet Programs/Interviews

Year	Actual
2018	28

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Farm, ranch, and rangeland owners/managers and allied industry professionals, participating in water quality education programs, gain knowledge of management practices for improving water quality.
2	Farm, ranch, and rangeland owners/managers and allied industry professionals, participating in water quality education programs, adopt management practices for improving water quality.
3	Farm owner/operators, allied industry professionals, and members of the public, participating in water conservation education programs, gain knowledge of water use and conservation practices.
4	Farm, ranch, and landscape owners/managers, and allied industry professionals and governmental agency representatives, participating in the programs, gain skills to conserve water and protect water quality.
5	Farm owners/managers, allied industry and natural resource professionals, and members of the public, participating in the programs, adopt of water conservation practices.
6	Participants learned about recommended management practices for water security.
7	Science-based research is applied to water supply policy and planning.
8	Participants learned about water use and conservation practices and intend to adopt, or adopted recommended management practices for water conservation.
9	Participants intend to adopt or have adopted recommended irrigation or other water and soil management practices.
10	Participants saved water after adopting recommended conservation measures.
11	Participants learned about recommended management practices for preserving water quality and intend to adopt or have adopted practices to preserve water quality.
12	Science-based information was applied to water quality policy and decision-making.

Outcome #1

1. Outcome Measures

Farm, ranch, and rangeland owners/managers and allied industry professionals, participating in water quality education programs, gain knowledge of management practices for improving water quality.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Farm, ranch, and rangeland owners/managers and allied industry professionals, participating in water quality education programs, adopt management practices for improving water quality.

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Farm owner/operators, allied industry professionals, and members of the public, participating in water conservation education programs, gain knowledge of water use and conservation practices.

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Farm, ranch, and landscape owners/managers, and allied industry professionals and governmental agency representatives, participating in the programs, gain skills to conserve water and protect water quality.

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Farm owners/managers, allied industry and natural resource professionals, and members of the public, participating in the programs, adopt of water conservation practices.

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Participants learned about recommended management practices for water security.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California's climate has the largest precipitation and streamflow variability in the contiguous United States. Further, groundwater pumping chronically exceeds natural recharge in many agricultural regions of the state, in fact, statewide groundwater overdraft estimates range from 500,000 to 1.5 million acre feet per year. Identifying new ways to ensure and secure a safe water supply are essential to the health and prosperity of California.

What has been done

UC ANR extends new knowledge using both real and virtual methods to increase understanding of groundwater resources and conservation. UC ANR academics inform water consumers about water resources and strengthen ties with water supply managers through extension workshops, newsletters to northern Sacramento Valley water users and collaborations with the 4-H youth program. Information has been extended to hundreds of northern Sacramento Valley water users on ways to be more prepared to manage and sustain groundwater. Education has focused on understanding dynamic groundwater conditions through drought and wet climatic cycles, investing in groundwater level monitoring to guide water resource management, defining short and long term management goals, and methods of conserving groundwater and actively replenishing depleted groundwater basins with surface water.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that lead to increased water supply security.

- Northern Sacramento Valley water users increased their interest and understanding of surface water and groundwater resources in the Northern Sacramento Valley. Distrust and conflict between different interest groups has been reduced, in favor of collaborative strategies to

manage water resources for multiple benefits. Water users in the valley are now more prepared to manage and sustain groundwater supplies in accordance with the Sustainable Groundwater Management Act.

This measured outcomes strengthened understanding of water supply and helped improve the actions taken to ensure a stable water supply to meet California's demand. UC ANR research and extension will support communities as they develop groundwater management plans to bring pumping and recharge into balance by 2042 in compliance with the state's Sustainable Groundwater Management Act. Thus, UC ANR contributes to the public value of protecting California's natural resources.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management

Outcome #7

1. Outcome Measures

Science-based research is applied to water supply policy and planning.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

California's climate has the largest precipitation and streamflow variability in the contiguous United States. Further, groundwater pumping chronically exceeds natural recharge in many agricultural regions of the state, in fact, statewide groundwater overdraft estimates range from 500,000 to 1.5 million acre feet per year. Identifying new ways to ensure and secure a safe water supply are essential to the health and prosperity of California.

What has been done

UC ANR extends new knowledge using both real and virtual methods to increase understanding

of groundwater resources and conservation. One program has developed decision support tools by repackaging soil survey data into models and interactive apps that help stakeholders characterize water resource challenges and apply mitigating management practices. Specifically, the program has created an agricultural groundwater banking index, which evaluates the suitability of soils to accommodate groundwater recharge.

Results

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that lead to increased water supply security. For example:

- The on-farm groundwater banking index tool has now been integrated into the California Department of Water Resource’s land use viewer to support groundwater basin assessment reports. These reports are a necessary first step in the new Sustainable Groundwater Management Act.

This measured outcomes strengthened understanding of water supply and helped improve the actions taken to ensure a stable water supply to meet California’s demand. UC ANR research and extension will support communities as they develop groundwater management plans to bring pumping and recharge into balance by 2042 in compliance with the state’s Sustainable Groundwater Management Act. Thus, UC ANR contributes to the public value of protecting California’s natural resources.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management

Outcome #8

1. Outcome Measures

Participants learned about water use and conservation practices and intend to adopt, or adopted recommended management practices for water conservation.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Eighty percent of the water used in California is for agricultural purposes and the state faces challenges to meet its water demands. As the state's population expands and agricultural uses of water are curtailed to meet new sustainable groundwater management guidelines, there is an expected decrease in water availability and increased competition between urban, environmental, and agricultural water uses. These issues create a need to identify new solutions to improve water use efficiency on agricultural lands and in the urban sector in and around homes, to meet increasing demands.

What has been done

UC ANR develops research projects throughout the state to identify more efficient water practices and extends them to growers, managers and the public to transform how Californians use water. Research and extension activities have included improvement in water application methods, introducing drought resistant crops, and helping homeowners understand how to use water more efficiently. The California Institute for Water Resources trained over 1,000 Certified Crop Advisors in nutrient and irrigation management. Training included how to manage water use and evaluate the economic impact of using irrigation management tools. Drought tolerant plant nurseries have been established at two UC ANR Research and Extension Centers. Other efforts to expand understanding of drought tolerant plants includes extending research on forage and grain yield trials, using drone data to better understand plant growth, launching a website to provide information on sorghum, and publishing identification and control guides for the weed, Johnson grass. At a Southern California REC, public presentations and tours led by Master Gardeners highlighted landscapes that use drought tolerant native plants and new irrigation technologies.

Results

As a result of UC ANR research, outreach and education, participants learned and adopted practices that lead to improved water use efficiency. Specific measured outcome indicators follow.

- Over 800 visitors learned about garden and landscaping practices designed to have less impact on water resources in urbanized environments. Eighty-three percent of respondents plan to adopt one or more of the water conserving best management practices they learned about, including planting low water use plant material, rescheduling the irrigation controller, installing a new irrigation system, and replacing turf.
- As a result of the training from the California Institute for Water Resources, crop advisors are now certified by the state to sign off on grower nutrient management plans and will be working with 70% of the growers in the state. Participants reported improved understanding of nitrogen management (95% good or complete understanding compared to 60% at the start). Participants also improved their capacity to advise on a nitrogen management approach (84% good or complete understanding compared to 47% at the start).
- Sorghum acres in California increased from 10,000 acres in 2011 to approximately 60,000 acres in 2018 because of their inherent ability to tolerate deficit irrigation and still produce acceptable yields.

These aforementioned measured outcomes demonstrate better understanding and adoption of water use efficiency measures to help California reduce its water demand while maintaining crop yields, and the benefits of home landscapes. Thus, UC ANR contributes to the public value of protecting California's Natural Resources. For example, through collaboration with the SWEEP

program, alone, UC ANR has helped growers save 100,000 acre-feet of water since 2014, enough to fill 50,000 Olympic size swimming pools. Ultimately, improved water management will increase water cost savings, and reduce water usage, benefiting the end user and reducing the over pumping of groundwater in California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
404	Instrumentation and Control Systems

Outcome #9

1. Outcome Measures

Participants intend to adopt or have adopted recommended irrigation or other water and soil management practices.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Eighty percent of the water used in California is for agricultural purposes and the state faces challenges to meet its water demands. As the state's population expands and agricultural uses of water are curtailed to meet new sustainable groundwater management guidelines, there is an expected decrease in water availability and increased competition between urban, environmental, and agricultural water uses. These issues create a need to identify new solutions to improve water use efficiency on agricultural lands and in the urban sector in and around homes, to meet increasing demands.

What has been done

UC ANR develops research projects throughout the state to identify more efficient water practices and extends them to growers, managers and the public to transform how Californians use water. A variety of projects around the state have focused efforts on informing and training growers to adopt improved water and soil management and irrigation practices. Examples include extension to inform adoption of zone irrigation systems, trainings on how to use pressure chambers for precise, plant-based irrigation management and how to measure water using weirs and flow meters. Information on using pressure chambers and research on how to determine the water stress of dormant orchard trees was further relayed through publications. Research focused on methods to identify water stress in trees and delay the first orchard irrigation application until trees demonstrate water stress instead of based on soil moisture. Additionally, UC ANR conducted research and outreach projects on reduced runoff, improved irrigation management techniques, variable rate irrigation practices, automation of surface irrigation systems, subsurface drip irrigation, deficit irrigation, and new crop varieties that tolerate salinity and limited water supplies.

Results

As a result of UC ANR research, outreach and education, participants learned and adopted practices that lead to improved water use efficiency. Specific measured outcome indicators follow.

- Real-time crop evapotranspiration (ET) information shared weekly with 175 farm managers in the Northern Sacramento Valley led to adoption of weather-conscious irrigation management practices. Over 100 managers and consultants are now incorporating orchard stress indicators measured with a pressure chamber, using real-time crop water use estimates, and/or conducting soil moisture monitoring into their routine on-farm water management practices and decisions.
- Four growers collectively with 3,500 acres of almonds and walnuts adopted zone irrigation systems in orchards with highly variable soils.
- 800 agricultural water users learned to measure irrigation water with weirs and flow meters and intend to use these practices to comply with agricultural regulations.
- 17 surveyed participants at a field meeting reported improved understanding of what pressure chamber measures (100% marked yes from 19% at the start), how to take the measurement (100% up from 41%) and how to interpret the results for refined irrigation management (100% up from 29%).
- Variable rate irrigation systems have been implemented on one commercial field and this technology is expanding to other fields in California. Automation of irrigation delivery gates has already been adopted by local growers on 80-acre and 160-acre fields in Holtville, and those fields have been used as demonstration sites for other interested growers.
- Because of a hands-on field meeting, 88% of respondents reported an increased likelihood to adopt pressure chamber readings.
- As a direct outcome of research on irrigation practices, two collaborating growers intend to change their irrigation practices and begin using the pressure chamber for better irrigation management.

These aforementioned measured outcomes demonstrate better understanding and adoption of water use efficiency measures to help California reduce its water demand while maintaining crop yields, and the benefits of home landscapes. Thus, UC ANR contributes to the public value of protecting California's Natural Resources. For example, through collaboration with the SWEEP program, alone, UC ANR has helped growers save 100,000 acre-feet of water since 2014, enough to fill 50,000 Olympic size swimming pools. Ultimately, improved water management will increase water cost savings, and reduce water usage, benefiting the end user and reducing the over pumping of groundwater in California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
404	Instrumentation and Control Systems
605	Natural Resource and Environmental Economics

Outcome #10

1. Outcome Measures

Participants saved water after adopting recommended conservation measures.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Eighty percent of the water used in California is for agricultural purposes and the state faces challenges to meet its water demands. As the state's population expands and agricultural uses of water are curtailed to meet new sustainable groundwater management guidelines, there is an expected decrease in water availability and increased competition between urban, environmental, and agricultural water uses. These issues create a need to identify new solutions to improve water use efficiency on agricultural lands and in the urban sector in and around homes, to meet increasing demands.

What has been done

UC ANR develops research projects throughout the state to identify more efficient water practices and extends them to growers, managers and the public to transform how Californians use water. In the San Francisco Bay area, Garden Walks inform residents about water saving measures and academics have tracked the resulting water savings from homeowners that implemented suggested practices as a result of these educational walks.

Results

As a result of UC ANR research, outreach and education, participants learned and adopted practices that lead to improved water use efficiency. For example:

- Garden Walks program participants saved over 9000 gallons a year on average when compared to control groups. Total water savings for all participants over the lifetime of the program are over 27 million gallons to date, and the program has cost less to run over that same time-frame than it would cost to simply buy 27 million gallons at the average rate paid by the Metropolitan Municipal Water District residential customers.

This measured outcome demonstrates better understanding and adoption of water use efficiency measures to help California reduce its water demand while maintaining crop yields, and the benefits of home landscapes. Thus, UC ANR contributes to the public value of protecting California's Natural Resources. For example, through collaboration with the SWEEP program, alone, UC ANR has helped growers save 100,000 acre-feet of water since 2014, enough to fill 50,000 Olympic size swimming pools. Ultimately, improved water management will increase water cost savings, and reduce water usage, benefiting the end user and reducing the over pumping of groundwater in California.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water

Outcome #11

1. Outcome Measures

Participants learned about recommended management practices for preserving water quality and intend to adopt or have adopted practices to preserve water quality.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Poor water quality can result from a variety of point and non-point sources of pollution such as land development, land use practices, stream modification from agriculture or forestry practices, or pollutants and sediment in runoff from storm water in urban and agricultural sites. Water quality regulations for irrigated lands in California require that growers monitor water use and nutrient

discharges to limit movement of fertilizers into groundwater and surface water. In addition to managing agricultural lands, protecting water quality from rangelands is also a major concern as surface runoff and ground water on rangelands provide important sources of municipal water for regional communities.

What has been done

UC ANR uses applied research to better understand the impacts of agricultural and rangeland management practices on water quality and extends outreach to growers, ranchers and the public. Activities span a wide range of research and extension efforts. One collaborative project is focused on conducting salinity modeling under altered irrigation strategies, and tests have been carried out in the avocado groves at one Research and Extension Center. Additionally, a study is examining the baseline contribution of water quality impairments from livestock. UC ANR is also performing ongoing testing of a slow sand filtration system that treats nursery water runoff so that water can be reused or discharged without violating water quality regulations. Field days in the Sacramento Valley have been used to share best irrigation and nitrogen practices in almond and walnut crops to protect groundwater. Outreach has been provided to producers through award-winning ranch water quality short courses. Water district personal have been reached through workshops and sharing research articles and fact sheets. An academic also provided an interactive program on stream monitoring and stewardship using aquatic insects at UC ANR's Elkus Ranch.

Results

As a result of UC ANR research, outreach and education, participants learned and adopted practices that lead to improved water quality. Specific measured indicators follow.

- The Avocado Commission is using UC ANR research findings on salt movement in the soil to extend information about salt management strategies to avocado growers.
- With the help of UC ANR's science-based information and assistance with facilitation between ranchers and watershed managers, ranchers have been able to participate in the development of proposed regulations and identify workable solutions for agencies and ranchers.
- Low-cost technologies have been adopted by nurseries, in response to regulations and in part UC ANR research. Adopted technologies include slow sand vegetative filter technology, which allows for an alternative to expensive water treatment systems requiring highly skilled staff to operate.
- Growers in the Sacramento Valley increased awareness of the connection between irrigation efficiency and non-point source agricultural pollution.
- Three San Francisco Bay Area Water Districts have maintained or reintroduced grazing programs on 11,500 acres. As a result of informed research provided by UC ANR, the water districts adopted controlled calving or grazing seasons to reduce risk from pathogens and have implemented comprehensive annual rangeland monitoring programs.
- 67 attendees at Elkus Ranch increased their knowledge and understanding of stream monitoring practices and reported they would change some of their practices (e.g., reduce use of algacides; begin monitoring soil water content) to better use and manage water and storm water.

These aforementioned measured outcomes demonstrate improved knowledge and adoption of mitigation management practices. Thus, UC ANR contributes to the public value of protecting California's Natural Resources. By reducing pollutants such as nitrates from fertilizers, pesticides, and animal waste that runoff or leach from agricultural and rangelands into water supplies, UC ANR helps preserve water quality. Additionally, improved practices enable managers to reduce inputs and costs leading to more economically and environmentally sustainable farming and ranching.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
103	Management of Saline and Sodic Soils and Salinity
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

Outcome #12

1. Outcome Measures

Science-based information was applied to water quality policy and decision-making.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Poor water quality can result from a variety of point and non-point sources of pollution such as land development, land use practices, stream modification from agriculture or forestry practices, or pollutants and sediment in runoff from storm water in urban and agricultural sites. Water quality regulations for irrigated lands in California require that growers monitor water use and nutrient discharges to limit movement of fertilizers into groundwater and surface water. In addition to managing agricultural lands, protecting water quality from rangelands is also a major concern as surface runoff and ground water on rangelands provide important sources of municipal water for regional communities.

What has been done

UC ANR uses applied research to better understand the impacts of agricultural and rangeland management practices on water quality and extends outreach to growers, ranchers and the public. Applied research is also being carried out to improve nitrogen use efficiency of agronomic crop systems. Information has been extended to 400 agricultural professionals about how to improve nitrogen use efficiency while remaining in compliance with local environmental regulatory requirements. Nutrient management research results were shared through a video interview with

California Dairy Magazine. Additionally, research is being conducted through collaborations with the Department of Pesticide Regulation and the Orange County Stormwater Division. These projects monitor pesticides and deliver training tools to pest control professionals.

Results

As a result of UC ANR research, outreach and education, participants learned and adopted practices that lead to improved water quality. Specific measured outcome indicators follow.

- The Central Valley Dairy Representative Monitoring Program used original research-based information to support the mandate to recommend revisions to the Regional Water Quality Control Board's waste discharge requirements for dairies.
- Research is enabling the Department of Pesticide Regulation to continuously monitor pesticides in residential runoff. This partnership with the agency has provided an avenue for large-scale reductions in pesticide toxicity in water conveyances, such as statewide product re-registration based on the research and extension results.

These aforementioned measured outcomes demonstrate improved knowledge and adoption of mitigation management practices. Thus, UC ANR contributes to the public value of protecting California's Natural Resources. By reducing pollutants such as nitrates from fertilizers, pesticides, and animal waste that runoff or leach from agricultural and rangelands into water supplies, UC ANR helps preserve water quality. Additionally, improved practices enable managers to reduce inputs and costs leading to more economically and environmentally sustainable farming and ranching.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

During FFY 2018, California experienced catastrophic wildfires across the state from the North to the South. Thousands of fires burned over one million acres, including five of the most destructive wildland-urban interface fires in the state's history to date. Wildfires affected UC ANR's research and program delivery focus, with dedicated attention going from immediate response to fostering resilience. UC ANR is committing more effort to

convening stakeholders across many fields including science, emergency response, community planning, public health, and policy. More attention is being put on the need to expand understanding of California's fire problem and provide an opportunity to build connectivity, interaction, and integration across disciplines and better understand the complexity of and find solutions to California's wildfire challenge.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

UC ANR's notable outcomes measured through program evaluation efforts are reported under the State Defined Outcomes section.

Key Items of Evaluation

The Report Overview's Federal Planned Program summary of accomplishments highlights UC ANR's most notable research and the significant extension outcomes from FFY 2018. In addition, under the Federal Planned Programs State Defined Outcomes section, the significant outcomes are highlighted in the impact stories.

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Sustainable Energy

Reporting on this Program

Reason for not reporting

UC ANR is no longer reporting on this separately given it is not one of the Strategic Initiatives.
The content is incorporated in the other Planned Programs.

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	0.4	0.0	2.8	0.0
Actual Paid	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
Actual Volunteer	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 Matching	1890 Matching	1862 Matching	1890 Matching
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 All Other	1890 All Other	1862 All Other	1890 All Other
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

V(D). Planned Program (Activity)

1. Brief description of the Activity

UC ANR's integrated research and extension activities will conduct research projects, workshops, education classes and demonstrations, as well as one-on-one interventions. In addition, the programs will use PSAs, newsletters, mass media, web sites and collaborations with other agencies and organizations

to create and deliver programs.

2. Brief description of the target audience

- Relevant agency and private-sector partners
- Lawmakers working on issues related to energy
- Members of the public in general
- Agricultural producers of crops for use as biofuels

3. How was eXtension used?

{No Data Entered}

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2018

Actual: {No Data Entered}

Patents listed

{No Data Entered}

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Workshops Conducted

Year	Actual
2018	0

Output #2

Output Measure

- Web Sites Created or Updated

Year	Actual
2018	0

Output #3

Output Measure

- Research Projects Conducted

Year	Actual
2018	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Program participants gain knowledge about new improved methods related to producing sustainable energy.

Outcome #1

1. Outcome Measures

Program participants gain knowledge about new improved methods related to producing sustainable energy.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

{No Data Entered}

What has been done

{No Data Entered}

Results

{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
{No Data}	null

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
0	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
0	Number of new crop varieties, animal breeds, and genotypes with climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
0	Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources.
Global Food Security and Hunger (Outcome 2, Indicator 1)	
0	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
0	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
0	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
0	Tons of feedstocks delivered.