Table of Contents

[PROMOTING ECONOMIC PROSPERITY IN CALIFORNIA 3](#_Toc103856875)

[Condition Change: UC ANR contributed to improved individual and household financial stability. 3](#_Toc103856876)

[Condition Change: UC ANR contributed to enhanced community economic development 6](#_Toc103856877)

[Condition Change: UC ANR contributed to improved animal management, productivity and efficiency 10](#_Toc103856878)

[Condition Change: UC ANR contributed to increased agricultural efficiency and profitability 15](#_Toc103856879)

[Condition Change: UC ANR contributed to increased emerging food economies and markets 29](#_Toc103856880)

[SAFEGUARDING SUFFICIENT, SAFE, AND HEALTHY FOOD FOR ALL CALIFORNIANS 32](#_Toc103856881)

[Condition Change: UC ANR contributed to improved food safety 32](#_Toc103856882)

[Condition Change: UC ANR contributed to improved food security 37](#_Toc103856883)

[DEVELOPING A QUALIFIED WORKFORCE FOR CALIFORNIA 40](#_Toc103856884)

[Condition Change: UC ANR contributed to increased workforce retention and competency 40](#_Toc103856885)

[Condition Change: UC ANR contributed to increased effective public leaders 45](#_Toc103856886)

[Condition Change: UC ANR contributed to improved college readiness and access 47](#_Toc103856887)

[Condition Change: UC ANR contributed to increased civic engagement 50](#_Toc103856888)

[DEVELOPING AN INCLUSIVE AND EQUITABLE SOCIETY 53](#_Toc103856889)

[Condition Change: UC ANR contributed to improved living and working conditions for California's food system and farmworkers 53](#_Toc103856890)

[Condition Change: UC ANR contributes to increased diversity, inclusiveness, and cultural competency in California's workplaces. 56](#_Toc103856891)

[PROMOTING HEALTHY PEOPLE AND COMMUNITIES 59](#_Toc103856892)

[Condition Change: UC ANR contributed to improved health for all 59](#_Toc103856893)

[Condition Change: UC ANR contributed to improved community health and wellness 65](#_Toc103856894)

[Condition Change: UC ANR contributed to improved access to positive built and natural environment 71](#_Toc103856895)

[PROTECTING CALIFORNIA’S NATURAL RESOURCES 72](#_Toc103856896)

[Condition Change: UC ANR contributed to improved management and use of land 72](#_Toc103856897)

[Condition Change: UC ANR contributed to improved air quality 75](#_Toc103856898)

[Condition Change: UC ANR contributed to the protection and conservation of soil quality 77](#_Toc103856899)

[Condition Change: UC ANR contributed to increased ecological sustainability of agriculture, landscapes, and forestry 80](#_Toc103856900)

[Condition Change: UC ANR contributed to improved water quality 89](#_Toc103856901)

[Condition Change: UC ANR contributed to improved water use efficiency 94](#_Toc103856902)

[Condition Change: UC ANR contributed to increased water supply security 100](#_Toc103856903)

[BUILDING CLIMATE RESILIENT COMMUNITIES AND ECOSYSTEMS 102](#_Toc103856904)

[Condition Change: UC ANR contributed to increased preparedness and resilience to extreme weather and climate change 102](#_Toc103856905)

# PROMOTING ECONOMIC PROSPERITY IN CALIFORNIA

## Condition Change: UC ANR contributed to improved individual and household financial stability.

**Issue**

California’s vibrant, diverse economy is the fifth largest in the world. To maintain its competitive edge, California must continually overcome technical, social, and environmental challenges. Over the past two years, the COVID-19 pandemic significantly disrupted Americans’ economic livelihoods through cascading shutdowns and layoffs. For example, between February 2020 and March 2021, the number of Americans unemployed for more than 27 weeks rose from 1.1 million (19% of unemployed workers) to 4.2 million (43% of unemployed workers). Resource management, particularly for families living below the poverty line, has been critical to making ends meet.

**Methods**

In partnership with communities and allied organizations, UC ANR conducts research and delivers education leading to improvements in individual and household financial management practices.

The CalFresh Healthy Living, UC (CFHL, UC) State Office at UC Davis provided statewide oversight, leadership, and guidance for the CalFresh Healthy Living Program. UCCE academics and CFHL, UCCE supervisors offered local leadership and guidance in program implementation and evaluation.

UC Cooperative Extension (UCCE) academics also provided oversight, leadership, and guidance for the Expanded Food and Nutrition Education Program (EFNEP) statewide programs. Curricula such as *Making Every Dollar Count* (MEDC), *Eating Smart Being Active* (ESBA), and *Plan, Shop, Save, and Cook* (PSSC) are designed to help adult participants gain the tools needed to take control of their money by teaching families food buying/budgeting skills and food resource management techniques. In Alameda and Contra Costa counties, for example, EFNEP educators provided a nine-part virtual series, *UCCE Connects to You!*, in English and Spanish focused on strategies to stretch the household food budget and provided information on COVID-19 related emergency food assistance programs. They also demonstrated recipes for the food items parents received at their local distribution programs. (Marisa Neelon)

As a result of UC ANR’s research and education, participants learned and adopted financial management practices. Outcomes with specific indicators follow.

**Outcomes**

**Participants learned about financial management practices.**

* In Alameda and Contra Costa counties, over 3,500 students participate in Youth EFNEP programming adapted to an asynchronous online learning format. A survey of 68 6th-8th graders showed that 49% percent of Contra Costa County respondents and 60% of Alameda County respondents reported improvements in food resource management skills. (Marisa Neelon)

**Participants improved food resource management practices.**

* Over 130 CFHL, UC participants statewide responded to a survey about their experience with the MEDC curriculum, with 66% reporting using tools learned at workshops to save money on food, 64% had made food last until they had more money, and 49% had determined if using a coupon was better than buying store brand. (CFHL, UC)
* Over 400 CFHL, UC participants statewide responded to a survey about their experiences with the PSSC curriculum. They reported adopting food resource management behavior changes such as planning meals more often (65%), shopping with a list more often (65%), and comparing unit prices more often (60%). (CFHL, UC)
* Over 1,400 EFNEP participants statewide responded to a survey, with 97% showing improvement in one or more food resource management practices. (EFNEP) Local highlights include:
  + In Alameda and Contra Costa counties, 248 out of 371 parents graduated from the virtual UCCE Connects to You! series. Post-survey results show that 97% and 93% of participants in each county respectively improved food management skills such as planning meals before shopping, making a shopping list, and comparing food prices. (Marisa Neelon)
  + In Alameda and Contra Costa counties, over 3,500 students participate in Youth EFNEP programming adapted to an asynchronous online learning format. A survey of 285 6th-8th grade students showed that 49% percent of Contra Costa County respondents and 60% of Alameda County respondents reported improved food resource management skills. (Marisa Neelon)
  + Out of 20 Eating Smart Being Active (ESBA) participants in Humboldt and Del Norte counties, 64% improved food resource management practices after participating in the workshop series. (Dorina Espinoza)
  + Surveys from EFENP participants in Los Angeles County that participated in UCCE Connects to You! workshops showed that 98% of 268 participants improved in one or more food resource management practices. In Orange County, 99% of 108 participants improved food resource management practices. (Natalie Price)

**Change in condition: Money saved.**

* EFNEP graduates statewide averaged a $41.63 savings in their monthly grocery budget, which is a $500 savings per year. (EFNEP) Local examples include:
* After attending the virtual *UCCE Connects to You!* series from EFNEP, families in Alameda County saved an average of $19 per month on food costs, and Contra Costa County families saved an average of $64 per month on food costs. (Marisa Neelon)
* Families in Los Angeles and Orange County saved an average of $38.70 and $18.90 a month on groceries, respectively, after participating in EFNEP’s workshop series. (Natalie Price)

These measured outcomes demonstrated improved knowledge and skills related to individual and household resource management. Furthermore, longitudinal studies of EFNEP graduates indicate that they maintain positive behavior change two to six months after completing the program. In this way, UC ANR contributes to the public value of promoting economic prosperity in California.

## Condition Change: UC ANR contributed to enhanced community economic development

**Issue**

California needs community economic development approaches to foster economic resilience and vigor across its working landscapes, especially now, given the severe economic effects of the COVID-19 crisis. The state’s working landscapes span fishing to agriculture and ranching and from mining to renewable energy. In 2018, the nine working landscape segments paid workers $85 billion in earnings and generated $333 billion in sales. Collectively, these segments contribute significantly to the state’s economic vitality and account for more than 1.5 million jobs and nearly 70,000 business establishments. In particular, small producers face challenges managing costs, marketing, and understanding and complying with regulations.

**Methods**

UC ANR’s efforts focus on California’s agriculture, ranching, and forestry sectors to identify opportunities for economic development through innovation and entrepreneurship while also fostering environmental and social sustainability.

UC Cooperative Extension (UCCE) works to support new farming businesses. Due to the pandemic, virtual workshops and peer support events were primary delivery methods until small-group, in-person workshops were held in spring 2021. Peer-to-peer learning is a critical component of the training, which results in the rapid adoption of new practices and improvements in farm and ranch profitability, so in-person workshops are critical for many participants. Thirty-two new and beginning farmers participated in three virtual/hybrid farm business courses (Start a Farm, Beginning Farming Academy, Intro to Commercial Citrus Production). These courses included guidance and requirements for starting an agricultural business, learning to assess resources and conduct market research, and an introduction to basic farm economics and key regulations. Eleven prospective farmers and ranchers participated in a 2-part “Start a Farm” webinar to learn about farm business. The Foothill Farming Website provides important business information and tools for producers. In 2020-21, 54% (26,559) of visitors to the site focused on the Farm Business pages. (Cindy Fake, Dan Macon)

A UCCE program in the Sierra Foothills incorporates agricultural business viability elements into natural resources and livestock production programming, including working with new and aspiring producers to build hands-on animal husbandry skills and practical knowledge that will increase both efficiency and profitability. In 2020-21, there was a combination of in-person workshops, one-on-one consultations and ranch visits, and virtual programming (webinars, videos, and podcasts). (Dan Macon)

UCCE provides information on agricultural tourism to foster opportunities for farmers and ranchers to diversify their operations and expand their revenue sources to help them stay in business. In 2021, the statewide UC Sustainable Agriculture Research and Education Program (SAREP) conducted an agritourism intensive course through webinar series and in-person workshops. (Gail Feenstra)

UCCE is the research partner on the French Meadows Project in the Middle Fork of the American River Basin, measuring and modeling water, carbon, and forest health benefits of watershed restoration. The field sites are used as a living laboratory for extension. Working with the Nature Conservancy, Sierra Nevada Conservancy, American River Conservancy, Place County Water Agency, Placer County, and US Forest Service, this award-winning project has developed and demonstrated a collaborative model for watershed restoration. (Safeeq Khan)

A UC Riverside UCCE Specialist is also director of the California Citrus Clonal Protection Program (CCPP). This was the first program of its kind in the world with roots in the 1933 discovery of the first citrus virus by Dr. H. S. Fawcett, who was part of the Citrus Experiment Station established in 1907 at UC Riverside. CCPP provides a safe mechanism for introduction into the state of citrus varieties through methods such as in vitro variety therapy and disease diagnostics to propagate healthy citrus trees for the growing California citrus industry and all Californians. (Georgios Vidalakis)

As a result of UC ANR research and extension, participants learned about and adopted agricultural business management practices that contribute to community economic development. Outcomes with specific indicators follow.

**Outcomes**

**Participants learned or planned to utilize innovation and entrepreneurial strategies.**

* The 11 participants who completed the evaluation survey for the 2-part “Start a Farm” webinar reported:
  + 100% increase in knowledge of agriculture rules and regulations,
  + 75% increase in ability to assess resources,
  + 38% increase in understanding of economic principles, and
  + One or more key actions to start their farm business that they would complete within 30 days. (Cindy Fake, Dan Macon)
* The seven Beginning Farming Academy participants reported:
  + 100% will analyze the start-up costs for their operation within six months,
  + 80% of respondents will develop a budget for the enterprise within six months,
  + 60% will develop a recordkeeping system for their operation within six months, another 20% within a year, and
  + 80% will analyze capital purchase costs and returns within one year. (Cindy Fake, Dan Macon)
* The 18 new and beginning farmers who participated in the farm business courses reported:
  + 64% increase in their knowledge of farm business practices,
  + 100% increase in their knowledge of farm economics and ag marketing, and
  + Three key actions that they needed to take within the next 6 months to get their farm business started. (Cindy Fake, Dan Macon)
* The 15 new/prospective citrus growers who participated in the Introduction to Commercial Citrus Production course reported:
  + increasing their knowledge of citrus nutrient management by 90%
  + citrus production and orchard management by 82%
  + citrus pest management by 71%. (Cindy Fake)
* Ninety-four producers improved their understanding of the financial, human, legal, and marketing risks associated with their operations generally. (Dan Macon)
* Of the 68 farmers and others who participated in UC SAREP’s Agritourism and Direct Sales webinar series, 87% reported increased their knowledge of direct sales options from the webinar series. (Gail Feenstra)
* All of the direct sales in-person workshop participants reported increased knowledge of agritourism and direct sales. (Gail Feenstra)

**Participants implemented innovation and entrepreneurial strategies.**

* From the 40 new citrus varieties that completed therapy and testing during this reporting period, 19 varieties were introduced by large California citrus producers that invested $190,000 towards the cost of the introduction. This means that the California citrus industry believes that 19 varieties have commercial potential. Thousands of agricultural jobs will be maintained or created in the next few years as these varieties are propagated, grown in the field, and come to production. (Georgios Vidalakis)
* Twenty-five producers developed capital purchase plans (i.e,. for items that cost $5,000 or more and have a useful life of more than one year) or other financial plans that will enable their operations to continue in the event of climate change impacts. (Dan Macon)
* Nineteen producers identified key risks to their operations related to increasing climate uncertainty. (Dan Macon)
* Ten producers developed and implemented financial analysis and recordkeeping systems, including enterprise analysis, cash flow, and profit and loss. This improved business decision-making and helped improve profitability. (Dan Macon)
* Podcast listeners reported implementing new management practices, including grazing management, animal health management, and business management. Ultimately, improved livestock management leads to greater profitability, improved resource management, and improved animal welfare. (Dan Macon)
* Of the 63 participants in the 2021 agritourism intensive, 24 took steps to start or expand their agritourism business, and 12 implemented at least one element of their new marketing strategy. This promotes economic prosperity among farmers and ranchers participating in agritourism (Rilla et al., 2011). (Gail Feenstra)

**Change in condition: Jobs created.**

* The French Meadows watershed restoration project partners have appeared on various forums highlighting the role of UCCE research in changing the pace and scale of forest restoration in California. UCCE’s continued engagement with research, education, advocacy, and fundraising resulted in 4,500 acres of forest restoration within the 28,000 acres of federal and private land. In the previous two seasons, this project generated jobs for over 200 contractors and removed 4 million board feet of timber to a local mill, and more than 2,500 tons of biomass to local renewable energy facilities which contribute to the local economy, and help offset restoration costs while generating 4,100 MWh renewable energy for 500 homes. (Safeeq Khan)

These aforementioned measured outcomes demonstrate changes that improve the economic, environmental, and social sustainability of California’s working landscapes. For example, increased agritourism demonstrates enhanced community economic development and contributes to promoting economic prosperity among farmers and ranchers participating in agritourism (Rilla et al., 2011). In this way, UC ANR contributes to the public value of promoting economic prosperity in California.

## Condition Change: UC ANR contributed to improved animal management, productivity and efficiency

**Issue**

California ranks fourth in the nation in total livestock receipts, with over $12.3 billion (2019). It remains the largest dairy-producing state, accounting for about 19% of the nation’s dairy product receipts (2019), 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. Forage crops linked to the livestock industry are an important economic driver in California’s food-producing system. Although livestock is a high-value commodity, it can be challenging to be profitable at the ranch level. Ranchers or their family members often need to work off the ranch to make ends meet and keep the farm running. Simultaneously, there is the need to improve the ecological viability of these animal production systems, including conserving aquatic species and managing stress in sustainable aquaculture.

**Methods**

UC ANR partners with public, non-profit, and private groups to create and extend new knowledge about animal systems management for dairies and livestock operations.

The UC Cooperative Extension (UCCE) Aquaculture Specialist at UC Davis continues work on his fish slaughter and animal welfare program. This year slaughter technology was expanded to all sturgeon and paddlefish caviar farms across the US. Also, a demonstration was conducted of percussion stunning at the State of California Nimbus Fish Hatchery for State Fish Biologists. This technology will also be demonstrated to other state-run salmon fish hatcheries. (Jackson Gross)

A UCCE Dairy Advisor evaluated the efficacy of two experimental post-milking teat dip barrier products compared to a commercial post-milking barrier teat disinfectant in preventing new infections and maintaining good teat skin condition. She also took the opportunity to train the milkers on milking procedures and the importance of using teat disinfectants to prevent mastitis. (Daniela Bruno)

This UCCE Dairy Advisor continued animal health and welfare work through a selective dry cow therapy project. Behavioral data such as lying down/resting, walking, standing patterns, are collected via activity monitors and can be useful in determining a cow's health. For example, little to no movement could indicate the cow has a health issue. Other equipment sensors such as conductivity sensors could assist in identifying cows with subclinical mastitis that need antibiotics at dry off. She provided technical assistance to a dairyman using existing on-farm tools. (Daniela Bruno)

In Northern California, two UCCE beef herd health and production projects worked specifically to increase cattle weight gain, given calves’ weight gain often is the difference in economic sustainability. These projects added an ionophore to a mineral supplement. The ionophore increases nutrient efficiency. The first project tested a low rate and found increased gains of 25 pounds added to solely salt and 50 pounds when added to a mineral supplement. These are a significant gain for a cost of roughly $1 per animal. A follow-up project is now looking at differing rates to target the most economical ionophore included in a mineral supplement. (Josh Davy)

A Livestock and Natural Resources Advisor working in the Central Valley has extended a local cow-calf cost study to new and existing ranchers so they can compare their operational budgets and make changes. (Rebecca Ozeran)

Livestock producers across California face increasing challenges related to large predators killing livestock due to increasing populations of large predators such as mountain lions, bears, and now gray wolves. Wolves have full legal protection from harm in California. While some non-lethal livestock protection tools work in limited circumstances, livestock raised on extensive rangeland systems is vulnerable to wolves. One potential means of mitigating this impact is via a compensation system by which losses documented by ranchers may be paid for by state or federal funding. The state allocated $3M to the California Department of Fish and Wildlife to compensate ranchers or livestock killed by wolves. However, there was no guidance on how the program would work, how livestock producers would be deemed eligible, or how livestock valued was provided. UCCE organized a meeting of local cattle producers to provide them an opportunity to voice their preference on how such a program might be structured. UCCE wrote a template of key discussion points to use in Lassen County so that other UCCE colleagues could also use it in their counties. (David Lile)

UCCE conducted the Water Diversion Monitoring and Reporting Training. This course provided knowledge and significant economic incentives to over 60 livestock producers. The training allowed clientele to be self-certified to report water usage and remain in regulatory compliance, versus employing a costly professional engineer to provide mandated reporting. To provide further assistance to property owners, site and office visits were provided to help them with complex reporting requirements and advised on implementing water monitoring systems to ensure regulatory compliance. (Tracy Schohr)

A UCCE Advisor in Modoc County organized several poultry extension events to address the increasing interest in producing and eating locally produced food. Technical assistance was provided to clientele wanting more information about proper production and processing of a small-scale poultry operation (~200 head/year). Additionally, information on state and federal direct meat sales guidelines is being shared with California State 4-H, California County Fairs, and local producers. (Laura Snell)

On the Central Coast, UCCE worked to improve the “Ag Pass” to soften future impacts of wildfire. The basic idea of the pass was to allow owners/operators of commercial farms and ranches limited, emergency access to areas that may otherwise be restricted to the public to protect or care for agricultural assets. In Ventura County, the local pass program had worked but with only moderate success because fire suppression resources and personnel from around the country were unfamiliar with it. UCCE is working to:

1. To help refine and reboot the program in Ventura County.
2. To establish a new program in Santa Barbara County.
3. To promote the adoption of this program statewide.

In December 2020, UCCE published a peer-reviewed document that serves as a “how-to” best practices guide for establishing community-based Ag Passes, which has been distributed throughout California, the nation, and globally. In July 2021, UCCE and the Santa Barbara County Agricultural Commissioner’s Office hosted the first 4-hour training and issued Ag Pass identification cards to producers, representing the culmination of 16 months of multi-agency planning and coordination. This provides a model to other counties throughout the state of establishing a program from scratch. (Matthew Shapero)

A rangeland forage production study is entering its 26th year. Each spring, forage samples are harvested to determine peak forage production. As a result of this work, colleagues across the state teamed up in Fall 2020 to begin a new statewide project that will utilize satellite imagery to quantify forage production across the state on annual rangelands. (Scott Oneto)

A UCCE Advisor in Tehama County increased individual technical assistance to rangeland managers due to the COVID-19 pandemic, which created a situation where individual, rather than group, contact with clientele was more feasible. (Josh Davy)

As a result of UC ANR research and extension, participants made changes that improve animal production systems. Outcomes with specific indicators follow.

**Outcomes**

**Participants adopted practices for more productive and sustainable animal management.**

* The three California sturgeon farms have adopted percussion slaughter technology. They are the largest sturgeon farms in the nation, and make up 80% of the US sturgeon caviar industry. This effort has increased the welfare of 100,000s of California White sturgeon. In addition, the adoption of the technology also reduces workplace injuries for fish biologists. (Jackson Gross)
* The State of California Nimbus Fish Hatchery for State Fish Biologists adopted the percussion slaughter technology for the winter-run chinook salmon spawning period. This effort has increased the welfare of around 10,000 Chinook salmon this year. Use of this technology also reduces workplace injuries for fish biologists. (Jackson Gross)
* After implementing the new selective dry cow therapy (SDCT), the dairy that adopted this strategy decreased the proportion of culled cows or new clinical mastitis from 11 to 8% in cows on the SDCT group, which decreases antimicrobials use and thus decreases mastitis related costs to the producer. A successful implementation of this therapy on California dairies has the potential to decrease antimicrobial use, keeping animal health without losing productivity and efficiency. (Daniela Bruno)
* Through individual farm visits, new implementation of ionophore research results was observed. Full implementation has been shown to have economic benefit. For example, it is estimated that there are nearly 500,000 weaned calves grazing in California that would be applicable to this ionophore research. With approximately 25 lbs. of added gain per animal from the use of an ionophore, that could lead to potentially 12.5 million extra pounds of beef produced in California. At a conservative value of $1.20 per lb., that could contribute $15 million to the California economy. The use also protects the well-being of cattle. (Josh Davy)
* As a result of UCCE poultry extension efforts, two local producers are working to start selling locally raised poultry in the food hub in the coming year.(Laura Snell)
* As a result of individual technical assistance in land management, clientele adopted recommended varieties and practices pulled directly from UCCE research. For example, recommended clover was seeded on nearly 800 acres of rangeland and recommended perennial grass on another 200 acres. In another case, a cooperator implemented the researched weed control of barb goatgrass on over 500 acres of rangeland, two years in a row. These learning and behavioral changes have led to improving forage production on rangelands. (Josh Davy)

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

* A consultant is using the cow-calf cost study as a basis for appropriate land lease pricing for grazing agreements. This work has potential impact on hundreds to thousands of acres of rangelands and irrigated pasture lands in Fresno County and beyond. (Rebecca Ozeran)
* The data from the rangeland forage production study is used by ranchers, federal, state, local agencies, and other stakeholders to quantify forage production on an annual basis. This scientific approach gives ranchers a better understanding of available feed. The values are also used to document forage loss in years of drought or forage loss from other causes, which is critical for the USDA Farm Service Agency Noninsured Crop Disaster Assistance Program. (Scott Oneto)
* UCCE’s proposed science-based information, developed in collaboration with the Lassen County Fish and Game Commission, the Lassen County Board of Supervisors, and the Lassen County Deputy Chief Administrative Officer, was adopted as a Lassen County Board of Supervisors’ resolution requesting state funding to compensate ranchers whose herds have been affected by gray wolves. (David Lile)
* Approximately 70 ranchers across five counties participated in local discussions using the UCCE developed discussion points. UCCE subsequently summarized their responses which have been incorporated into the wolf compensation policy-making process. As there are now three active wolf packs in California and livestock depredations have occurred with all three, it is likely that a significant number of livestock producers will benefit from a fair and effective compensation program. (David Lile)
* In September 2021, when the Alisal Fire in Santa Barbara County severely impacted homes, property, agriculture, and transportation, the Ag Pass program worked seamlessly and allowed ranchers and orchardists to access their properties to evacuate livestock and irrigate. (Matthew Shapero)
* In October 2021, Governor Newsom signed AB 1103, a bill that provides a more formalized framework for counties throughout the state to institute Ag Pass programs. UCCE worked closely with organizations that supported the bill and testified to the Agriculture Committee of the California State Legislature on the merits and positive impacts of the program. (Matthew Shapero)

**Change in condition: Money saved.** Note: out in target audience outcome section

* Milkers learned to correctly identify cows with mastitis which decreased the number of cows in the hospital being treated. The decreased use of antibiotics, due to fewer cows in the hospital, leads to savings for the dairies. (Daniela Bruno)
* For the 60 Water Diversion Monitoring and Reporting Training attendees, it is estimated that they each saved at least $750 each year in consultant fees for regulatory compliance offered from the workshop, providing a local value of $45,000 annually. (Tracy Schohr)

These measured outcomes demonstrate ranch-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 5% from 2018 (California Agricultural Statistics Review 2019-2020). Thus, UC ANR contributes to the public value of promoting economic prosperity in California and the ecological viability of the livestock industry.

## Condition Change: UC ANR contributed to increased agricultural efficiency and profitability

**Sustainable Food Systems**

**Issue**

California is a national leader in agricultural production, leading the country in cash income received for agricultural products, with farms and ranches receiving more than $50 billion for their output. The state accounts for almost half the country’s fruit and nut production and over half of vegetable production. 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 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 affect small-scale farmers more adversely, as many lack the resources or skills that larger farms have.

**Methods**

UC ANR creates and extends new knowledge about agricultural production from variety trials to post-harvest.

California is the nation’s largest milling state for small grains. Cereals are integrated into most of the cropping systems in the state, and production is dispersed across a broad range of California agroecosystems, soil types and precipitation totals. The agronomic practices and information needs of the small grain stakeholders around the state are incredibly diverse. Although COVID restrictions hampered in-person field events, a UC Cooperative Extension (UCCE) Agronomy Specialist at UC Davis helped organize five virtual events and three small group gatherings. Activities included demonstrations of how to use the Nitrogen fertilizer management tools they developed, presenting their results from statewide small grain variety evaluations, and roundtable discussions of UCCE’s work related to cropping system adaptation in the face of increasing water scarcity. Aggregate attendance at these events was more than 280 individuals and included growers, industry professionals, policymakers, agronomists, and other researchers. (Mark Lundy)

A UCCE CE Specialist of Agricultural Mechanization at UC Davis works directly with growers to test run the technologies developed at the Digital Ag Lab and solicits feedback for improvements. The major outputs include an interactive web application tool: myvirtualorchard.com, which is a free online application to visualize the results of aerial image analytics in the form of shapefiles and imagery. Users can analyze their within-field variability, define management zones, and export data. The first version of this web application was made available online. In addition, two methodologies were designed and implemented for yield forecasting. The first approach for almond maps bloom density and estimates expected yield based on blossom conditions. Aerial RGB imagery was used to develop a deep learning algorithm to detect and count the number of flowers for each tree. The second method uses 3D modeling and simulation to estimate canopy-intercepted light, or photosynthetically active radiation (PAR), which is crucial for quantifying crop biomass development and yield potential. (Alireza Pourreza)

From 2018-2021, one UC Cooperative Extension (UCCE) research project explored the viability of adopting drip irrigation for organic and conventional spinach production to reduce loss from disease and input costs. Field experiments were conducted at the UC Desert Research and Extension Center and three commercial fields in the low desert of California. An overall effect of the irrigation system on downy mildew was observed. The disease incidence was two-to-five times lower in plots irrigated by drip compared to sprinklers. The findings were shared with growers and stakeholders through several media interviews, presentations in workshops/webinars, and extension and peer-review publications. (Ali Montazar)

An innovative UCCE research project on using biosolids for fertilizer continued. The data from the trials have provided valuable insights into what growers can expect when they use biosolids as an occasional substitute for synthetic nitrogen fertilizers. The findings provide a general picture of how growers can use biosolids to reduce fertilizer costs, utilize local sources of macronutrients, minimize leaching, and improve nitrogen efficiency in certain conditions. In 2021, the new knowledge was extended through a virtual field day and presentations. (Konrad Mathesius)

UCCE on-farm workshops in the Sierra Foothills continue to teach practical skills and knowledge. Peer-to-peer sharing of knowledge and experiences at these workshops results in the rapid adoption of new practices. In addition, on-farm research on pruning and mulching in five citrus orchards continues to provide important data on the impacts of mulch on soil temperature and moisture, microbial activity, and the impacts of tree stress on fruit drop. New knowledge on how to manage mulch throughout the year has been developed. (Cindy Fake)

Another UCCE orchard management effort focuses on developing and promoting best practices, including genetic, cultural, and chemical practices to reduce tree damage and loss. This information was extended through popular press publications and the media; the latter mostly related to walnut freeze. (Luke Milliron)

The Botryosphaeriaceae fungi and Phomopsis species are now widely distributed in walnut orchards in almost all walnut-growing regions in California. In 2021, a new spray program starting at bloom time provided a significant disease reduction compared to the grower’s standard fungicide program. Research results will help walnut growers to avoid at least three fungicide sprays they were using at the wrong time, thus saving millions of dollars to the walnut industry and reducing the impact of pesticides on both human health and the environment. Further research is still ongoing to reduce the number of sprays. (Mohamed Nouri)

In the Central Valley, a UCCE research and extension project continued on rootstocks that can decrease boron toxicity. This came in response to growers asking how to properly manage this over-supplied, naturally occurring element in irrigation water, allowing more efficient use of California’s scarce water resources. Research findings were extended through local meetings and the statewide meeting hosted by the Almond Board of California, and an interview with an industry news outlet. (Katherine Jarvis-Shean)

UCCE led attendees through a multi-county field tour extension meeting: Tree Fruit Orchard Tour, High-Efficiency Tree Architecture and Harvest Aids for Cherries, Pears, and Apples. This field tour provided fruit growers the opportunity to see platform harvest aide equipment in action. (Kari Arnold)

A UCCE Advisor responded to a farm call about apricots in Stanislaus County, which contains the greatest acreage for apricots in California with approximately 4,000 acres. Apricots have minimal research-based information on rootstocks and incompatibility. Thus, a nursery requested UCCE conduct a study and donate the trees. The apricot rootstock trial showed that two rootstocks are not compatible with the Patterson apricot cultivar; thus, these rootstocks will not be recommended for use in future Patterson cultivar orchards. The research aims to save nurseries and growers the cost of removing trees and future yield loss by providing information on compatible rootstocks. (Kari Arnold)

In 2021, a UCCE study on grafted watermelon continued after a 1-year hiatus due to COVID. The research investigated and compared the impacts of reduced plant population on grafted watermelon yield, fruit quality, and economic gains with the traditional production pattern. The findings generated optimal plant spacing and rootstock-scion combinations that could consistently out-yield non-grafted plants and maximize economic revenues. This new information was disseminated via extension activities, and a scientific journal article is under development. (Zheng Wang)

A UCCE Advisor in the Sacramento-San Joaquin Delta has had an annual field corn variety trial since 2013 and is the only UC researcher to trial corn varieties statewide. She has developed expertise in corn nitrogen management and is the principal investigator on a project to test nitrogen stabilizer efficacy in improving plant nitrogen uptake and corn yield. (Michelle Leinfelder-Miles)

A UCCE Agronomy Advisor presented on getting the most fertilizer value from manure during the UC Golden State Dairy Management Webinar, and on using N-Rich Reference Zones to guide nitrogen fertilizer management for irrigated Triticale in the San Joaquin Valley during the UC Small Grains: Alfalfa/Forages Virtual Field Day. (Nicholas Clark)

UCCE continued analysis of the evolution of conservation easements in the Northeastern region of California. The impetus stemmed from the Sierra County Board of Supervisors’ concerns. A UCCE Advisor analyzed the terms of 38 deeded easements to develop a presentation that provided clarity for clientele on the value and drawbacks of selling a conservation easement on their land. Information has been provided to land trust staff and local agencies about restrictive easement language that can jeopardize the future viability of working landscapes. (Tracy Schohr)

As a result of UC ANR research and extension, participants learned and adopted agricultural management practices. Outcomes with specific indicators follow.

**Outcomes**

**Participants intend to adopt recommended practices for plant production.**

* Of the 112 participants in the UCCE agronomy virtual field event, 22 individuals identified as growers or industry professionals participated in a post-event evaluation survey and rated their knowledge about the topics presented before and after the presentations. Topics included information on UC's statewide small grain variety evaluations, webtools available on the UC Small Grains RIC, how to use N rich reference zones to guide in-season fertilizer management, and the potential for biosolids as a fertilizer in California small grain crops. Across these topics, individuals indicated an average increase in knowledge of 22% before and after the presentations. Depending on the topic, between 62% and 84% of respondents indicated that they would likely use the information presented in their work (77% on average across topics).(Mark Lundy)
* Pre- and post-education surveys were administered to determine the shift in mindset and potential changes in future industry practices to further adopt digital agriculture. Growers, managers, consultants, crop advisors, educators, and the research community improved knowledge about the factors that influence grower decision-making, robust and scalable aerial and/or ground-based sensing tools to assess crop health and productivity, and precision-agriculture principles for high-resolution data-driven crop management. A total of 205 responses were received from four surveys conducted during this reporting period. The survey results showed that all audiences reported 10-85% (51% on average) the training material improved their knowledge. (Alireza Pourreza)
* Nine fruit growers learned hands-on techniques at the Cover Crops, Mulch, and Vegetation management workshop and reported:
  + 42% increased knowledge of soil and organic matter management;
  + 56% plan to seed a cover crop, compost plant residues, and plant insectary plants;
  + 44% will mulch their orchards and include those nutrients in their nutrient management plan; and
  + 44% plan to monitor soil moisture under mulch and adjust irrigation appropriately. (Cindy Fake)
* Of the 25 beginning farmers who participated in the Understanding and Improving Foothill Soils workshop, 63% reported increased knowledge of soils and the ability to manage soils. (Cindy Fake)
* Of the grape growers who participated in the Grapevine Stress Workshop, 91% of survey respondents (n=28) stated the intention to change one or more practices as a result of the workshop. (Cindy Fake)
* Of the 80 citrus growers in the citrus-growing area of Placer and surrounding counties, 72% now consider using mulch as standard practice and appreciate the benefits it provides in the Sierra Foothills variable climate. (Cindy Fake)
* Direct interactions with approximately 20 growers in San Joaquin County showed they have already changed their production practices responsible for spreading fungal pathogens in walnut orchards. In addition, growers plan to follow the new spray program in their orchards to control Botryosphaeria/Phomopsis disease in walnuts. (Mohamed Nouri)
* Of the 23 agricultural industry participants at the UC Small Grains Virtual Field Day who took an evaluation survey, 65% indicated an increase in their knowledge pertaining to the use of biosolids. Sixty percent indicated they were likely to use biosolids as a soil amendment. Biosolids reduce grower fertilizer costs, provide a slow-release nitrogen source, reduce nitrate leaching, close nutrient cycles, and feed soil microbial communities. (Konrad Mathesius)
* The 20 attendees on the Tree Fruit Orchard Tour expressed an increased knowledge of harvest mechanization (average score 4.2 on a scale of 1 to 5, with 5 being very much). (Kari Arnold)
* The Stanislaus County apricot grower participating in the study learned two rootstocks were incompatible and thus not to grow those. If this grower had planted these available cultivars, now knowing they were incompatible, he would have had to remove these trees. According to the UC Davis tree loss calculator for peaches (apricot tree loss calculator not available), a 2-year-old peach tree was approximately worth $72 in replacement cost in 2009. If considering a 40-acre orchard consisting of 151 trees per acre, this would have cost $434,880 in replacement value. If considering all 4,000 acres of apricots in Stanislaus County, this would amount to $43,488,000. (Kari Arnold)
* Eighty-nine percent (17 of 19) of corn workshop survey respondents indicated that they learned useful information, and 15 intended to use what they learned in the next 12 months. (Michelle Leinfelder-Miles)
* Of the 41 attendees polled during the Dairy Management Webinar, 93% reported they gained information, and 90% said they would apply the information they gained. (Nicholas Clark)
* At the UC Small Grains Virtual Field Day, 22 poll respondents indicated gaining knowledge of how to use N-rich reference zone for in-season nitrogen fertilizer management in small grains. On average, respondents were very likely to use these learned practices in their commercial production. (Nick Clark)

**Participants adopted recommended practices for plant production.**

* Four growers and six researchers at UC Davis and UC ANR used the yield forecast technology in 2021. The insights from yield forecast technology help growers start thinking about field optimization to recover the low yield zones, avoid loss, and improve sustainability. Growers can estimate nitrogen and water demand per tree with a yield forecast map and manage accordingly. (Alireza Pourreza)
* One hundred and eighty-six specialty crop producers implemented one or more new soil management, water conservation, or pest management “best practices” on their farms. These include mulching, cover crops, nutrient management, soil moisture monitoring, irrigation scheduling, and pruning. These practices increase organic matter, build healthier soil, conserve water, and mitigate climate-change-induced plant stress. (Cindy Fake)

**Change in condition: Economic benefits.**

* As a result of participating in research trials, a cooperative grower reported a considerable cost reduction of $300 per acre in conventional spinach under drip irrigation due to less/no water treatment applications for downy mildew control. In addition, a lower energy cost of $200 per acre is estimated for spinach produced under drip irrigation. Such savings demonstrate that drip irrigation has the potential for producing more profitable and efficient spinach in the California crop production system. (Ali Montazar)
* Growers' adoption of grafted watermelon continued to increase, which provides economic benefits given a reduction of cost for grafted transplants by up to 35% and an increase of net income by up to $2,500 per acre. The gross planting area of grafted watermelons in California increased from less than 250 acres in 2018 to over 1,500 acres in 2021, and this number keeps growing. On average, growers reported that successfully grafted fields could produce 15-25% more watermelons than the non-grafted fields per acre using the same amount of water and fertilizers. In addition, the plant population in grafted fields is about two-thirds of that in non-grafted fields, which lowers growers' input costs. (Zheng Wang)
* Growers reported thousands of acres were not damaged in the November 2020 freeze because of adopted best practices to reduce tree damage and loss. (Luke Milliron)
* Two clientele were better informed and decided the terms of their easement under negotiation were overly burdensome and did not align with terms from other land trusts with easements in the region. They decided to not enter into the perpetual contract, thanking UCCE for educating their family on a long-term decision that would have had significant negative economic and management impacts on their ranching operation for future generations. (Tracy Schohr)
* Adoption of the almond rootstock for high-boron conditions has increased as measured by the sales of the best-suited rootstocks. The findings from the research trial suggest proper rootstock selection yields $3,871 more income per acre per year at prime production (2018 prices). Across the 5,000 acres of Yolo County's recent high-boron almond plantings, this is estimated to be a $20 million in annual increased yield. This value will grow as this research enables more almond orchards to be planted in these high boron areas. (Katherine Jarvis-Shean)
* One greenhouse manager explained the local economic benefit of UCCE helping connect local growers to local greenhouses. She has received orders to produce more than 500,000 grafted watermelon transplants, a total sale value of over $600,000, for the 2022 season, which is a 10-15 times increase compared to 2018 before the research and extension effort. Growers ordered all needed grafted plants from out-of-state nurseries in the past. California watermelon growers are now shifting transplant orders to local nurseries to save the shipping cost and prevent plant damage during long-distance transportation. (Zheng Wang)

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 the public value of promoting economic prosperity in California. Statewide the sales value generated by California agriculture continues to increase. As last measured by the California Department of Agriculture, the sales value increased by more than 1 percent between the 2018 and 2019 crop years.

**Endemic and Invasive Pests and Diseases**

**Issue**

Pests, diseases, and invasive plants decrease California’s agriculture efficiency and profitability. Eight to ten exotic arthropods are introduced to California annually, with nearly 20% developing into invasive pests. In agricultural systems, pests reduce yields, render crops unmarketable, and negatively impact revenues. For example, fungicide use for mitigating grapevine powdery mildew accounts for 90% of the environmental cost of grape production. As California’s population increases, crop production must increase to meet the greater food demands despite lagging resources for detection. (Monica Cooper) Science-based information is needed for growers, managers, and policymakers to develop practices and policies that sustain economic vitality while protecting environmental quality.

**Methods**

UC ANR conducts research and partners with public, governmental, and private groups to extend new knowledge and develop integrated pest management plans to increase agriculture efficiency and profitability.

*Viticulture & orchard systems*

A UC Cooperative Extension (UCCE) Farm Advisor in the Central Sierra region organized a highly successful “Airblast 2021 Conference: Optimizing Canopy Sprayers” 2-day for 270 pesticide applicators, supervisors, growers, licensed professional applicators, Pest Control Advisors and anyone involved in spray application decision making in the orchard or vineyard. The goal was to increase the knowledge and insight needed to assess and improve spray operations. A collaboration with UC ANR’s Program Support Unit supplied evaluation survey data with a 25% response rate. (Lynn Wunderlich)

UCCE took a network-based approach to address grapevine leafroll disease, one of grapevines' most economically consequential viral diseases worldwide. It causes negative impacts on plant health, fruit quality, and yield, equating to losses of $30,000 to $226,405 per hectare in California. The network-based approach disseminated best management practices and demonstrated the value of participatory research to disease management. (Monica Cooper)

A UCCE Specialist at UC Davis conducted research projects directly funded by the grape and wine industry in response to new issues and direct requests from industry members. Topics include limiting the impact of grapevine red blotch virus, causing a disease for which there is currently no mitigation. Findings are disseminated through extension programs. (Anita Oberholster)

A UCCE Advisor in Kern County continued to survey growers' vineyards and educate their staff about Pierce's Disease, which has plagued grapevines. For over a decade, this program has led to the monitoring of more than 1 million grapevines for Pierce's Disease and a mark and removal program that has resulted in the removal of tens of thousands of infected vines. (David Haviland) Additionally, UCCE Viticulture Advisors and Specialists conducted the Napa Grape Short Course, including field demonstrations. (Kari Arnold)

UCCE’s Walnut Workgroup teamed up to provide an online, two-day course in 2019 combining several regional walnut days into one online series called the UCCE Virtual Statewide Walnut Series. The agenda covered fertilizer, pruning methods, irrigation practices, pests, and diseases. The series was well attended via zoom, with over 200 attendees each day. (Kari Arnold, Mohamed Nouri, Elizabeth Fichtner) UCCE also organized and hosted Quad County Walnut Institute (QCWI) extension meetings in Stanislaus County and neighboring counties, with over 100 attendees at each annual meeting. (Kari Arnold, Mohamed Nouri, Kamyar Aram) Surveys were used to evaluate the outcomes of the virtual series and QCWI meetings. (Kari Arnold)

A UCCE Specialist at UC Riverside conducted research on plant-parasitic nematodes, key soil-borne pests that reduce the productivity of perennial crops, including the susceptibility of pistachio rootstocks. These studies supplement investigations on almond, stone fruit, grape, and walnut rootstocks. Information was extended to farm advisors, crop consultants, pest control advisors, and growers, who frequently asked questions about what nematode populations could harm new pistachio plantings when following crops that leave noticeable population densities of nematodes. (Andreas Westphal)

UCCE continued its research and extension efforts on brown marmorated stink bugs in Mendocino and Lake Counties. Trap sites were chosen where pear orchards were close to areas of high-volume human traffic to monitor places where BMSB would most likely be first introduced. In May of 2020, the very first two BMSB adults in Lake County’s history were found in two of UCCE’s traps funded by the California Pear Board. Findings were extended in industry presentations and a magazine article. (Cindy Kron)

One UC Riverside UCCE Specialist is the director of the California Citrus Clonal Protection Program (CCPP), which provides a safe mechanism for statewide introduction of different citrus varieties from any citrus-growing area of the world for research, variety improvement, or use by the commercial industry and citrus enthusiasts. (Georgios Vidalakis)

A UCCE Specialist at UC Davis located at UC ANR’s Kearney Agricultural Research and Extension Center operated a diagnostic lab. It extended science-based information at industry, farm advisors, workgroup meetings, and short courses in California. Attendees included growers, pest control advisors, farmers, field workers, and representatives of various agricultural industries. Topics included diagnosis and management of foliar, fruit, wood, and soilborne diseases affecting the fruit and nut crops. Research on almond canker diseases provided strong evidence that successful protection of almond trees from canker diseases can be achieved through a single application of a pruning wound protectant such as Topsin M® or Vintec right after pruning in January. (Florent Trouillas)

Topsin-M® was also studied in grapevines in the Coachella Valley by a UCCE Specialist at UC Riverside. For six years, vines were manually pruned during the winter. One-half of the vineyard was tractor sprayed Topsin® M 70WP, whereas the other half remained untreated. Disease incidence, the number of replaced vines, and total and marketable fruit yield were measured. Trunk diseases incidence was about twice as high in the untreated block compared to the treated block. The decrease in marketable fruit was even more significant, with a drop from 10 kg per vine in the treated block to 5 kg per vine in the untreated block.(Philippe Rolshausen)

*Agronomy & vegetable crops*

A UCCE Specialist at UC Davis conducted research on endemic and invasive pest management in lettuce, safflower, melon, cotton, alfalfa, and rice. Research findings were shared with industry boards, growers, pest control advisors, and state agencies via presentations, reports, meetings, and individual consultations. (Ian Grettenberger)

UCCE academics continued to conduct research and extension on rice management, specifically a pest called weedy rice, which can cause yield reductions of up to 80% and quality downgrades. Weedy rice is the same genus and species as cultivated rice; therefore, herbicides used in rice do not control it. UCCE conducted a survey of weedy rice infestation in California rice fields and extended best management practices through farm calls, newsletters, field days, and courses. If weedy rice is not addressed, farmers could be forced to fallow their fields using burndown herbicides such as glyphosate. Additionally, farmers could experience increased production costs and poor grain quality, which may “bruise” the good grain quality reputation of California rice, potentially affecting trade. (Luis Espino, Whitney Brim-DeForest). In another rice pest management project, UCCE continued to maintain an armyworm monitoring network using pheromone traps in locations across the rice production area of the Sacramento Valley. This includes an email alert system to share the results weekly with more than 500 clientele. (Luis Espino)

A UCCE Advisor runs a plant pathology laboratory at the UC ANR West Side REC to help provide clientele with quick diagnoses, build relationships, conduct applied research with clientele, and extend research-based mitigation strategies. Long-term UCCE research on white rot of garlic identified an approach that consistently reduced the damage done by this soilborne fungus: application of a fungicide at planting at the trench where the garlic planting material is dropped. (Tom Turini)

UC ANR scientists work on various strategies to help growers reduce yield losses. In response to injury and yield reductions after applications of Roundup to a variety of alfalfa called Roundup Ready alfalfa within the Scott Valley region, researchers investigated the reason for crop injury and agronomic practices to reduce the risk of yield losses. One study found that applying glyphosate when the crop is no taller than 2 inches and avoiding glyphosate applications before frost events resulted in no crop injury. Findings were presented at the Siskiyou County Pest Management Seminar and other county, state, and national events. (Giuliano Galdi, Thomas Getts, Rob Wilson) In another alfalfa project, UCCE examined eight different herbicides and their application timing to identify efficient and sustainable control of noxious weeds. (Giuliano Galdi)

A UCCE Advisor conducted research trials on pesticide efficacy on the European asparagus aphid for USDA’s Interregional Research Project No. 4 (IR-4) program. This program aids in registering pesticides on minor acreage and specialty crops. As older pesticides have been retired (disulfoton, chlorpyrifos), asparagus growers have been left with few options to control this highly damaging pest, which can result in the death of perennial asparagus crowns. (Brenna Aegerter)

A UCCE Specialist at UC Davis studied Verticillum dahliae, a disease to which lettuce was previously considered immune, but unfortunately became more prevalent after methyl bromide and chloropicrin use were discontinued. Affected lettuce fields have suffered near-total losses and commercially acceptable lettuce cultivars with resistance to Verticillium wilt are not yet available. Research was conducted to understand the biology of the pathogen and disease management. (Krishnamurthy Subbarao)

A UCCE Advisor researched beet leafhopper (BLH) and curly top virus (BCTV), a damaging insect and disease affecting processing tomato growers in the northern San Joaquin Valley and lower Sacramento Valley. Ten monitoring sites were established in Stanislaus County, covering a total of 2,200 acres of processing tomato fields. BLH population dynamics and BCTV incidence were monitored, and samples of BLH and infested tomato plants were collected from 22 monitored tomato fields. The research found that BLH preferred attacking plants near big gaps between plants and that replanting timely to close the gaps effectively reduced BLH feeding and BCTV incidence. Findings were shared widely with the tomato industry at extension educational meetings and were published in the [Progressive Crop Consultant](https://progressivecrop.com/magazine-archive/november-december-2021/). The advisor also identified processing tomato plants infected with Fusarium Race- 3 and provided information about the availability of resistant processing tomato varieties. (Zheng Wang)

A three-year project evaluating the novel insecticide, Verimark, consistently reduced beet curly top virus incidence in tomatoes. Under moderately high disease pressure, Verimark treated transplants yields were 32% higher than those untreated. (Tom Turini)

A UCCE Advisor in the Capitol Corridor region continued a long-term study on disease-resistant rootstocks of fresh market heirloom tomatoes. These are a cornerstone crop in the region, and many varieties lack resistance to soilborne diseases. This is a persistent and increasing issue for organic growers with few organic management options. Preliminary findings have been extended to growers through two extension meetings and several one-on-one conversations. (Margaret Lloyd)

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that increased agriculture efficiency and profitability. Outcomes with specific measured indicators follow.

**Outcomes**

**Participants gained knowledge of detection and control practices for invasive and endemic pests and diseases.**

* Pesticide applicators who attended the Airblast 2021 Conference indicated they learned something they can use in their work (97% of 69 respondents). In an open-ended question about intended behavior change, respondents mentioned calibrating (26%) and using water-sensitive paper (26%), which were key learning concepts for improving spray operations. (Lynn Wunderlich)
* Over half of the Napa Grape Short Course participants who responded to a survey agreed they would in some way consider changing the way they grow or manage vineyards. Attendees rated the meeting as high to very high value (average score 6.07 on a scale of 1 to 7, 1 being very low, 7 being very high). (Kari Arnold)
* When asked how likely UCCE Virtual Statewide Walnut Series participants are to implement practices discussed in these meetings, 91% responded mildly likely to highly likely.(Kari Arnold)
* QCWI attendees reported intended behavior change in the way walnuts are grown or managed (91%). (Kari Arnold)
* Pistachio growers increased their awareness of the susceptibility of pistachio rootstocks to nematodes and potential risks for plantings, as observed by UCCE. (Andreas Westphal)
* Clientele shared with UCCE their intent to follow recommendations for alfalfa weevil resistance management, increased understanding of using newer and more selective materials for management of cotton pests, increased knowledge of how to monitor and trap armyworms, increased knowledge of how drone applications of natural enemies can fit within leafy greens integrated pest management programs, and increased willingness to adopt novel monitoring and management tactics for cucumber beetles. (Ian Grettenberger)

**Participants adopted prevention and detection practices for invasive and endemic pests and diseases.**

* UCCE’s work on weedy rice has resulted in a change of attitude within the rice industry: from perceiving a weedy rice infestation as something to be kept secret, to realizing the high risk of this pest and willingness to share where infestations occur. This change has allowed UCCE’s field surveys to determine the extent (3,500 acres), severity, and location of all known weedy rice infestations, which will allow UCCE to evaluate the success of management practices that have been developed. (Luis Espino)
* The UCCE-maintained armyworm trapping network has successfully promoted field monitoring and management of armyworms, as reported by Sacramento Valley clientele. In 2021, the trapping network showed that armyworm pressure during 2021 was low, confirming clientele observations and aiding in the decision to skip treatment when appropriate. This resulted in savings of $25 per acre. (Luis Espino)

**Participants adopted recommended treatment and management practices for invasive and endemic pests and diseases.**

* Participants of the network-based approach to grapevine leafroll disease reported in a survey that 89.6% and 88.4% had adopted at least one management practice for leafroll and red blotch disease, respectively. Furthermore, a median of 4 out of 5 best practices were adopted for leafroll and 3 out of 6 for red blotch disease. Participatory research demonstrated the value of leafroll disease management at the individual and regional scale. As a result, leafroll disease severity and economic impacts have decreased significantly in Napa County. Stakeholders have "all the resources at my disposal at this point…[and are] not really spending a lot of money on leafroll management like we were ten years ago”. (Monica Cooper)
* Several growers have used UCCE's research-based information to inform decisions related to minimizing the impacts of grapevine red blotch disease through roguing (removing vines). Research outcomes showed that this mitigation action makes more sense for high quality red varieties than white grape varieties. Data indicated that the quality impact on whites is lower than reds, although both experience a decrease in yield. Producers have used the data to limit the removal of white grapevines. Additionally, about 10-20 wineries have changed their cleaning and sanitation protocols after receiving technical assistance after UCCE's extension events. (Anita Oberholster)
* During 2021, the Citrus Clonal Protection Program’s budwood system registered 2,273 new users for a total of 5,850 overall users. Over 1,000 users placed 1,411 orders for 92,050 buds of 369 different citrus varieties.Therefore, this project not only has achieved measurable behavior change but has also reduced the risk of people smuggling desirable citrus varieties into California. (Georgios Vidalakis)
* UCCE’s recommendations on disease control have been broadly adopted in the field based on feedback to UCCE from industry leaders and stakeholders. These include the use of Thiophanate-methyl as a standard practice to protect pruning wounds against canker pathogens in almonds**.** (Florent Trouillas)
* Three garlic processors have adopted UCCE’s recommended white rot fungicide and application method, which has been shown in replicated studies to reduce damage by as much as 68%. Most fields are not as severely infested as the trial site, and not every acre is infested, so a smaller benefit would be expected. Even with a reduction of damage by 1%, the savings to the garlic industry in Fresno County would be $3.6 million per year, based on the 2019 Fresno County Ag Commissioner’s Crop Report. (Tom Turini)
* The data from Processing Tomato Advisory Board and Processing Tomato Variety Guide indicate a remarkable increase to nearly 70 Fusarium wilt Race- 3 (Fol 3) resistance processing tomato varieties for the 2022 season, compared to only 12 in 2018. According to the state’s processing tomato production data in 2021, 46% of the total tonnage was harvested from Fol 3 resistance varieties compared to 12% in 2018. In Stanislaus County, 54.3% of the total tonnage was produced by Fol 3 resistance varieties in 2021 compared to 5.7% in 2018. UCCE recommendations are impacting the tomato industry and favoring the advancement of more resistant cultivars that maintain healthy and sustainable food production. (Zheng Wang)
* Tomato growershave adopted recommended transplant treatment in the highest risk areas in Kings County, as observed by UCCE. This has the potential to save growers $2.5 million per year, assuming moderately high pressure over 2,000 acres annually at the prices, and average yields in the 2020 Kings County Ag Commissioner’s Crop Production Report. There are several materials that have consistently performed similarly to the malathion standard, but there is need for at least one more season of data. (Tom Turini)

**Participants adopted strategies to maintain yields and reduce crop losses.**

* Results from the Roundup Ready Alfalfa trials generated information on the maximum crop height at the time of Roundup application to reduce the risk of crop injury followed by frost. In conversations with extension participant growers, approximately 50% utilized this information to prevent yield loss in the 2019 growing season. (Giuliano Galdi)
* The commercial alfalfa cooperator benefitted from participating in the UCCE field trial by experiencing a significant difference in crop injury. Crop injury six days after herbicide treatment ranged from 0-100% and then improved over time. At 47 days after treatment, crop injury ranged from 0-12.5%. Besides improving weed control, applying herbicide in a timely way increases growers' profitability and makes agriculture more sustainable by avoiding unnecessary herbicide applications. (Giuliano Galdi)

**Science-based information was applied to integrated pest management policy and decision-making.**

* Due to the brown marmorated stink bug discoveries in UCCE's traps, the Agricultural Commissioner's offices in Mendocino and Lake counties decided to fund the deployment of their own traps in urban areas of each county (three in Lake County, ten in Mendocino) to complement UCCE's trapping efforts in agricultural areas. This joint effort in county-wide trapping for BMSB increases the likelihood of early detection that can help prevent the establishment and economic damage. (Cindy Kron)
* Thanks to UCCE’s work, the biological control product Vintec was registered in California for use against canker diseases of almonds. (Florent Trouillas)
* UCCE’s European asparagus aphid research trials resulted in the new registration of sulfoxaflor, which will give growers an effective, reduced-risk option to control this pest. Additionally, this registration has been highlighted as an IR-4 Success Story. (Brenna Aegerter)
* Many seed companies utilized UCCE’s research to develop elite cultivars resistant to Verticillium wilt in lettuce. (Krishnamurthy Subbarao)

**Change in condition: Money saved.**

* Processing tomato growers adopted UCCE’s recommendations of replanting early in the season to reduce the chance of BLH feeding and BCTV infection. Some fields prevented up to $900 of losses per acre, an approximate yield reduction of 10 tons per acre, compared to growers' other fields that were not replanted.(Zheng Wang)
* The Capitol Corridor cooperating grower benefitted from participating in UCCE’s on-farm study in disease conditions as the seven UCCE recommended rootstocks produced economically viable disease protection. Additionally, extension of these initial findings has already prevented seven growers from abandoning tomato acreage, saving them thousands of dollars and preserving important marketing relationships for their whole business. (Margaret Lloyd)
* UCCE’s grapevine field trial in the Coachella Valley measured gains in net returns from spraying Topsin® M 70WP in year 2 and beyond. They ranged approximately between $210,000–310,000 per hectare over 25 years in a scenario of 50–75% disease control. This translates to a gain of approximately $8,500–$12,500 per hectare annually. This work provides a benchmark about the long-term benefits of adopting preventative pruning wounds protection on trunk disease incidence, vineyard productivity, and economic return. (Philippe Rolshausen)

**Change in condition: Reduced pest incidence.**

* The Pierce’s Disease extension and removal efforts in UCCE Kern County have contributed to a low incidence of Pierce’s disease county-wide, as indicated by data collected in UCCE’s vineyard surveys. (David Haviland)
* UCCE's extension efforts, collaborative relationships, and monitoring survey contributed to measured reductions in weedy rice infestations. Only 20% of previously known acreage was still infested with weedy rice, meaning that about 80% of the known acreage was no longer infested. Weedy rice can have a substantial economic impact on the rice industry in California, reducing yields for impacted growers. Results of the greenhouse studies indicated yield losses of over 70% at high densities. (Whitney Brim-DeForest)

These measured outcomes can improve the state’s ability to prevent, control, and mitigate pests and diseases and create new opportunities for economic sustainability. For example, using mating disruption to reduce navel orangeworm increased the crop value in almonds by more than $250 per acre, which is more than twice the cost of using the technique. In these ways, UC ANR contributes to increased agricultural efficiency and profitability and the public value of promoting economic prosperity in California.

## Condition Change: UC ANR contributed to increased emerging food economies and markets

**Issue**

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 the nation's major producer. Although California already has the most diverse agriculture in the nation, the search for new opportunities responds to ongoing challenges and does not stop. 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 farmers and ranchers to continually innovate to stay abreast of market forces. Small-scale and limited resource producers are more exposed to risks and susceptible to failure, thus needing different market opportunities. In addition, aquaculture is expanding in California like elsewhere. In 2018, worldwide farmed seafood exceeded that produced from wild-caught fisheries.

**Methods**

UC ANR develops new scientific knowledge and extended science-based information that helps create new food products and market opportunities.

A UC Cooperative Extension Specialist (UCCE) in Agricultural Economics at UC Davis conducted a project to evaluate the impacts of the COVID-19 pandemic on California agriculture. She composed a peer-reviewed article summarizing the initial impacts of the pandemic on California's produce and tree nut industries. She also produced a recorded webinar discussing the effects on the tree nut industries. One hundred and twelve people registered for the webinar, and the recording has been played hundreds of times since it was posted. The objective was for participants to increase their knowledge about how California's agricultural industries were impacted by the pandemic, which can improve the tree nut and other agricultural industries' abilities to deal with future supply chain shocks. (Brittney Goodrich)

A UCCE Specialist also at UC Davis collaboratively founded and manages a diverse network of academics, shellfish growers, resource managers, tribal members, and others from British Columbia to Baja California focused on native Olympia oyster restoration. The goal is to both improve the resilience of native oysters to climate change and to simultaneously develop a new small-scale commercial fishery for Olympia oysters. They are working through the details of the hatchery production of these native oysters. (Ted Grosholz)

Because of the San Joaquin Valley's changing climate, the well-known 'Bing' cherry is not performing well. A UCCE Pomology Specialist at UC Davis worked on some low-chill cherry cultivars with great flavor and an earlier market window than 'Bing'. These included 'Brooks,' 'Coral Champagne' and 'Tulare.' (Carlos Crisosto)

A UC ANR statewide Sustainable Agriculture Research and Education Program (SAREP) project built upon Yolo and Solano County farms' efforts to utilize the native western blue elderberry, grown in hedgerows, to create value-added products and incentivize planting of hedgerows. This native subspecies is well adapted to an extensive range of California microclimates, is drought and fire-resilient, and is often grown in multi-species native hedgerows, providing valuable ecosystem services to farmland. The project developed and extended information on hedgerow design, cost, management, growth, and yields. The team also conducted a market assessment and collaborated with food science colleagues to research the food chemistry composition of blue elderberry, a key component of the health-promoting properties of elderberries that motivate herbalists and other product makers to utilize them. They also met with three different California native tribes’ members to document their perspectives on elderberry management and use. (Sonja Brodt, Gwenael Engelskirchen)

As a result of UC ANR research and extension, participants utilized research-based information on emerging food economies and markets. Outcomes with specific indicators follow.

**Outcomes**

**Participants are trying out new market opportunities.**

* The two prominent shellfish growers in Marin County's Tomales Bay are testing growing the native Olympia oysters. There are thousands of these oysters now being raised in bags in the bay. The hope is that the native oysters will provide a new small fishery and support restoration by increasing the abundance of the local wild populations. This would be a win-win for both the market and the environment. (Ted Grosholz)
* An online survey was sent to an "Elderberry in California" listserv with over 330 subscribers, resulting in 17 responses (5% response rate). These reported activities took place in numerous locations around the state, concentrating on the Central Coast and in the Sacramento and San Joaquin Valleys. These reported activities can enhance economic development by selling lucrative, high-demand products and supporting emerging crops and markets.
  + 9 individuals planted blue elderberry in hedgerows and outside of hedgerows during this time period;
  + 9 maintained existing plantings;
  + 6 propagated blue elderberry, and four started planting, harvesting, and/or selling other subspecies of elderberry;
  + 3 started harvesting and selling blue elderberry products; and
  + 3 extension or technical service providers noted passing information on to their clientele who planted blue elderberry and/or harvested and sold blue elderberry products. (Sonja Brodt, Gwenael Engelskirchen)

**Science-based information was applied to agricultural markets policy and decision-making.**

* When the new cherry cultivars were first introduced, their lighter skin color at optimum maturity did not meet the ‘Bing’ USDA maturity color standard for shipment to high-value early export markets. However, the standards were changed after UCCE demonstrated to the USDA that the new cherry cultivars had high consumer acceptance and better long-distance shipping performance when picked at their optimum maturity. The ‘Coral Champagne’, ‘Brooks’ and ‘Tulare’ are becoming dominant California cherry cultivars, comprising 40% of acreage. (Carlos Crisosto)

These measured outcomes helped create new market opportunities, expanding revenue sources and strengthening local food systems and emerging food economies. For example, recent research (Brekken, et al., 2019) shows that food hubs have contributed to strengthening emerging food markets and improving small and midscale farmers' economic prosperity. In this way, UC ANR helps maintain the California food system's competitive edge and the state's role as a global leader in agriculture, contributing to the public value of promoting economic prosperity in California.

# SAFEGUARDING SUFFICIENT, SAFE, AND HEALTHY FOOD FOR ALL CALIFORNIANS

## Condition Change: UC ANR contributed to improved food safety

**Sustainable Food Systems**

**Issue**

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

**Methods**

In partnership with communities and allied organizations, UC ANR conducts research to design and deliver educational programs promoting improvement in farm and food system food safety.

UC Cooperative Extension (UCCE) Specialists in food safety located at UC Davis developed a food safety course to train inspectors employed by the California Department of Public Health Manufactured Cannabis Branch. The regulation developed for manufactured cannabis products (commonly referred to as edibles, including products such as tinctures, candies, chocolate, baked goods, teas, infused beverages, etc.) refers to components of existing food safety regulations but does not adopt any of these regulations directly. The Zoom training integrated traditional food safety training with the new manufactured cannabis regulation and was attended by 21 inspectors. To supplement the course, a web page on the UC Food Safety website was built dedicated to housing resources on manufactured cannabis to support inspectors and processors of manufactured cannabis products. (Erin DiCaprio, Linda Harris)

Several UCCE Specialists working in food safety and agronomy worked together to develop and deliver the California Farm Food Safety – Biological Soil Amendments of Animal Origin (BSAOO) e-learning series and the California Farm Food Safety – Production Agricultural Water e-learning series. Over 250 individuals registered, spanning industry, academia, regulatory or government, and growers. From the recorded sessions, 15–20-minute videos were developed and posted on YouTube. The eleven videos from the BSAAO series have been viewed 482 times, and the eleven videos from the production water series have been viewed 312 times. (Erin DiCaprio, Linda Harris, Alda Pires)

To support food safety compliance for small-scale culturally diverse growers in California, UCCE established a partnership with the California Department of Food and Agriculture (CDFA): the Produce Safety Technical Assistance Program. A website was developed including information on food safety in multiple languages (English, Spanish, Mandarin, Hmong, lu Mien), and six UC ANR Community Education Specialists were hired across four counties to support small farm food safety efforts with funding from CDFA. As part of this program, UCCE surveyed to determine the consumer preparation practices of Hispanic and Asian specialty crops, which received over 6000 responses. The goal of this survey was to use science-based information to give recommendations to the U.S. Food and Drug Administration (FDA) so that proper edits could be made to the food safety laws: FSMA Produce Safety Rule. We analyzed the data and presented findings to the FDA. (Erin DiCaprio, Aparna Gazula, Ruth Dahlquist-Willard, Ramiro Lobo, Margaret Lloyd, Qi Zhou)

Developing and implementing the required Food Safety Plans for the FSMA Preventive Controls Rule for Human Food can be very challenging, especially for small and very small processors and for processors. A UCCE project aims to bridge the knowledge gaps in food quality assurance and its connection to food safety that may hinder small processors from successful development and implementation of robust Food Safety Plans. The team developed a series of four webinars covering basic concepts, techniques, and programs in quality assurance and quality control. In addition, the webinars content was divided into nine high-quality videos that were uploaded to YouTube in September 2021. (Linda Harris, Erin DiCaprio)

UCCE continued work to increase Food Safety Modernization Act (FSMA) compliance for farmers from socially disadvantaged communities and improve food safety. Collaborating with the Santa Clara County Department of Planning and Development, four Food Safety workshops and one Agriculture Land Planning and Development workshop were conducted for small farms. Extension activities and materials were provided in both English and simplified Chinese. Also, a food safety video addressing the six most common troubling food safety areas noticed through on-farm visits to small farms was produced and translated into different languages, such as Chinese and Spanish, and shared with the socially disadvantaged farming communities. UCCE also cooperated with Cornell University Produce Safety Alliance and the University of Florida to host a 2-day Produce Safety Growers Training to help small farmers receive training and FSMA required food safety certification. Lastly, on-farm food safety assessments helped small farms prepare for upcoming CDFA FSMA inspections. (Qi Zhou)

As a result of UC ANR research and education, participants learned about and adopted farm, individual, and household food safety behaviors. Outcomes with specific indicators follow.

**Outcomes**

**Participants learned and intended to adopt farm food safety behaviors.**

* A retrospective pre-/post-test measured learning outcomes from the cannabis food safety training. Increases in knowledge were reported by the 21 participating California Department of Public Health inspectors on 1) different types of specific hazards (physical, chemical, and biological) associated with manufactured cannabis products; 2) components of and evaluation of the Hazard Analysis and Critical Control Point plans; 3) record requirements; and 4) food safety resources available. All 21 inspectors received certificates of completion for the course. (Erin DiCaprio, Linda Harris)
* A retrospective pre-/post-learning evaluation for the California Farm Food Safety – Biological Soil Amendments of Animal Origin (BSAOO) e-learning series showed increases in knowledge across the 114 participants in the live BSAAO sessions in key topic areas. These included risks associated with BSAAOs, definition of compost, and regulatory requirements. (Erin DiCaprio, Linda Harris, Alda Pires)
* A retrospective pre-/post-learning evaluation for the California Farm Food Safety – Production Agricultural Water e-learning series showed increases in knowledge across the 137 participants in the live agricultural production water sessions in key topic areas. These include risks associated with production agricultural water, testing requirements, treatment options, and regulatory requirements. (Erin DiCaprio, Linda Harris)
* A retrospective pre-post test was administered to the processed food safety webinar participants following attendance. All 151 participants reported an improvement in their understanding of key concepts after the webinar compared to before the webinar in all aspects presented. (Linda Harris, Erin DiCaprio)

**Participants adopted farm food safety behaviors.**

* As a result of the UCCE efforts, 79 small, socially disadvantaged farmers attended FSMA required Produce Safety Growers Training and received FSMA required certification. (Qi Zhou)
* Identified through follow-up on-farm visits, 21 small farms started adopting farm food safety behaviors, including monitoring wildlife and domestic animal activities; not harvesting contaminated produce; maintaining good personal hygiene during working activities by washing hands frequently and thoroughly; not eating or smoking in the production field and cleaning up trash; making sure the storage cardboard boxes (vegetable containers) are covered and off the ground; collecting records/documents for qualified exemption; attaching FSMA required labels on the boxes. (Qi Zhou)

**Science-based information was applied to farm food safety policy and decision-making.**

* The survey data was used in an FDA comment letter drafted in collaboration with the National Sustainable Agriculture Coalition to consider the inclusion of a number of these crops on the "Rarely Consumed Raw List," which would exempt growers of these crops from the FSMA Produce Safety Rule. Upon review of the comment letter, UCCE was invited to present the data to FDA in summer 2021 to advocate for the addition of 14 of the crops to the "Rarely Consumed Raw List." (Erin DiCaprio, Aparna Gazula, Ruth Dahlquist-Willard, Ramiro Lobo, Margaret Lloyd, Qi Zhou)

These measured outcomes demonstrate improved knowledge and skills around individual and household and farm food safety practices that can decrease foodborne illness and highlight UC ANR's leadership in addressing natural events and environmental issues that impact food safety. In this way, UC ANR contributes to the public value of safeguarding sufficient, safe, and healthy food for all Californians.

**Healthy Families and Communities**

**Issue**

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, communities, and public health. Furthermore, the Center for Disease Control and Prevention estimates that one in six people get sick from foodborne diseases each year, including 128,000 hospitalizations.

**Methods**

In partnership with communities and allied organizations, UC ANR conducts research to design and deliver educational programs promoting improvement in individual and household food safety practices.

UC ANR statewide programs conducted extension activities about individual and household food safety. UC Cooperative Extension (UCCE) academics provided oversight, leadership, and guidance for the statewide implementation of the UC 4-H Youth Development Program, CalFresh Healthy Living, University of California program (CFHL, UC) and Expanded Food and Nutrition Education Program (EFNEP), and the UC Master Food Preserver statewide programs, which delivered the food safety education. (UC 4-H; CFHL, UC; EFNEP)

UC 4-H also conducts the Cooking Academy series, which provides youth development guidance for a teens-as-teachers approach for healthy eating and food preparation techniques to be delivered to other youth in the community. (UC 4-H)

As a result of UC ANR research and education, participants learned about and adopted individual and household food safety behaviors. Outcomes with specific indicators follow.

**Outcomes**

**Participants learned about home food safety practices.**

* 233 4-H youth statewide responded to the Healthy Living common measures survey, and 76% of youth reported knowing how to keep a cooking area clean to stop the spreading of germs due to what they may have learned at 4-H. (UC 4-H)
* In Alameda and Contra Costa counties, over 3,500 students participate in Youth EFNEP programming, which has been adapted to an asynchronous online learning format. A survey of 374 K-8th grade students showed that 50% percent of Contra Costa County respondents and 38% of Alameda County respondents reported improved food safety skills. (Marisa Neelon)

**Participants adopted home food safety practices.**

* EFNEP surveyed over 1,400 participants, and 84% of adult participants showed improvement in one or more food safety practices, such as washing hands before preparing food or using a meat thermometer, as a result of participating in the program. Out of 218 youth EFNEP participants, 57% reported washing fruit and vegetables before eating and 64% reported putting cold foods back in the refrigerator within two hours, as a result of participating in the program. (EFNEP) Local EFNEP outcomes include:
  + Out of 248 parents that graduated from the virtual *UCCE Connects to You!* series from EFNEP in Alameda and Contra Costa counties, 80% and 75% respectively showed improvement in one or more food safety practices (washing hands and food prep surfaces; thawing foods properly; using a meat thermometer to cook meat to a safe temperature). (Marisa Neelon)
  + In Los Angeles County, 80% of 268 EFNEP adult participants improved in one or more food safety practices. In Orange County, this figure increased to 94% of 108 participants. In the EFNEP youth program in Los Angeles, 55% of 195 youth surveyed use safe food handling practices more often. (Natalie Price)
* In Sacramento County, 16 teens delivered the 4-H Virtual Cooking Academy every other week for 12 weeks to elementary-aged students attending five different “day camps” in Elk Grove Unified School District. Follow-up surveys showed that 55% of student participants used safe food handling practices more often, 47% percent improved at putting cold foods back in the refrigerator, and 45% improved at washing fruits and vegetables. Additionally, 89% of teen teachers reported knowing how to keep a cooking area clean and make changes to a recipe. (Marianne Bird)

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

## Condition Change: UC ANR contributed to improved food security

**Issue**

One out of ten Californians does not know where their next meal will come from. Of the four million Californians struggling with food insecurity, 1.2 million are children. Food insecurity for youth increases school absences and behavioral problems and reduces children's concentration and academic achievement. There is an ongoing need to increase participation in the CalFresh (SNAP) benefits program and connect families to additional resources such as the Women, Infants, and Children (WIC), USDA's Summer Food Service Program, and the broader charitable food network. As COVID-related shutdowns and economic challenges persist into a second year, these programs are a cornerstone for families' food security and physical health.

**Methods**

In partnership with communities and allied organizations, UC ANR conducts research to design and deliver educational programs that promote individual and household food budget practices and overall food security.

UC ANR's statewide programs provide academic oversight and local implementation of the Expanded Food and Nutrition Education Program (EFNEP), CalFresh Healthy Living, UC (CFHL, UC), the Master Gardener Program, and the Master Food Preserver Program. EFNEP and CFHL, UC use evidence-based curricula to deliver direct education on food security to participants across California. For example, in Alameda, Contra Costa, San Bernardino and Kern counties, EFNEP and CalFresh Healthy Living, UCCE educators provided a ten-part virtual series, UCCE Connects to You, in English and Spanish. Lessons focused on strategies to stretch the household food budget and provided information on COVID-19 related emergency food assistance programs. Some programs also demonstrated recipes for the food items parents received from local distribution programs. (CFHL, UC, EFNEP, Marisa Neelon, Chutima Ganthavorn)

A UCCE collaborative agriculture effort in community food security, specialty crops, orchards, and small farms worked with small growers in cities or at the edge of cities selling or distributing food produced in backyards, vacant lots, school gardens, and community gardens. UCCE Advisors co-organized a two-part workshop on orchard management for 49 local producers. Before the pandemic, the Second Harvest of Silicon Valley Food Bank estimated that one in four residents was at risk of hunger after the region's high cost of living was taken into account. During the pandemic, food insecurity increased, doubling the quantity of food and the number of people served by the food bank and its partners. (Lucy Diekmann, Kamyar Aram, Aparna Gazula, Phoebe Gordon)

To increase access to farmers market incentive programs and address barriers, UCCE in San Luis Obispo County convened partners through the EBT at Farmers Markets working group of the San Luis Obispo Food System Coalition. The workgroup includes partners from multiple sectors, including agriculture, government, private industry, and community-based organizations. The workgroup aims to increase the use of CalFresh at farmers markets to create equitable access to healthy food and support for local farmers. Partners collaborated to increase the visibility of farmers market incentives through social media, text messaging, materials distribution to local client-serving organizations, press releases, paid advertisements, and promotion at local food bank distributions and farmers markets. The workgroup applied for and received $30,000 in funding from the Danone Foundation to pilot a Farmers Market Navigator program to increase access to farmers market incentives among Hispanic and Latino customers who use CalFresh. (Katherine Soule, Shannon Klisch, Emily Dimond, Rosa Vargas)

A UCCE Specialist at UC Berkeley continued researching the impact of a nutrition course with an integrated teaching kitchen implemented in the college setting. Their study used a pre-post model to evaluate its effects on food security, nutrition, and students' self-efficacy related to food preparation and cooking. This year they improved the study design to include a comparison group (students who are not taking the class) in addition to the intervention group. In-person measurements of skin carotenoid as a biomarker of fruits and vegetable intake and blood pressure are being collected. (Susana Matias)

As a result of UC ANR research and extension, changes were made that lead to improved food security. Outcomes with specific indicators follow.

**Outcomes**

**Participants learned how to increase food resources.**

* Out of 248 parents that graduated from the virtual *UCCE Connects to You* series from EFNEP in Alameda and Contra Costa counties, 17% and 21% in those counties respectively improved in one or more food security indicators such as having enough money to buy food and having enough food to eat. (Marisa Neelon)
* Out of 128 JobTrain students in San Mateo County who participated in Plan, Shop, Save, Cook (PSSC) workshops with CFHL UC, 88% reported improvements, ranging from comparing unit prices more often (43%) to reading/using nutrition facts labels more often (60%). In addition, 28% of participants reported running out of food less often before the end of the month, suggesting they were more food secure after taking the course. (Andra Nicoli, Mary Vollinger, Laura Vollmer, Elaine Silvers, Aileen Trujillo)
* Local producers who attended the UCCE series on orchards reported learning about orchard pests and diseases as well as nutrient, irrigation, and weed management, cover cropping, and compost application. This new knowledge about urban agriculture and local food production can help contribute to food security, access to healthy foods, and community resilience. (Lucy Diekmann, Kamyar Aram, Aparna Gazula, Phoebe Gordon)

**Participants adopted growing practices that contribute to increased access to fresh produce.**

* 52% percent of 830 members of the public who participated in UC Master Gardener volunteer-led public education events reported that they applied gardening practices that reduced food loss in a statewide follow-up survey. Additionally, 11% of 825 members of the public donated produce to community programs that distribute food to individuals in need of food assistance. (UC Master Gardener Program)
  + In Ventura County, over 450 pounds of fruits and vegetables harvested from Master Gardener sites were donated to local hunger relief agencies. (Jim Downer)

**Change in condition: Improved food security**

* EFNEP surveyed nearly 1,400 participants statewide, and 13% of those adult respondents showed improvement in one or more food security indicators such as not eating less than you wanted so there was more food for your family or having enough money to get food for your family. (EFNEP)
* Of the 42 parents who participated in CFHL, UCCE Kern County programming, 30 parents participated in a post-survey. After attending the PSSC class series, 33% reported running out of food before the end of the month less often, indicating an improvement in families' food security. Ninety percent reported improvement in at least one of five food resource management behaviors (plan, prices, shop, think, facts). (Beatriz Rojas)
* Out of 216 study participants in the nutrition and cooking course study at UC Berkeley, 171 completed pre-and post- food security survey data. Respondents showed statistically significant improvements in food security, increasing those who indicated they were “food secure” at follow-up by 44%. The number of respondents indicating “very low food security” also decreased by 76%. Findings from the original evaluation study were published in two manuscripts in peer review journals in 2021. (Susana Matias)
* CFHL, UCCE in San Luis Obispo worked with extenders, schoolteachers, and staff at partnering school sites to harvest over 1,600 pounds of produce from school gardens. Produce was donated to school meal programs and local food pantries. (Katherine Soule, Shannon Klisch, Abbi Marrs)
* Since UCCE San Luis Obispo started convening the EBT at Farmers Markets workgroup, they have seen a 171% increase in CalFresh and Market Match redemption between 2017-2021, with a 49% increase occurring between 2020-2021. This has generated $386,000 in direct income to local farmers and farmers markets. In addition, the workgroup has supported two additional markets in launching their Market Match program and has advocated for and achieved a regional standard incentive amount of $15 from Paso Robles in northern San Luis Obispo County to Lompoc in northern Santa Barbara County. This regional standard simplifies communication to low-income clientele and ensures a meaningful and standardized food budget when clients shop at local farmers markets. (Katherine Soule, Shannon Klisch, Emily Dimond, Rosa Vargas)

These measured outcomes showed learning and behavioral changes related to food resource management and informed decision-making that can lead to food policy changes at the local and state levels. They also demonstrate how UC's network of researchers and educators participate in cross-sector collaboration to address emerging food security issues. In this way, UC ANR's efforts contribute to the public value of safeguarding sufficient, safe, and healthy food for all Californians.

# DEVELOPING A QUALIFIED WORKFORCE FOR CALIFORNIA

## Condition Change: UC ANR contributed to increased workforce retention and competency

**Issue**

California requires a highly skilled workforce to remain 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, in youth education and obesity prevention, two areas where California ranks among the worst in the country. Technological advances have reduced manual labor in agriculture but increased the need for skilled labor. Projections for near-future retirements of people working in California's agricultural production, marketing, and post-harvest handling sectors indicate severe re-staffing needs. The California Agricultural Vision statement of CDFA (2017) strongly recognizes the critical need to equip the next generation of agricultural workers. Landscape management professionals are also in need of training; California's landscaping services is a $9 billion industry.

**Methods**

UC ANR’s extensive network links campuses and communities across California to develop information and tools needed to train workers within educational settings and urban, agricultural, and natural resource communities.

UCCE academics provided oversight, leadership, and guidance for the statewide implementation of the UC 4-H Youth Development (UC 4-H) statewide program, which conducts research and extends new knowledge to youth development professionals. (UC 4-H) UCCE academics trained afterschool staff and teen teachers in 4-H Water Wizards, computer science, and experiential learning methods. Once schools and recreation centers closed due to COVID-19, programs adapted meetings, lessons, and youth field trips to take place virtually.

Academics at UC ANR’s Nutrition Policy Institute (NPI) work with the California Department of Public Health (CDPH) to help local health departments meet federal program evaluation requirements through overseeing the PEARS activity tracking system used by federally funded nutrition education programs nationwide. In prior years, they have assisted in training and onboarding for the reporting system. In FY 2021, they helped CDPH dive deeper into issues related to COVID-19 program implementation and continuous improvement of PEARS to capture local health departments’ innovative and wide-ranging efforts. (Carolyn Rider, Janice Kao, Evan Talmage, Christina Becker)

Last year (FY 2020), NPI helped provide beta-testing and training on Site Level Assessment Questionnaires (SLAQs) for statewide evaluation use across settings such as K-12 schools, early childcare, and retail to examine policies and practices related to nutrition and physical activity. During FY 2021, their efforts focused on continuing to test, revise, improve, and train agencies on using the SLAQs and on capturing pandemic-related setbacks to CFHL programming. (Janice Kao, Carolyn Rider, Gail Woodward-Lopez, Amanda Linares, Christina Becker)

NPI developed new mini-training tutorials for using the Eating and Activity Tool for Students (EATS), which measures the impact of direct education and PSE supported by local health departments. These 2–5-minute tutorials were intended to provide easy access for practitioners to the most important components of survey administration and project record-keeping in school settings. Their team also developed an online EATS survey to help LHDs evaluate these activities as schools transitioned to virtual and asynchronous learning environments during the COVID-19 pandemic. (Amanda Linares)

UC Cooperative Extension (UCCE) helped develop a new exam for the updated California Nitrogen Management Specialty Program for California-based Certified Crop Advisers who desire to provide nitrogen management planning services for their clients. This included identifying competency areas and respective performance objectives and drafting questions. (Doug Parker, Patrick Brown, Daniel Geisseler, Dan Munk, Allan Fulton, Sat Darshan Khalsa, Ben Faber, Khaled Bali, Katherine Jarvis-Shean, Michael Cahn, Sarah Light, Mae Culumber, Phoebe Gordon, Luke Milliron, George Zhuang, Nick Clark, Andre Biscaro, Michelle Leinfelder-Miles)

A UCCE Agronomy Advisor presented on using N-Rich Reference Zones to guide nitrogen fertilizer management for irrigated Triticale in the San Joaquin Valley during the UC Small Grains and: Alfalfa/Forages Virtual Field Day. (Nick Clark)

UCCE Advisors hosted the California Statewide Pear Research Webinar after converting it to a two half-day virtual format due to the COVID-19 pandemic. The program reached 71 attendees on the first day and 73 on the second day, with 77% of registrants seeking continuing education units. Post-webinar quiz information was sent to the Department of Pesticide Regulations to award the continuing education units to attendees. (Cindy Kron, Rachel Elkins)

A UCCE Advisor converted the North Coast Integrated Pest Management Seminar into a two half-day virtual format. The seminar offered educational presentations, daily quizzes, and continuing education units from the Department of Pesticide Regulations. The program reached 145 attendees on the first day and 143 on the second day, with 80% of registrations seeking continuing education units. (Cindy Kron)

A UCCE Advisor in Plumas and Sierra Counties and a UCCE Specialist at the UC Davis School of Veterinary Medicine hosted Cattleman’s Clinic webinar series with over 330 attendees. This series was a continuation of a highly rated course offered every three years about livestock, rangeland management, and economics and coincides with Beef Quality Assurance Certification terms. In 2021, this course pivoted to a webinar series in 2021 due to the COVID-19 pandemic. (Tracy Schohr and Gaby Maier)

A UC Cooperative Extension (UCCE) Advisor in San Luis Obispo co-organized the 2021 “Pest Management in the Garden/ Landscape” webinar series in English and Spanish that consisted of six and eight (two-hour educational webinars, respectively. A total of 230 individuals attended the Zoom webinars, which were pivoted from in-person meetings due to the COVID-10 pandemic. (Chris Greer)

UC ANR's Informatics and Geographic Information Systems (IGIS) continued to extend information about cutting-edge geospatial technology. While the primary audience of IGIS is internal UC ANR employees, their trainings also reached partner organizations, state and local governments, growers, and other public groups in California. Based upon a sample of 531 recent virtual workshop registrations, workshop participants consisted of approximately 38% UC and non-UC students, 24% non-UC campus-based staff and academics, 17% UC ANR staff and academics, 6% from the private sector, 4% UC affiliate volunteers, 4% non-governmental or non-profit organizations, 4% international attendees, and 3% governmental employees. In coordination with UC ANR's Program Support Unit, post-workshop surveys were sent to training participants, and 140 responses were received. (Sean Hogan)

At UC ANR's Hopland Research and Extension Center, one UCCE Advisor and industry collaborators offered for the 27th year. Sheep shearers are rare in the United States; this course teaches students the method of shearing to get the fleece off in one piece and how to sort out the lower quality belly wool. The students also learned about the equipment and maintenance, in addition to sheep and range production topics, so that they can be extenders of information from this program. In 2021, the online registration for the 30 student slots was filled within two minutes of going live, demonstrating the need for these types of educational resources. Each year, students are surveyed on the course and its short-term learning impacts. (John Harper)

UCCE’s Integrated Pest Management Breakfast meetings have been attended by clientele for many years. Participants received continuing education credits for required licenses and expressed frequent gratitude for the meetings. Many clientele requested to be added to another Extension effort, the Weekly Crop Water Use Reports email list and expressed appreciation for the irrigation guidance. (Kari Arnold)

UCCE also helps prepare the future agricultural workforce. UCCE in Napa County and the Sonoma-Marin Fairgrounds co-hosted a Youth Animal Science Drive-Thru event designed to educate youth (and their adult leaders, teachers, and mentors) about livestock animal production in the areas of beef cattle, dairy cattle, small ruminants (sheep and goats), and poultry. Each track had five interactive stations designed to highlight various topics, including biosecurity, production, husbandry, welfare, ecosystem services, nutrition, food safety, and an additional station covering fire preparedness. Speakers included members of UC Cooperative Extension, Santa Rosa Junior College, Sonoma Marin Cattlewomen, North Bay Dairy Women, Sonoma-Marin, and Napa County Young Farmers and Ranchers, Halter Project, and 4-H leaders and members. (Steven Worker, Suzanne Amaral)

A UCCE Specialist at UC Riverside (UCR) and collaborators continued to deliver the Annual UCR Urban Pest Management Conference for pest management professionals, pesticide and environmental regulators, and pesticide companies to provide up-to-date scientific, technical, and regulatory information related to urban pests. (Dong-Hwan Choe)

As a result of UC ANR research and extension efforts, participants learned skills and adopted strategies to improve workforce competency.

**Outcomes**

**Participants learned agricultural production management competencies.**

* So far, 57 people registered for the new exam with a 90% pass rate. A California Certified Crop Adviser must pass the California Nitrogen Management Specialty exam before being eligible to certify Irrigation and Nitrogen Management Plans for clients. (Doug Parker, Patrick Brown, Daniel Geisseler, Dan Munk, Allan Fulton, Sat Darshan Khalsa, Ben Faber, Khaled Bali, Katherine Jarvis-Shean, Michael Cahn, Sarah Light Mae Culumber, Phoebe Gordon, Luke Milliron, George Zhuang, Nick Clark, Andre Biscaro, Michelle Leinfelder-Miles)
* Of the 112 attendees at the Alfalfa/Forages Virtual Field Day up to 45 attendees earned continuing education units. (Nick Clark)
* Pear Research Webinar participants indicated in a survey (n=50) that they gained new knowledge about pear diseases and pear pests (over 92%) and planned to implement the knowledge gained from attending the webinar (86%). Additionally, certificate or license holders with the Department of Pesticide Regulations received continuing education units. (Cindy Kron)
* North Coast Integrated Pest Management Seminar participants indicated in a post-seminar survey (n=66) that they gained new knowledge about grapevine diseases and grapevine pests (over 98%) and plan to implement knowledge gained into their IPM programs (89%). (Cindy Kron)
* Cattleman’s Clinic webinar participants increased knowledge of beef quality assurance, beef carcass quality, parasites, and foothill abortion, as demonstrated by 240 attendees passing a post webinar quiz. Furthermore, participants obtained industry-recognized Beef Quality Assurance certificates during the COVID-19 pandemic. (Tracy Schohr, Gaby Maier)
* Out of 130 youth that attended the Animal Science Drive-Thru event, 100% agreed that the various learning tracks improved their knowledge of an animal science-related topic. (Steven Worker)

**Participants gained new skills in agricultural production.**

* After participating in UCCE’s sheep shearing course, 48% percent said that the instruction provided them with more knowledge and skills than they expected. Twenty-eight students completed the course, with three mastering the skill set sufficiently to receive Intermediate Certification. (John Harper)
* When surveyed in 2021, 82% of Integrated Pest Management Breakfast meeting attendees claimed they adopted one or more practices discussed in these meetings (pruning, young tree management, crop water use reports for irrigation management, use of Integrated Pest Management tools such as traps leaf/nut sampling degree days timing sprays etc., rotating modes of action to reduce resistant pest/disease populations, vertebrate/rodent pest management, weed management, nematode management, disease management, effective use of nutrients/fertilizers, and orchard design), and observed little to high improvement in their practice. (Kari Arnold)

**Participants gained landscape management competencies.**

* Over 95% of the “Pest Management in the Garden/ Landscape” webinar participants indicated they gained useful information from the webinars. Additionally, participants acquired the continuing education units needed to renew their California Department of Pesticide Regulation Maintenance Gardener License and appropriately and safely implement effective pest management programs when needed. (Chris Greer)

**Participants learned new, practical informatics and GIS technology.**

* Participants learned new subject matter IGIS workshop evaluations (n=140), which revealed that internal and external participants increased knowledge of the geospatial technology and other subject matter. On a scale from 1 to 5, attendees self-reported an average rating of 1.8 on subject matter knowledge before the workshop and an average rating of 3 after the workshop. The median evaluation scores for all workshops were consistently 5 out of 5. (Sean Hogan)

**Participants intend to improve urban pest management.**

* UCR Urban Pest Management Conference participants reported in a survey (n = 271) that they intend to apply at least one thing learned in urban pest management. On a scale from 1 for strongly disagree to 5 for strongly agree, the average response was 4.9. (Dong-Hwan Choe)

The measured outcomes reported above demonstrate changes in learning and improvements in how participants work. Youth development professionals, nutrition educators, decision-makers, growers, and land managers learned cutting-edge skills that increase workforce retention and competency. A [2007 World Bank study](https://openknowledge.worldbank.org/handle/10986/5990) determined the effects of agricultural education and training on agricultural productivity, including enhanced worker productivity, increased grower abilities to choose prime combinations of inputs and outputs, and increased grower capacity to innovate and adopt new technologies. Developing a more qualified agricultural production and landscape management workforce contributes to poverty reduction for smallholders and other marginalized groups, facilitating interaction with commercial markets. In this way, UC ANR contributes to increasing workforce competency and the public value of developing a qualified workforce in California.

## Condition Change: UC ANR contributed to increased effective public leaders

**Issue**

According to data from the United Nations, half of the world's population was under 25 years old in 2019. Just one year prior, 61% of U.S.-based Pew Research respondents stated that "significant changes" are needed in the American government's fundamental "design and structure" to make it work for current times. This global majority of young people must be prepared to provide leadership in a dynamic and changing world, with emerging issues such as climate change and increasingly complex political, social, and economic challenges. The COVID-19 pandemic has also posed serious challenges to global, national, and local leaders and highlighted the importance of community leadership and resilience.

**Methods**

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 Cooperative Extension (UCCE) academics provided oversight, leadership, and guidance for the statewide implementation of the UC 4-H Youth Development Program (UC 4-H). Program activities like Project 4H20, Mindful Me, Cooking Academy, Healthy Choices in Motion, and 4-H Student Advisory Nutrition Councils (4-H SNAC Club) empowered youth to take on leadership roles in research, teaching, and service-learning projects to improve their communities. (UC 4-H)

UC 4-H conducted a Public Speaking Confidence Study. However, while 4-H has a robust public speaking program, what influences youth's communication confidence has yet to be explored. The statewide study took place in 2020 and 2021, exploring what 4-H members report as their communication confidence and the role that California 4-H plays in building that confidence. (Nicole Marshall-Wheeler)

UC 4-H in Colusa and Sutter-Yuba Counties held 4-H Officer Trainings that featured programming and guest speakers for 4-H Community Club Program youth leaders. (Nicole Marshall-Wheeler)

As a result of UC ANR research and educational efforts, youth participants learned and applied scientific methods, leadership, presentation, and advocacy skills. Outcomes with specific indicators follow.

**Outcomes**

**Participants felt more confident in their leadership skills.**

* The 175 youth who participated in the 4-H Public Speaking Confidence Study reported being highly confident in their communication abilities. 4-H professionals and 4-H adult volunteers will use this finding to inform future decisions about 4-H presentation and communication opportunities. (Nicole Marshall-Wheeler)
* The 51 youth who attended 4-H Officer Training in Colusa and Sutter-Yuba counties reported they better understood their officer duties after attending the training (16% before vs. 84% after) and felt more prepared to successfully complete those duties and feeling more connected to their fellow 4-H officers. Additionally, 75% of participants reported feeling excited to be a 4-H club officer and hold a leadership role after attending Officer Training. (Nicole Marshall-Wheeler)

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

* Over 301 4-H youth responded to the universal positive youth development common measures survey, and 56% of youth report having leadership skills, including the ability to communicate in a group (41%) and being comfortable working in a group (63%) as a result of what they may have learned at 4-H. (UC 4-H)
* In Sacramento County, sixteen teens delivered the 4-H Virtual Cooking Academy every other week for 12 weeks to elementary-aged students attending five different “day camps” in Elk Grove Unified School District. Teens reported growth in all leadership areas, especially in leading group discussions, planning, and teaching others. (Marianne Bird)
* In Colusa, Sutter, and Yuba Counties, 4-H collaborated with CFHL, UC on their Cooking Academy series, where 13 teen teachers served 273 youth across 16 sites. Teen teachers reported an increase in leadership and communication skills following their teaching experience with Cooking Academy. For example, 92% of teen teachers reported good or excellent ability in leading group discussions after being a teen teacher, compared to 54% before the teen teacher experience. Similarly, 100% of teens reported good or excellent ability in working as a team member after being a teen teacher, compared to 69% before the teen teacher experience. (Nicole Marshall-Wheeler)

These measured outcomes demonstrated that leadership skills were learned and applied for the benefit of local California communities. Research findings published in the 2018 Health Education & Behavior journal indicate that involvement in youth participatory action research such as the projects described above can lead to positive leadership, academic, and career outcomes. In this way, UC ANR contributes to the public value of developing a qualified workforce for California.

## Condition Change: UC ANR contributed to improved college readiness and access

**Issue**

California requires a highly skilled workforce to remain competitive, prosperous, and an innovative global leader. According to the [National Center of Education Statistics](https://nces.ed.gov/), California’s 85% graduation rate lagged slightly behind the national rate of 86% in 2019-20. Improved college readiness and access can contribute to the development of a qualified workforce for California and a robust and thriving state economy.

**Methods**

UC ANR’s youth and community development programs equip the next generation for college and successful careers.

UC Cooperative Extension (UCCE) academics provide oversight, leadership, and guidance for the statewide implementation of the UC 4-H Youth Development Program (UC 4-H), which reached nearly 49,000 youth and had over 6,700 adult volunteers contributing nearly 1.2 million hours. Program activities like *Project 4H20, Mindful Me, Healthy Choices in Motion*, and 4-H Student Advisory Nutrition Councils (4-H SNAC Club) empowered youth to take on leadership roles in research, teaching, and service-learning projects to improve their communities. (UC 4-H)

In response to the pandemic and the need and opportunity to address college and career readiness, 4-H Career Spark Interviews (CSI) provided 21 weekly webinars to youth, highlighting different careers with successful Millennial Professionals. CSI webinars were coordinated by Educators in UC and Idaho 4-H. Professional millennials were interviewed by college students, sharing their experiences and advice. A diverse panel of professionals was selected so that youth from various backgrounds could see themselves in careers they may not typically consider themselves in. A total of 187 youth registered for the Career Sparks Interviews (CSI) webinar series from UC and Idaho 4-H between October 2020 - May 2021 sessions. In addition, Facebook Live views totaled approximately 2,465 views through the end of June 2021 for twelve Career Spark Interview Videos. At least 71% of guest speakers represented a marginalized group in their career industry. (Yu Meng)

A UCCE Specialist at UC Davis worked on *Destination UC*, an education and career exploration project designed for youth in grades 7-12. Its principal components include a sequenced curriculum and guest speakers and experts from the community, including UC alumni, Collegiate 4-H Youth from UC campuses, and college admissions advisors. It also entails a tour of one of the UC campuses. Activities are geared towards helping youth identify their passions and professional interests; set educational and professional goals and develop skills to achieve them; establish resources to learn about higher education opportunities and requirements and explore various pathways to higher education. Outcome testing on the curriculum revealed that participating youth were more prepared for post-high school education and increased life skills development (e.g., goal setting, motivation, self-esteem, record keeping, and communication). (Martin Smith)

As a result of UC ANR research and educational efforts, youth participants demonstrated learning gains to better prepare them for college and careers. Outcomes with specific indicators follow.

**Outcomes**

**Participants had positive attitudes and learned information about preparing for college and careers.**

* 179 4-H youth statewide responded to the college and career readiness common measures survey and reported learning information to prepare them for college and a career resulting from what they may have learned at 4-H. (UC 4-H)
  + 90% of youth reported when choosing a career, it is important to be passionate about the work they do
  + 84% of youth report that for the type of career they want, it is important to go to college
* 105 4-H youth between the ages 9-18 responded to the science common measures survey about positive attitudes and aspirations toward science they may have learned in the 4-H program. (UC 4-H)
  + 82% of youth reported liking science
  + 69% of youth reported liking a job that involves using science
  + 70% of youth reported interest in studying science after high school
* Out of 187 youth registered for the Career Sparks Interviews (CSI) webinar series from UC and Idaho 4-H, 84% of youth responded that the interview session shared a lot helpful information; 84% found the session inspiring to develop a career interest; and 83% learned something new about pursuing a career in a career field. Career Spark Interviews webinars were archived for youth and youth professionals to have continued access, further explore careers, and gain insights from Millennial professionals. (Yu Meng)
* The *Destination UC* curriculum was peer-reviewed and accepted for publication. For the 228 youth who participated in Destination UC, evaluation results indicated:
  + A statistically significant difference (p < .001) in the percentage of young people reporting they had a better idea of what they might do after high school after participating in the program (65.2%) compared to before the program (35.1%).
  + A significant difference (p < .001) between the number of youths exploring career options before (19.7%) and after (64.7%) the program. Additionally, approximately 60% of youth responded that they had learned about post-high school education options that might be a good fit for them, whereas 25% of youth responded that they had done so prior to participating in the program (p < .001).
  + Statistically significant differences in researching post-high school education career options, knowing a major they might pursue, learning about scholarships and the post-high school application process, and knowledge of the importance and level of post-high school education they will need to pursue a desired career. (Martin Smith)

**Participants adopted science and teaching skills to prepare them for college and careers.**

* 105 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 (59%), trying new things to see how they will work (56%), looking at how things are the same or different (48%), and comparing how different things work (43%). (UC 4-H)
* 179 youth statewide responded to the college & career readiness common measures survey and reported learning information to prepare them for college and a career resulting from what they may have learned at 4-H. Youth reported having intrapersonal professionalism skills such as it being important to arrive on time for work (97%), be trusted by an employer (98%), do their job well (98%), show respect for others (97%), and have a professional image on social media (61%). (UC 4-H)

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

## Condition Change: UC ANR contributed to increased civic engagement

**Issue**

California requires a highly skilled workforce to remain competitive, prosperous, and an innovative global leader. Volunteering and civic engagement can develop skills and confidence that make individuals employable and create attachments to communities that encourage people to invest, spend, hire, and promote the quality of life in their community.

**Methods**

UC ANR delivers educational programs that increase civic engagement. On an annual basis, there are over 14,500 volunteers who donate over 1.7 million hours across six statewide programs. This includes UC-managed volunteers and individuals from other organizations. (UC 4-H; CalFresh Healthy Living, UC; EFNEP; UC California Naturalist, UC Master Food Preserver, UC Master Gardener).

The UC 4-H Youth Development Program reached nearly 49,000 youth 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. Over 11,000 adult volunteers contributed over 1.2 million hours. (UC 4-H) Program activities like Project 4H20, Mindful Me, Healthy Choices in Motion, and 4-H Student Advisory Nutrition Councils (4-H SNAC Club) empowered youth to take on leadership roles in research, teaching, and service-learning projects to improve their communities. (UC 4-H, CFHL, UC) For example, in Alameda and Contra Costa counties, five teen leaders participated in 24 weekly virtual meetings for 36 hours of education on a Youth Participatory Action and Research (YPAR) curriculum. The teens also learned about health inequities caused by the social determinants of health in preparation for choosing an issue they will work on in the 2021-2022 school year. (Marisa Neelon, Charles Go, Eli Figueroa)

A UCCE Advisor and a UCCE Specialist from UC Davis participated in a multi-state collaboration with the National Science Foundation’s Center for Sustainable Polymers, as well as Minnesota, California, and New York 4-H, Cooperative Extension educators to develop and pilot youth-focused curricula to introduce youth to the prevalence and impacts of plastics in everyday life. The curricula were designed to build foundational skills of science and engineering: observation, asking questions and defining problems, planning, and carrying out investigations, and communicating. The curricula are intended for delivery during out-of-school time and facilitated by educators such as trained volunteers or program staff. (Steven Worker, Martin Smith)

CFHL, UC worked with over 130 youth leaders statewide to lead direct education activities about nutrition, physical activity, and health across 12 counties. Over 370 youth statewide were also involved with shaping Policy, Systems, and Environmental (PSE) changes in their communities through participation in activities such as Youth-led Participatory Action Research (YPAR), and Student Nutrition Advisory/Action Councils. (CFHL, UC)

The UC California Naturalist Program conducts activities and training to introduce Californians to the wonders of our unique ecology and engage the public in the study and stewardship of California’s natural communities. It aims to increase knowledge, skills, identity, and self-efficacy related to California natural history and environmental issues, increase public participation and civic engagement in environmental education, and enhance citizen science, climate adaptation, and planning toward environmental and climate justice. (Gregory Ira)

A UCCE Advisor in Orange County worked on three participatory science projects. *The Bad Beetle Project* was focused on the Santa Monica Mountains and collaborated with the Santa Monica Mountains Resource Conservation District, the Los Angeles Agricultural Commissioner’s office, and the office of Supervisor Sheila Kuehl. The Advisor trained 35 volunteers on identifying trees infested with invasive shothole borers and gold spotted oak borers and how to report infestations through iNauralist, a free online interactive tool. The second project, the *Invasive Shothole Borer (ISHB) Monitor Project*, focused on Orange and Los Angeles counties and evaluated if participatory science could be a feasible tool to monitor invasive shothole borers, given the challenges of accurately identifying the presence of this pest. Together with the California Naturalist program, the Advisor developed a reporting tool in iNaturalist and a 6-hour training that trained 27 volunteers. The third project collaborated with the UC 4-H Program and offers an adaptation of the ISHB Monitoring Project to fit the format and needs of a 4-H club. The Advisor created a project targeted to a young audience that included online lessons on invasive species, the importance of urban trees, participatory science, invasive shothole borers, and a hands-on activity in which the students would collect data and contribute to the ISHB Monitoring program. (Beatriz Nobua-Behrmann)

**Outcomes**

**Participants had positive attitudes and gained skills for civic engagement.**

* 115 4-H youth responded to the Civic Engagement common measures survey about what they may have learned at 4-H.
  + 81% of the youth reported that they like to help people in their community, and 58% feel a responsibility to help their community.
  + Nearly 89% of 4-H youth statewide who responded to a teamwork survey indicated that they respect the differences and strengths of individuals on the team. Critical teamwork skills are becoming increasingly important as California and the U.S. are becoming increasingly racially and ethnically diverse.
  + 87% of youth in the teamwork survey reported that they would stand up for what they believe in even if their friends didn’t agree, demonstrating critical thinking skills. (UC 4-H)
* 4-H youth self-reported that they learned some materials can be recycled and some cannot (89% of 161 youth surveyed) and that many things are made of plastic (86% of 155 youth surveyed). Youth also came up with ideas for how to care for the environment (87% of 158 youth) and expressed their intent to help family or friends recycle more (91% of 156 youth). (Steven Worker, Martin Smith, Karen Giovannini)
* In Contra Costa and Alameda counties, a cohort of five Youth Participatory Action Research (YPAR) teen leaders reported an increase to in wanting to make a difference in their school or community (75% increase), knowing where and how to gather valuable data on making their school or community a healthier place (50% increase), understanding how their surrounding affects their health (75% increase), and seeing themselves as part of a youth community that can solve their concerns (50% increase). (Marisa Neelon, Charles Go, Eli Figueroa)
* After participating in the YPAR projects with CFHL, UC, 54 youth responded to a follow-up survey saying that they could “YES, probably” (31%) or “YES, definitely” (63%) make a difference in their community. (CFHL, UC)
* Volunteers trained under The Bad Beetle Project submitted 206 reports of invasive shothole borers infestations, which helped map the presence of this pest throughout the region and direct rapid response efforts to areas that are newly infested. The ISHB Monitor Project also collected 45 reports of suspected infestations. The pilot project results helped show that online training helps volunteers accurately identify ISHB-infested trees 85% of the time. The 4-H club that adapted the ISHB monitoring project had 10 participants who unanimously showed engagement and excitement during the activities. (Beatriz Nobua-Behrmann)

**Participants engaged in community service.**

* Of the 115 4-H youth who responded to the Civic Engagement common measures survey about what they may have gained through 4-H, 86% reported they had done a community service project, and 33% said they look for ways to help when they learn about a problem in the community. (UC 4-H)
* Over 500 certified California Naturalist volunteers conducted 9,135 hours in environmental education, 9,834 hours in participatory citizen science, 9,124 hours in conservation and restoration, 730 hours in community resilience and adaptation, and 394 hours in environmental and climate justice. (Greg Ira)

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. UC ANR’s youth development programs equip the next generation to be active participants in their communities, contributing to a robust and thriving state economy.

# 

# DEVELOPING AN INCLUSIVE AND EQUITABLE SOCIETY

## Condition Change: UC ANR contributed to improved living and working conditions for California's food system and farmworkers

**Issue**

In 2019 there were 22.2 million full- and part-time jobs related to the agricultural and food sectors – 11% of total U.S. employment. Migrant and seasonal farmworkers are a vital component of those jobs, yet they continue to live in poverty with poor health indicators and limited access to health care services. Farm labor conditions are intricately entwined with farmworker quality of life, farm profitability, and the socioeconomic vitality of agricultural communities. For example, recent labor shortfalls have reached as high as 20% in California, resulting in $3 billion in lost production. Agriculture, one of the most hazardous industries for workers, with over 75,000 injuries and illnesses reported annually across the U.S. (Monica Cooper) Farmworker communities have been hard hit by the pandemic; crowded living and working conditions, low wages, and fear of deportation all contribute to high rates of COVID-19.

**Methods**

UC ANR continues research and extension efforts to improve conditions for workers in California’s food system.

The COVID-19 pandemic brought to light the importance of essential workers in maintaining food system resiliency and, at the same time, worsened the inequities they face. In particular, farmworkers have experienced exacerbated challenges in maintaining healthy, safe, and sustainable livelihoods during the pandemic given dense living and working conditions, vulnerable legal status, and lack of equal protection under labor law. A UC Cooperative Extension (UCCE) Nutrition Specialist at UC Berkeley presented a talk titled, "In the middle of two pandemics: COVID-19 & chronic disease in farmworkers," as part of a webinar focused on "Farm Labor During the Pandemic: Critical links between Essential Work, Farmworker Health and Food System Resiliency." The webinar presented the key findings from a COVID-19 Farmworker Survey and other innovative efforts to adapt research, outreach, and policy work to improve farmworker living and working conditions in the pandemic context. The UCCE talk focused on increasing awareness of the farmworker population's dual risk: 1) high rates of transmission and 2) the high prevalence of pre-existing/chronic health conditions (e.g., obesity, diabetes, hypertension, etc.) that increase the risk of COVID complications. (Susana Matias)

A UCCE Specialist working on social justice in agriculture at UC Berkeley conducts evaluation research on social certification in agriculture. The researcher works with the Equitable Food Initiative (EFI) in its continuous improvement process to strengthen its social certification and workforce development program. EFI’s primary goal is to improve the working conditions of farmworkers in California and beyond. (Christy Getz)

Pesticide drift is a health concern for farmworkers, the surrounding farm and school communities, and the environment. A UCCE Advisor completed a 3.5-year project to train California pesticide applicators on recommended practices to reduce pesticide drift. She led a team of UC and industry professionals to deliver two hands-on training sessions and completed the online course development. (Lynn Wunderlich)

The UC Sustainable Agriculture Research and Education Program (UC SAREP) has a focus area on social equity to address inequities and racism in California's agriculture and food system. The program works to build capacity within extension. Guest speakers include professionals experienced in working with clientele who are people of color, farmers of color, and members of community-based organizations who interact with or would like to interact with extension professionals. In 2020-21, two webinars on serving farmworkers and farmers of color reached 135 real-time participants and many others who watched the recorded webinars later. (Sonja Brodt, Gail Feenstra, and Stephanie Parreira)

The UCCE Viticulture Advisor improved access to educational resources for vineyard workers and supported the professional development of the vineyard labor force, to promote equitable farm labor conditions and agricultural workforce development. (Monica Cooper)

**Outcomes**

**Participants reported learning gains that are intended to lead to improved farmworker outcomes.**

* Of the 78 attendees at the UC SAREP’s webinars for those working farmworkers and farmers of color, 25 completed an evaluation survey and reported:
  + 100% said they gained new knowledge;
  + 96% indicated the webinar improved their awareness of the topic;
  + 84% said the webinar modified their opinions of the topic;
  + 80% said they are likely to use what they learned in future educational programming; and
  + 28% learned new skills.

Several attendees appreciated the suggestions to provide more outreach materials in the form of visual graphics and consider adding indigenous Mexican and Central American languages. For many farmworkers in California, Spanish is not their primary language. Many people asked about suggestions for organizations to partner with to engage with farmworkers effectively, and they appreciated the concrete suggestions provided by the panel. (Sonja Brodt, Gail Feenstra, Stephanie Parreira)

**Farmworkers had learning gains intended to improve working conditions.**

* Farmworkers gained knowledge in the areas of communication, leadership, facilitation, and technical viticulture information, specifically soil health and insect identification. These strategies help improve farm labor conditions to support agricultural resilience and promote a more inclusive and equitable food system. (Monica Cooper)

**Participants adopted practices that led to improved farmworker safety.**

* A postseason follow-up survey found that 39% of 36 respondents, including Pest Control Advisers, growers, and pesticide applicators, adopted at least one recommended practice to reduce pesticide drift, improving farmworker working conditions and health. (Lynn Wunderlich)

**Change in condition: Improved working conditions for farmworkers.**

* EFI has implemented many of the evaluation-based recommendations from the 2017 UCCE report, improving the working conditions of farmworkers. Between 2017 and 2021, the number of EFI certified farms increased from 19 to 48 and, relatedly, the number of workers on certified farms from 10,000 to more than 57,000, magnifying the impact of UCCE’s recommendations. (Christy Getz)

These measured outcomes demonstrate changes to improve the 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 food system through workforce retention, improved safety, and product quality.

## Condition Change: UC ANR contributes to increased diversity, inclusiveness, and cultural competency in California's workplaces.

**Issue**

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 is 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 college preparation. California continues to be challenged by social, health, and economic inequities.

**Methods**

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 UC ANR resources. UC ANR academics live and work in communities building trust and credibility to solve local problems together through research, outreach, and education.

A UC Cooperative Extension (UCCE) Specialist located at UC Berkeley served on the California FarmLink Board and helped establish a new Diversity, Equity, and Inclusion (DEI) Committee to assess and develop principles and best practices for DEI for this organization. They developed a survey that was administered to like-minded non-profits assessing the status of DEI principles, practices, challenges, and successes the organizations had with implementing DEI practices. The report California FarmLink DEI Assessment: Policies, Principles and Practices of DEI and Inclusive Governance within the California Non-profit Agricultural Services Sector was presented to the organization and at the Eco-farm conference. (Jennifer Sowerwine)

The UC Sustainable Agriculture Research and Education Program’s (SAREP) focus area on social equity that addresses inequities and racism in California's agriculture and food system includes engaging UC ANR colleagues to further DEI-advancing efforts within the organization. Lessons learned in implementing diversity, equity, and inclusion measures in Extension, are published in blogs and articles geared toward the Extension audience. (Sonja Brodt, Gail Feenstra)

UC ANR’s statewide California Naturalist program continues its efforts to broaden participation and address Justice, Equity, Diversity, and Inclusion (JEDI) in the program. The program established a framework for operationalizing its JEDI efforts using a Four “R’s” approach: 1) investing in Relationships, 2) focusing on local and cultural Relevance in our content, 3) breaking down barriers to Recruitment or access, and 4) promoting individual and program Responsibility and accountability. During this period, the program initiated a new demographic data collection approach using course evaluations for course participants and registration for events. (Gregory Ira)

A 4-H Youth Development Program in the San Francisco Bay Area continued work to integrate a social justice youth development perspective into programs. With a team of national collaborators, a UCCE Advisor wrote three curricular activities and co-wrote the introduction to a curriculum titled “True Leaders: Culture, Power and Justice, A Youth Development Approach to Social Justice” which was published in the spring 2021 after passing the National 4-H peer review system. Another immigrant youth as teen teachers project is a qualitative study that represents the voices of eleven 4-H professionals, of which six were immigrants, and five were of European American descent. Empirical findings reflect 4-H professionals’ cultural competence facilitated culturally responsive teaching and supported adolescents to navigate cultural worlds and adversity. (Fe Moncloa)

A UCCE scientist working in the UC ANR statewide Agricultural Issues Center was the lead on a $1M grant from the National Institute for Health for community-based participatory research. A course in human subject research ethics was developed so that the community researchers could receive their CITI certifications. (Karen Jetter)

As a result of UC ANR’s multipronged efforts to better reach underserved audiences, program staff gained cultural competency skills, and UC ANR increased engagement with diverse communities across California. Outcomes with specific indicators follow.

**Outcomes**

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

* UC SAREP’s webinars on working with farmworkers and farmers of color provided useful networking connections and contributed to growing the membership of a newly formed UC ANR Diversity, Equity, Inclusion, and Justice Program Team, which currently counts 44 members from across UC ANR. (Sonja Brodt)

**UC ANR better engages communities historically underrepresented in its programs.**

* As a result of the California Naturalist program operationalizing the *4R* framework, the following outcomes have been achieved:
* *Relationships:* New partnerships were established with the California Tribal College and the Anahuacalmecac School, and Audubon Center at Debs Park.
* *Relevance:* Course content is made locally and culturally relevant through co-design of the course syllabus.
* *Responsibility:* Program team members pursue professional development, including completing the Intercultural Development Inventory (IDI) training.
* *Recruitment*: 31.8% of all course participants (258 of 812) received either full or partial scholarships to eliminate cost barriers to participation. (Gregory Ira)
* Results from the first year of the California Naturalist Climate Stewards courses show promising results for Hispanic and non-white participation: 31% Hispanic (39% in 2019 CA Census); 4% Black (7% in 2019 CA Census); and 13% Asian (16% in 2019 CA Census). (Gregory Ira)
* UCCE Santa Clara County integrated more equity and Latinx youth development practices into extension programs; for example, all programs are free, program materials are culturally relevant and in Spanish and English, and transportation is provided for youth to participate in events. 4-H staff engages in familial relationships with youth and parents, and we communicate via WhatsApp since most youths do not have access to the Internet at home. Long-term impacts will increase the diversity and sense of belonging for diverse youth and families in 4-H and increase Latinx youths' access to various career pathways. (Fe Moncloa)
* Community researchers from three Northern California Tribes: The Mechoopda Indian Tribe of the Chico Rancheria, the Grindstone Indian Rancheria of Wintun-Wailaki Indians, and the Round Valley Indian Tribes were engaged. Two clinics, the Northern Valley Indian Clinic, Inc, and the Round Valley Indian Health Center, also collaborated with this project. All community and clinic partners, 40 people total, were able to pass the course to be certified to conduct research with human subjects on federally funded projects. (Karen Jetter)

**Change in condition: Workplaces are more inclusive.**

* California FarmLink organization increased the adoption of new DEI principles and practices and increased diversity of the board in both racial and farmer representation. (Jennifer Sowerwine)

These measured outcomes demonstrate how UC ANR has strengthened its internal capacity to do effective outreach to diverse audiences to have participants better reflect the state's diversity. 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 finds California ranking in the top quarter amongst the states for inclusiveness. However, the state dropped from fifth to twelfth in the nation between 2018 and 2020, indicating there is still much work to do.

# PROMOTING HEALTHY PEOPLE AND COMMUNITIES

## Condition Change: UC ANR contributed to improved health for all

**Issue**

California’s rapid population growth increases pressure on community resources and presents numerous challenges to health and safety. Adult and childhood obesity is a public health crisis for the state and nation, resulting in many negative health consequences. According to the Centers for Disease Control (CDC) Behavioral Health Risk Surveillance System, 64% of California’s adults are overweight or obese, and obesity in California’s adult population has increased over 15% between 2015-2020. The CDC’s Youth Risk Behavior Survey also indicates that 30% of California’s high school-aged youth are either overweight or obese. Childhood obesity alone is estimated to cost the nation $14 billion per year.

**Methods**

In partnership with communities and allied organizations, UC ANR produces new knowledge, tools, programs, and policy-relevant research that result in healthy living for individuals.

The CalFresh Healthy Living, UC (CFHL, UC) State Office at UC Davis provides statewide oversight, leadership, and guidance for the CalFresh Healthy Living Program. UCCE academics and CFHL, UCCE supervisors offer local leadership and guidance in program implementation and evaluation. CFHL, UC, and UCCE offices throughout the state offer nutrition education aligned with policy systems and environmental change initiatives to generate sustainable healthy outcomes in communities. Partnering with SNAP-Ed funded and non-funded organizations furthers local engagement and impact. CFHL, UC delivered nutrition education programs such as *Happy Healthy Me, Glow, Go, Grow, Plan, Shop, Cook, Save* (PSSC) to over 36,000 youth and adults. CFHL, UC policy, systems, and environmental interventions such as *Coordinated Approach To Child Health Early Care Education* (CATCH ECE) and *Shaping Healthy Choices Program* integrate to create comprehensive overweight and obesity prevention programming. (CFHL, UC)

UCCE academics also provided oversight, leadership, and guidance for the statewide implementation of the Expanded Food and Nutrition Education Program (EFNEP) statewide programs. These programs serve adults with income less than 185% of the federal poverty level and youth that attend Title 1 schools in which 50% or more of the students qualify/receive free or reduced-price lunch or live in households that receive food assistance. EFNEP delivered *Eating Smart Being Active* (ESBA), *Happy Health Me*, and *It’s My Choice...Eat Right! Be Active!* programs to over 9,200 youth and adults. (EFNEP)

UCCE academics provided leadership and science-based information for the statewide implementation of the UC Master Gardener Program. Volunteers delivered public education workshops, and 2,264 participants who collectively attended 156 workshops responded to a survey about any changes made from attending. (UC Master Gardener Program). For example, a UCCE academic in Los Angeles County led an effort with Master Gardener volunteers to deliver and evaluate the project, Promoting Alternatives to Citrus for Backyard and Community Gardeners in the Fight Against Asian Citrus Psyllid/Huanglongbing. As of April 2021, over 3,500 adults were reached through this campaign. (Rachel Surls)

UC Cooperative Extension (UCCE) academics provided oversight, leadership, and guidance for the statewide implementation of the University of California 4-H Youth Development Program (UC 4-H). UC 4-H provided hands-on, experiential learning opportunities about healthy lifestyles with participation from over 7,600 youth. (UC 4-H) This includes the Cooking Academy series, which provides youth development guidance for a teens-as-teachers approach for healthy eating and food preparation techniques to be delivered to other youth in the community. (Marianne Bird)

Academics at NPI piloted and evaluated an innovative approach to integrating food and nutrition information into CalFresh (EBT). The project, a collaboration between NPI, the UCSD Center for Community Health, ideas42, a nonprofit applying behavioral science insights, and the San Diego County Health and Human Services Agency consisted of developing a series of monthly text messages in English, Spanish and Arabic promoting the consumption of seasonal California-grown fruits and vegetables and sending them from the CalFresh Agency to all CalFresh participants. The text messages reached approximately 170,000 San Diego County households each month. Each text message included a link to a newly developed website available in English, Spanish, and Arabic highlighting 24 seasonal specialty crops, with in-depth information on the health benefits of fruits and vegetables, tips for selecting, storing, and preparing them, as well as user-friendly recipes, tips for reducing food waste and links to additional resources. NPI’s survey findings indicated that 65% of website visitors reported eating more fruits and vegetables after receiving the texts, while 66% reported buying more CA-grown produce. Additionally, 79% reported gaining knowledge about eating more specialty crops, while 85% would like to continue receiving the messages. User feedback from survey comments and focus groups was overwhelmingly positive; participants appreciated receiving health-related information from CalFresh. They reported that the warm and friendly tone of the text messages made them feel cared about. (Wendi Gosliner, Ron Strochlic, Celeste Felix)

Each of these programs works statewide to promote healthy eating and active living. Collaboration across programs that included nutrition education, gardening, and food preservation helped bolster programs like Harvest of the Month in California’s public schools. In response to COVID-19 safety requirements, statewide programs have shifted many of their offerings to virtual delivery platforms and employed innovative strategies to engage students and families.

Local programs utilized statewide evaluation tools to measure participant outcomes. CFHL, UC’s State Office at UC Davis, along with UC ANR’s Nutrition Policy Institute (NPI) provided evaluation technical assistance for all agencies implementing CalFresh Healthy Living (CFHL) interventions. As a result of UC ANR research and extension efforts, participants learned about and adopted healthier lifestyles. Outcomes with specific indicators follow.

**Outcomes**

**Participants gained knowledge about and changed attitudes toward healthy eating practices.**

* Over 400 CFHL, UC participants statewide responded to a survey about their experience with the Plan, Shop, Save, Cook curriculum, with 57% reporting more frequently thinking about healthy food choices when deciding what to feed their family.
* Based on over 200 surveys from teachers working with over 3,000 students across the state who participated in CFHL, UC programming, 86% reported students were now more aware of the connection between food and health after participating in lessons on nutrition and physical activity. (CFHL, UC) A local highlight:
  + CFHL, UC in San Luis Obispo and Santa Barbara provided nutrition education through virtual lessons, directly reaching 3,288 youth. The percentages of 4th and 5th grade students (N=282) who reported that when they have a choice "YES" they will try to eat more fruits (70%), eat more vegetables (47%), drink less sugary beverages (48%), drink water (90%) and get more physical activity (79%). (Katherine Soule, Shannon Klisch, Kelly Hong, Miguel Diaz, Abbi Marrs, Melissa LaFreniere, Betsy Plascencia, Rosa Vargas)
* EFNEP received survey responses from nearly 1,000 youth participants across the state about their participation in a nutrition education program, and 83% of youth gained knowledge or improved their abilities to choose foods according to federal dietary recommendations. (EFNEP) Local highlights include:
  + In Los Angeles, 82% of 127 youth participating in EFNEP’s youth programs improved their abilities to choose foods according to USDA recommendations. (Natalie Price)
* As of April 2021, 79% of survey respondents from the UC Master Gardener “Alternatives to Citrus” program in Los Angeles County gained knowledge about the importance of eating more fruits and vegetables, and 69% of survey respondents reported an intention to eat more fruits and vegetables. (Rachel Surls)

**Participants adopted healthy eating practices.**

* Over 230 youth across the state responded to the Healthy Living common measures survey and reported paying attention to how much water (40%) and how many sugary beverages (55%) they drink each day, as a result of what they may have learned at 4-H. (UC 4-H)
* CFHL, UC surveyed 323 adults statewide with a Food Behavior Checklist pre/post survey after participating in a nutrition education program series. Respondents reported improvements in eating more than one kind of fruit (64%) and more than one vegetable (71%) each day. (CFHL, UC) Local highlights include:
  + More than half (54%) of 408 adults who participated in the Plan, Shop, Save, Cook series with CFHL, UCCE in Santa Clara County indicated that they would use the nutrition facts labels more often. (Laura Vollmer)
  + CFHL, UCCE in Santa Clara and San Mateo counties surveyed 23 teachers about the impacts of nutrition education on youth. Ninety percent of teachers reported that their students were more aware of the connection between food and health after participating in our lessons. (Laura Vollmer)
  + Of the 42 parents who participated in CFHL, UCCE Kern County programming, 30 parents participated in a post-survey. After attending the PSSC series, 80% reported using MyPlate to make food choices more often, and 67% reported that they use "Nutrition Facts" on the food label to make food choices more often. (Beatriz Rojas)
* EFNEP received survey responses from over 1,400 adult participants across the state about their participation in a nutrition education program, where 98% of adult participants improved in one or more recommended practices in diet quality and 85% improved practices in physical activity. (EFNEP)
  + Out of 248 parents that graduated from the virtual *UCCE Connects to You!* series from EFNEP in Alameda and Contra Costa counties, 99% improved in one or nutrition practices (eating more fruits and vegetables daily, drinking less soda and sugary drinks, and cooking dinner at home more often). (Marisa Neelon)
  + Out of 20 ESBA participants in Humboldt and Del Norte counties, 68% improved diet quality indicators by adopting one or more food selection behavior(s) consistent with Federal Dietary Guidelines. (Dorina Espinoza)
  + In Los Angeles, 97%% of 267 EFNEP participants who participated in ESBA and *UCCE Connects to You!* workshops showed improvements in one or more dietary quality indicators. In Orange County, 100% of 195 workshop participants showed improvements in one or more dietary quality indicators. (Natalie Price)
* In Sacramento County, 16 teens delivered the 4-H Virtual Cooking Academy every other week for 12 weeks to elementary-aged students attending five different virtual day camps in Elk Grove Unified School District. Follow-up surveys showed that 91% of youth improved their abilities to choose foods according to Federal Dietary Guidelines, 32% improved in their responses on drinking less soda or fruit flavored drinks, eating more vegetables as a snack, and tasting new foods, and 29% improved in their responses to reading Nutrition Facts labels. Additionally, 89% of teachers reported practicing healthy food habits that include paying attention to how much fruit they eat and water they drink each day. (Marianne Bird)
* In Alameda and Contra Costa counties, over 3,500 students participate in Youth EFNEP programming, which has been adapted to an asynchronous online learning format. A survey of 374K-8th grade students showed that 86% percent of Contra Costa County respondents and 72% of Alameda County respondents reported improvements in healthy food choices (eating more fruits and vegetables, whole grains, and less sugary foods and beverages). Teachers for 6-8th grade students observed that students who participated in EFNEP programming choose less sugary snacks and beverages and drink more water. (Marisa Neelon)

**Participants gained knowledge and changed attitudes toward healthy lifestyle and decision-making practices.**

* Based on over 200 surveys from teachers working with over 3,000 students across the state who participated in CFHL, UC programming, 87% reported students were more aware of the connection between physical activity and health after participating in lessons on nutrition and physical activity. (CFHL, UC)

**Participants adopted healthy lifestyle and decision-making practices.**

* Of the 230 youth statewide who responded to the Healthy Living common measures survey, 50% reported paying attention to how active they are each day, what they may square feet have learned at 4-H. (UC 4-H)
* A partnership between CFHL, UC Santa Barbara County and the Santa Marita-Bonita School District reached more than 1,000 students across two school sites with quality nutrition education using the *Serving UpMyPlate* and *Up4It!* curricula tailored to their grade level. As a result, 59% of 73 4th-6th grade youth surveyed reported that when given a choice they will drink water, and 45% reported that when given a choice they will try to engage in more physical activity. (Kelly Hong, Melissa LaFreniere, Shannon Klisch, Rosa Vargas)
* EFNEP received survey responses from over 1,400 adult participants across the state about their participation in a nutrition education program, and 85% of adult participants improved in one or more physical activity behaviors. (EFNEP)
  + Out of 248 parents that graduated from the virtual *UCCE Connects to You!* series from EFNEP in Alameda and Contra Costa counties, 80% and 67% in those counties respectively improved in one or physical activity practices (exercise for at least 30 min. more often, strengthen muscles). (Marisa Neelon)
  + Out of 20 ESBA participants in Humboldt and Del Norte counties, 58% improved physical activity behaviors after participating in the workshop series. (Dorina Espinoza)
* In Alameda and Contra Costa counties, over 3,500 students participate in Youth EFNEP programming, which has been adapted to an asynchronous online learning format. A survey of 374 K-8th grades showed that 67% percent of Contra Costa County respondents and 38% of Alameda County respondents reported improvements in physical activity (increasing frequency and duration). (Marisa Neelon)
* Based on the successes of the innovative text-messaging pilot developed by NPI, the San Diego County Health and Human Services Agency plans to continue sending nutrition education text messages monthly. (Wendi Gosliner, Ron Strochlic, Celeste Felix)

**Participants adopted edible gardening practices.**

* 825 participants of public education events led by UC Master Gardener volunteers responded to a 2021 statewide survey and reported starting or improving the growing of edible plants (75%) and expanded varieties of edible plants grown (63%). They also reported applying what they learned to nearly 1.4 million square feet of food gardens. These behaviors are correlated with increased consumption of fruits and vegetables. Furthermore, 68% of 1,535 respondents spent more time gardening and outdoors, which is associated with improved individual emotional and physical health. (UC Master Gardener Program)

**Participants spent more time outdoors.**

* Over 2,200 participants of UC Master Gardener volunteer-led educational programs reported in a statewide survey that they started or improved practices on over 2.2 million square feet of home gardens in California. (UC Master Gardener Program)
* In Ventura County, 65% of Master Gardener Program attendees stated that they spent more time outdoors/gardening as a result of attending a Master Gardener presentation. (Jim Downer)

These measured outcomes lead to and demonstrate improved health for Californians where they learn, work, and play. Furthermore, longitudinal studies of EFNEP graduates indicate that they maintain positive behavior change 2-6 months after completing the program (Dollahite, 2014; Koszewski, 2011; Swindle, 2007). Healthy habits can prevent or reduce the detrimental effects of chronic disease, and for every dollar spent on California EFNEP, there is a savings of $8.34 in health care costs (California EFNEP Impact Report, 2018). Collectively these efforts contribute to the public value of promoting healthy people and communities.

## Condition Change: UC ANR contributed to improved community health and wellness

**Issue**

California’s rapid population growth increases pressure on community resources and presents numerous challenges to health and safety. Adult and childhood obesity is a public health crisis for the state and nation, resulting in many negative health consequences. According to the Centers for Disease Control (CDC) Behavioral Health Risk Surveillance System, 64% of California’s adults are overweight or obese, and obesity in California’s adult population has increased over 15% between 2015-2020. The CDC’s Youth Risk Behavior Survey also indicates that 30% of California’s high school-aged youth are either overweight or obese, and only one-fifth are receiving the recommended 60 minutes of daily physical activity. Childhood obesity alone is estimated to cost the nation $14 billion per year. Public health experts agree that poor nutritional choices, lack of physical activity, school, community, home environments, income level, and education are factors in the obesity epidemic.

Also affecting community health are pest groups such as bed bugs, cockroaches, human lice, and fleas, which pose significant importance to public health and ongoing issues for landlords, tenants, businesses, and property managers. Many of these species have developed insecticide resistance and can cause commodity damage and spread diseases and unsanitary situations.

**Methods**

In partnership with communities and allied organizations, UC ANR produces new knowledge, tools, programs, and policy-relevant research that contribute to healthy communities.

The CalFresh Healthy Living, University of California (CFHL, UC) State Office at UC Davis provides statewide oversight, leadership, and guidance for the CalFresh Healthy Living Program. UC Cooperative Extension (UCCE) academics and CFHL, UCCE supervisors offer local leadership and guidance in program implementation and evaluation. UCCE academics provided oversight, leadership, and guidance in educational programs and policy, systems, and environmental (PSE) interventions delivered statewide through CFHL, UC. Programs such as Coordinated Approach to Child Health; Smarter Lunchrooms Movement; Gardens; and School Wellness Policy were conducted to increase healthy choices, food-based gardening, and quality physical activity in early childhood centers, schools, and community environments. (CFHL, UC)

CFHL, UC in Alameda County partnered with 28 preschools in Oakland Unified School District to conduct education on nutrition, wellness, physical activity and help support policy, system, and environmental changes. Sixty-six Early Childhood (EC) teacher extenders used the Happy Healthy Family Curriculum (six lessons) to reach 924 children under five years old with nutrition and wellness classroom activities. (Mary Blackburn) In Santa Barbara County, CFHL, UC partnered with schools to extend the Happy Healthy Family Curriculum to 64 parents or guardians. (Rosa Vargas, Miguel Diaz, Emily Dimond, Melissa LaFreniere, Kelly Hong, Betsy Plascencia, Shannon Klisch)

Since 2018, UCCE and CFHL, UCCE in Riverside County have worked with Torres Martinez Desert Cahuilla Indian Tribe to advance sustainable community health initiatives that can foster positive health outcomes. This includes working with their leadership to acquire funding to pursue healthy community development. This collaboration has resulted in three grants focusing on tribal youth participatory action research (YPAR) project, farm to school, and discussions around the tribal community's interest in food sovereignty. UCCE and CFHL, UCCE's partnership with the Torres Martinez Desert Cahuilla Indian Tribe, resulted in a YPAR project that engaged 11 youth ages 12-17 to explore the community food environment raised questions about the low availability of healthy foods. The YPAR project contributed to the tribe's decision to reinstate the Tribal Youth Council, which incorporates youth feedback in the design of community programs. Additionally, an intergenerational group of 32 tribal members participated in the vegetable planting in the A'Avutem (elders) garden. Thirty tribal members participated in the UCCE led farm tour, and over 20 youth participated in the CFHL, UCCE led education about farm to school. (Chutima Ganthavorn, Andra Nicoli, Jose Aguiar)

*Mindful Mechanics* was developed through a partnership between UC ANR and the University of New Hampshire and serves as a tool for having mental health conversations and interventions with 4-H youth members National 4-H ages twelve and older. A statewide 13-lesson virtual project for teen members took place in the winter of 2021, one year into stay-at-home orders that exacerbated mental health issues for many youths. The Mindful Mechanics project taught youth to check in with their bodies, manage thoughts and emotions, focus on the present moment, find reasons to be grateful, use positive self-talk to improve their outlook and visualize joy. All of these skills are found to increase positive psychology in individuals. (Anne Iaccopucci, Kendra Lewis, Katherine Soule)

UCCE Advisors in Santa Clara County conducted stakeholder research and engaged over 70 nonprofits, businesses, government agencies, and existing food system collaboratives to develop the Santa Clara County Food System Workplan. The workplan presented key findings, including a review of pandemic conditions, and offered goals, strategies, action steps, and proposed evaluation metrics to assess continued progress. Laura Vollmer, Lucy Diekmann)

NPI researchers provide evidence-based reviews and community health needs assessments to recommend health improvement investment strategies in California and throughout the United States that support policies, environment, and programmatic changes designed to promote health. Their work helps to communicate findings to further the policy and program improvements by presenting and producing reports and products for funders, communities, and other stakeholders to improve the effectiveness of community health interventions. (Suzanne Rauzon)

One NPI Academic led a statewide survey to determine if WIC participants would prefer changes to the WIC food packages in alignment with recent National Academies of Sciences, Engineering and Medicine recommendations, specifically, an increase in the WIC cash value benefit (CVB) for fruits and vegetables. In response to COVID-19, the CVB was increased nationally. NPI was tasked with collecting qualitative and quantitative data from WIC participants in California and five other states to understand the impacts of this change. NPI also led the publication of several reports demonstrating that the COVID-related pivot to virtual WIC interactions, allowed due to the USDA's emergency waivers to states, were viewed favorably by both WIC staff and WIC participants in California and 12 other states, and that both participants and staff want that these changes to be made permanent. (Lorrene Ritchie)

An NPI partnership with Stanford University and community organizations built upon their parent engagement work with eight school districts in California's Central Valley. The goal was to understand how school food operations pivoted during COVID-19 and to gain families' perspectives on what types of healthy changes they wanted in their school districts' school lunch programs. A photovoice project was developed to conduct research; one result was a series of Parent Voices briefs used as advocacy tools. (Christina Hecht, Ken Hecht)

NPI academics also provided leadership as part of the National Drinking Water Alliance (NDWA) that conducts research and advocacy toward access to safe and appealing drinking water to reduce consumption of sugar-sweetened beverages. This included the provision of information and recommendations to the Environmental Protection Agency related to lead in school and childcare drinking water. The EPA Lead and Copper Rule Revision (LCRR), enacted in December 2021, requires regular testing in elementary schools and childcare sites constructed before 2014, including two samples in childcares and five samples in schools. (Christina Hecht)

A UCCE Specialist at UC Berkeley has maintained an ongoing relationship with Oakland Unified School District focused on evaluating the impacts of their farm to school program, “Rethinking School Lunch.” Their research examines how school nutrition programs can impact revenue for local farms, reduce food and packaging waste, and improve nutrition and access to healthy food for students. (Christina Getz)

A UCCE Advisor extends information about the latest pest control technology with the goal of increasing pest control clientele's understanding of the biology and management of structural pests and efficient, environmentally friendly pest control methods. Presentations, technical assistance, and social media engagement provide information to address issues such as insecticide resistance, commodity damage, and the spread of diseases and unsanitary situations. Clientele includes pest management and application professionals, pest control advisors, housing professionals, public schools, and municipalities. (Siavash Taravati)

During the COVID-19 pandemic, the UC Integrated Pest Management Statewide Program (UC IPM) has conducted outreach and education for urban audiences to help ensure the proper use of disinfectants. Disinfectants have been vital to preventing the spread of COVID-19, and many people are using them more than before, but most don't realize they are registered pesticides. Like any other pesticide, they must be used carefully to avoid personal injury during exposure and work as intended. The UC IPM program wrote newsletter articles and blogs to reach the general public. For the licensed urban pest management professional audiences and business owners adding disinfection services for customers, the program extended information through webinars, reaching hundreds to help ensure they had the correct license category and used the correct pesticide for the job and followed the label instructions. This activity does not yet have a measured outcome but it is included to illustrate Extension’s responsiveness to the pandemic. (Karey Windbiel-Rojas)

As a result of UC ANR research and extension, participants learned about and adopted strategies to improve community health and wellness. Outcomes with specific indicators follow.

**Outcomes**

**Participants learned integrated pest management practices that contribute to improved community health.**

* Participants of UCCE structural pest talks stated that they learned something new or interesting (95.6% of 204 participants) and that they have or will use some parts of the presentation in their work (96.1%). (Siavash Taravati)

**Partners adopted behaviors that contribute to improved community health and wellness.**

* CFHL, UCCE in Alameda County conducted evaluations at 10 out of 28 preschools that received the Healthy Happy Family Curriculum. These data showed that compared to the pre-test, there was an increase in the frequency of the following behaviors: 80% of children eat meals with an adult; 70% of early childhood educators provide a snack at the same time every day; 80% do not use treats to get children to eat; 60% do not beg children to eat food; 70% do not remind children to keep eating food; 90% do not avoid serving foods the child does not like. (Mary Blackburn)
* CFHL, UCCE in Santa Barbara County conducted pre- and post-course surveys with 64 parents/guardians that participated in the Healthy Happy Family Curriculum. After attending the classes, adult participants who shared that they would not offer a treat as a reward for eating other foods increased from 36% to 60%. Additionally, the proportion of parents/guardians who indicated that they would offer food to their child rejected more than once increased from 36% to 80%. (Rosa Vargas, Miguel Diaz, Emily Dimond, Kelly Hong, Betsy Plascencia, Melissa LaFreniere, Abbi Marrs, Shannon Klisch)

**Partners adopted community-level changes that contribute to improved community health and wellness.**

* CFHL, UC reported statewide Policy, Systems, and Environment (PSE) changes at 210 SNAP-Ed sites, contributing to improved community health and wellness for more than 28,400 people. For example, 60 program sites in 11 counties made at least one physical activity-related PSE change; more than half of these sites improved the quality of structured physical activity. (CFHL, UC)
* CFHL, UC sites statewide adopted or enhanced edible gardening and food access strategies, including new or expanded edible gardens at 93 sites, initiating or expanding a mechanism for distributing seedlings and/or other materials to families or communities for home gardening at 84 sites, initiating or expanding use of garden produce for meals and snacks at 22 sites, initiating or expanding a mechanism for distributing produce to families/communities at 17 sites, and initiating or expanding farm-to-table use of fresh or local produce at ten sites. (CFHL, UC) Local highlights follow:
  + CFHL, UCCE in San Luis Obispo County engaged 41 community partners in CFHL, UC programming, including agricultural partners, schools, food banks, nonprofit organizations, and public housing agencies. As a result, these sites collectively adopted 47 nutrition and four physical activity PSE changes, reaching 13,327 community members. (Rosa Vargas, Miguel Diaz, Betsy Plascencia, Kelly Hong, Melissa LaFreniere, Abbi Marrs, Katherine Soule, Shannon Klisch)
  + CFHL, UCCE in Santa Clara, San Mateo, and San Francisco counties supported 66 policy, system, and environmental changes at 51 sites and created innovative strategies to promote fruit and vegetable consumption at home via virtual taste tests and by sending seedlings home and helped to keep farm to school and Smarter Lunchroom Movement efforts moving despite pandemic restrictions.

(Laura Vollmer)

* During the COVID-19 pandemic in Riverside County the Torres Martinez Desert Cahuilla Indian Tribal Council led efforts to increase access to healthy food by distributing 1,600 USDA Farmers to Families Produce Boxes to 400 tribal families and the surrounding community. Finally, the Tribe has recently formed an 8-member Community Wellness Committee to guide the 5-year CDC ACORNS project which implements culturally-tailored policy, systems, and environmental changes, with clinical-community linkage strategies that address chronic disease. (Chutima Ganthavorn, Andra Nicoli)
* The Santa Clara County Board of Supervisors adopted the Santa Clara County Food Systems Workplan in May of 2021. The County’s departments have started to shift resources in order to adopt recommendations outlined in the Workplan, including a sustainability plan and commitment to Good Food Purchasing Plan guidelines; the allocation of funding to hire a Program Manager to coordinate food system work; targeted nonprofit and Social Services agency partnerships to enroll MediCal recipients in CalFresh; a grant to UCCE to support additional food insecurity needs assessment work; and the adoption of food security screening questions by a county clinic. (Laura Vollmer, Lucy Diekmann)

**Science-based information was applied to community health and wellness policy and decision-making at local, state, and national levels.**

* The Mindful Mechanics curriculum developed by UC 4-H and partners at the University of New Hampshire was adopted by the National 4-H program to have mental health conversations and interventions with 4-H youth members National 4-H ages twelve and older. (Anne Iaccopucci, Kendra Lewis, Katherine Soule)
* Kaiser Permanente used NPI’s economic opportunity research to develop its [community health strategy in economic opportunity](https://about.kaiserpermanente.org/community-health/improving-community-conditions/economic-opportunity). These community health needs assessment reports will be used by Kaiser hospital service areas to identify the significant health needs in the communities they serve. NPI also used the data to create a research brief that will be used by the California Department of Public Health to SNAP-Ed stakeholders. The brief will help agencies working with schools encourage their support of improved emergency school food service in the future. (Suzanne Rauzon)
* NPI’s survey on pandemic-related changes to WIC’s CVB demonstrated that WIC participants have a strong preference for the increased CVB amount. NPI also found that the CVB increase translated into higher fruit and vegetable intakes by young children on WIC in the multi-state study. The National WIC Association is using the results of this study to advocate that the CVB be permanently increased, which would have a far-reaching, national impact. NPI’s evaluation of virtual WIC appointments and programming are also being used by advocates, the USDA, and states to inform WIC program improvements and Child Nutrition Reauthorization to improve nutrition and prevent obesity in low-income children across the country. (Lorrene Ritchie)
* The *Parent Voices* photovoice project in California’s Central Valley resulted in a school Based on recommendations from NPI and Harvard University academics, in the Summer of 2021, the EPA’s Office of Drinking Water released their “e-Trackers” for states’ data on school and childcare tap water lead testing results. Widespread e-Trackers could be the foundation for a national database that tracks elevated lead levels in drinking water in these settings. (Christina Hecht)
* Based on recommendations from NPI and Harvard University academics, in the Summer of 2021 the EPA’s Office of Drinking Water released their “e-Trackers” for states’ data on school and childcare tap water lead testing results. Widespread use of the e-Trackers could be the foundation for a national database that tracks elevated lead levels in drinking water in these settings. (Christina Hecht)
* Results of the “Rethinking School Lunch” evaluation bolstered advocacy for farm to school funding by California legislators. As a result, the Governor’s budget included $60 million one-time General Fund allocation for the CDFA-F2F to sustain and expand the California Farm to School Incubator Grant Program. UCCE will be lending support toward the effort to evaluate this grant program over the next five years. (Christina Getz)

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

## Condition Change: UC ANR contributed to improved access to positive built and natural environment

**Issue**

There are documented health benefits of spending time in nature. Yet, a 2019 landscape and urban planning study found inequities in access to urban vegetation in communities that are more ethnically, racially diverse, and have lower income levels. 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 many negative health consequences.

**Methods**

In partnership with communities and allied organizations, UC ANR delivers educational programs and policy, system, and environment (PSE) interventions to improve access to positive built and natural environments.

UCCE academics provided leadership and science-based information for the statewide implementation of the UC Master Gardener Program. Volunteers delivered public education workshops on sustainable landscaping and edible gardening. (UC Master Gardener Program)

As a result of UCCE research and extension efforts, participants learned about the environment and increased access to positive built environments. Outcomes with specific indicators follow.

**Outcomes**

**Change in condition: Improved access to positive built and natural environments.**

* Over 76 participants of UC Master Gardener volunteer-led educational programs reported in a statewide survey that they applied practices to 510,000 square feet of school and community gardens. Gardening interventions have the potential benefit to the broader community. A 2016 nationwide study found that living near greenery may help you live longer due to less air pollution, more physical activity, more social engagement, and most significantly better mental health as measured by a lower prevalence of depression. (UC Master Gardener)

These measured outcomes demonstrated individual learning gains related to the environment and PSE changes that created more opportunities to spend time in gardens and outdoors. In this way, UC ANR improved access to green spaces and the outdoors for people and communities where they live, learn, work, and play. According to the Center for Disease Control and Prevention, you can burn up to 300 calories during just one hour of light gardening and yard work. In addition, research with students has demonstrated that just 30 minutes spent in nature after completing a stressful task improves their mood. The students who were studied exhibited lower levels of cortisol, the stress hormone. Collectively these efforts contribute to the public value of promoting healthy people and communities.

# PROTECTING CALIFORNIA’S NATURAL RESOURCES

## Condition Change: UC ANR contributed to improved management and use of land

**Issue**

Public and private land in California is managed for a wide variety of uses. Challenges include loss of productive working landscapes, human and wildlife conflicts, protecting water quality, living in fire-prone areas, and a better understanding of ecosystem services. Research and extension are needed to help land managers and owners balance the social, economic, and ecological benefits.

**Methods**

UC ANR activities focus on management strategies concerning livestock, wildlife, and land maintenance.

A University of California Cooperative Extension (UCCE) Advisor in the Central Sierra region continued to disseminate information on a recent research project about chemical control recommendations for the invasive weed, oblong spurge (Euphorbia oblongata). With no prior, effective control strategies in place, this plant has continued to expand its range. After the Butte fire of 2015, this plant has rapidly spread in wildland areas throughout the burn. After several herbicide trials, the UCCE Advisor developed a treatment method that provides nearly 100% control. Information was presented to local clientele, UC Master Gardener groups across the state, several government agencies, and professional societies. (Scott Oneto)

UCCE Advisors collaborated with the National Park Service’s national office to update a basic grazing plan for Pinnacles National Park, located in San Benito and Monterey Counties. The update included providing clarification and adding several points in response to questions from the national office. UCCE determined sampling methods, trained contractor and park staff, and obtained input from ranchers. (Devii Rao and Leslie Roche)

A UCCE Specialist’s lab at UC Berkeley spearheaded several testing approaches for pathogen detection in plants, fruits, plant products, oaks, and timber. These include generating composite samples, training dogs and using sniffing jars, and sampling air spora. Furthermore, the lab developed the first polymerase chain reaction(PCR) test to be officially used by a nation (USA) to detect a regulated pathogen. That test was a standard PCR test for the detection of Phytophthora ramorum. (Matteo Garbelotto)

A research project was conducted between a UCCE Advisor, a UCCE Specialist at UC Riverside, a professor at UC Riverside, and other collaborators to develop baiting strategies to control yellowjacket wasps in recreational areas using minimal amounts of toxicants. Two of the sites in this project are located within Orange County Parks: one in Irvine Regional Park and one in Caspers Wilderness Park. Yellowjackets are a pressing problem in these two parks during the summer when they become particularly abundant and prevent the public from safely using the campgrounds and other outdoor facilities. Monitoring traps and experimental baiting stations were set up throughout both parks. (Beatriz Nobua-Behrmann, Dong Hwan Choe, Mike Rust)

A UCCE Advisor and her team monitored Orange County Parks’ trees for emerging tree pests and provided science-based management advice. Orange County Parks manages 60,000 acres of parkland and open spaces with 40,000 inventoried trees, valued at $184 million. Invasive tree pests, like the invasive shot-hole borers, have already affected many of those trees resulting in big ecological and economic losses. (Beatriz Nobua-Behrmann)

A UCCE Advisor in Modoc County continued to address the overpopulation of wild horses on public and private lands, affecting wildlife populations, rangeland health, and short and long-term livestock productivity. The once native perennial grass-dominated rangeland is being turned into bare ground and annual invasive grasses. In the last few years, UCCE has targeted education to policy makers to continue wild horse gathers and developing strategies to place gathered horses in good homes, and developed the 2019 Colt Challenge, which results in 150 horses going home with 4-H and Future Farmers of America youth, family, and friends. (Laura Snell)

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that improved land management. Outcomes with specific measured indicators follow.

**Outcomes**

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

* As a result of UCCE’s oblong spurge efforts, the Amador County Agricultural Department decided to pursue grant funding to implement a county-wide control program informed by UCCE research.This weed poses significant harm to the natural environment as it forms dense stands and outcompetes native and desirable vegetation in riparian areas, roadsides, grasslands, and oak woodlands. This plant is poisonous to animals and can cause severe dermatitis and eye injury. (Scott Oneto)
* The National Park Service used information provided by UCCE to inform their approval of experimental grazing on 75 acres, which is a major step forward in thinking, where grazing becomes a conservation tool instead of a threat. This project is expected to result in an additional 75 acres of grazed land and potentially improve rangeland management and increase ecological sustainability of landscapes. (Devii Rao, Leslie Roche)
* PCR tests are routinely used in California now for all regulated pathogens on all crops, after UCCE advocated for this and designed the first test ever used, as observed by UCCE. This impact is in the billions of dollars nationally. Additionally, entities in the European Union have adopted the airspora sampling approach and PCR tests to identify Heterobasidion in conifers, as observed by UCCE. The impact is equivalent to millions of Euros in savings. (Matteo Garbelotto)
* The first PCR test designed by the UCCE Specialist’s lab was used to identify immediately the first introduction of the EU1 lineage of Phytophthora ramorum in California, providing a much-needed early alert that may substantially have helped the state to slow down its spread. Del Norte County used this information to inform their decision to lead an eradication effort. (Matteo Garbelotto)
* UCCE’s research findings, best management practices, and diagnostic approaches have been used to make restoration decisions by entities like National Parks, the UC Berkeley Botanical Garden, the California Native Plant Society, East Bay Regional Parks, Marin Open Space, Santa Lucia Preserve, Air Force, and San Francisco Recreation and Parks. This has saved tens of millions of dollars from using infected plants, as observed by UCCE. For example, in 2021, the lab contributed to 3,087 oaks being protected via the removal of infectious bay laurel and chemical and cultural treatments. The average success of treatments was 95%, with a range of success between 75 and 100%. The mean cost per tree treatment was $175.00, with the cost per large, monumental tree being as high as $1500 per tree. The value of the effort is estimated at $4,287,500.00. (Matteo Garbelotto)
* East Bay Regional Parks, Bay Area Townships, and others are now using information from UCCE in their long-term management plans for over 1,000,000 Acacias and Eucalyptus trees in the East Bay region. (Matteo Garbelotto)

**Change in condition: Reduced pest incidence.**

* During the summer of 2021, Irvine Regional Park and Caspers Wilderness Park had a 50-88% measured reduction in the number of yellowjackets captured in traps after baiting. This project allowed UCCE to test the efficacy of control methods in a field situation while also providing a solution to local partners and improving the use of natural areas by the general public. (Beatriz Nobua-Behrmann)
* As a result of UCCE’s tree monitoring program and adoption of best management practices recommendations, 80% of Orange County Parks have shown a steady reduction in the number of infested reproductive hosts during the last two years. Some of the parks, like Peters Canyon Regional Park and Mile Square Regional Park, show particularly favorable trends with reductions of 16% and 25% respectively in the number of infested trees during the last year. (Beatriz Nobua-Behrmann)
* Modoc County’s wild horse population decreased from 20 times the appropriate management level to about half due to UCCE’s collaboration and perseverance in the last few years. Furthermore, this decrease has resulted in all except one producer returning to summer grazing and resuming the use of their allotment per a multi-use mandate of public land that supports the local economy. (Laura Snell)

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 maximize the benefits that managed lands provide. In this way, UC ANR contributes to the public value of protecting California’s natural resources.

## Condition Change: UC ANR contributed to improved air quality

**Issue**

More than 90% of Californians breathe unhealthy air sometime during the year. California’s San Joaquin Valley is home to 10% of the state’s population and 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 workdays 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.

**Methods**

UC ANR partners with public, governmental, and private groups to extend new knowledge and develop agricultural management and composting practices to improve air quality.

A UC Cooperative Extension Specialist (UCCE) at UC Davis provided two studies to the California Air Resources Board. (Steve Kaffka) A UCCE Advisor conducted tree fruity industry research about whole orchard recycling and extended results about its air and soil quality benefits. Whole orchard recycling costs $1,000 per acre to recycle, which is more expensive than options like biomass co-generation, which became less available after biomass facilities started closing in 2015. (Brent Holtz)

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that improved air quality. Outcomes with specific measured indicators follow.

**Outcomes**

**Science-based information was applied to industry decision-making to reduce greenhouse gas emissions.**

* The California Air Resources Board used the UCCE studies to improve the accuracy of their method to measure greenhouse gas emissions. Later the California Department of Food and Agriculture adopted the more accurate method to evaluate projects submitted through their competitive grants program. (Steve Kaffka)
* Over 400 growers farming on more than 40,000 acres have recycled their orchards in the last decade after UCCE began conducting the whole orchard recycling research and extension. Additionally, these UCCE efforts helped inform the decision to allocate grants funding received by 539 growers who received awards totaling $18.1 million, recycling 25,934 acres and diverting 727,980 tons of woody biomass from being burned. Furthermore, the California Air Resources Board said that UCCE’s presentation and research program influenced state policy. On February 20, 2020, Assembly Member Flora introduced Assembly Bill No. 2831 with the additional section 38562.1 that would provide carbon offset credits to growers who implement whole orchard recycling. These efforts improve air quality by diverting woody biomass from being burned and increasing soil’s resilience to climate change by sequestering carbon. (Brent Holtz)

These measured outcomes demonstrate improved knowledge and adoption of a variety of practices and policies that reduce air contaminants. From 2017 to 2018, there was a 2.8 million pound reduction in the toxic air contaminants from pesticides in California, as last measured by the California Department of Pesticide Regulation. In these ways, UC ANR contributes to improved air quality and the public value of promoting healthy communities.

## Condition Change: UC ANR contributed to the protection and conservation of soil quality

**Issue**

Soil health is essential for productive agricultural lands. Critical issues that require solutions in California include addressing salinity and nutrients in the soil. Healthy soils can lead to reduced greenhouse gas (GHG) emissions, improvements in crop yields, drought and flood tolerance, and better air and water quality. Soil health can be improved through farm management that increases soil organic matter. Proper understanding and care of soil are essential for a healthy and abundant food supply for Californians.

**Methods**

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.

One UC Cooperative Extension (UCCE) Advisor and collaborators examined the effects of a Delta grower's voluntary agreement with the State Water Resources Control Board Office of the Delta Watermaster to cut back surface water diversions by 25% on soil quality. In another project, the advisor connected UCCE with local government and water agency executives, synthesized the relationship between surface water quality and soil health and helped deliver a report that addressed Delta agriculture, salinity, and management actions in response to the 2012-2016 drought. Findings of these efforts were extended in meetings, presentations, newsletter/blog articles, fact sheets, and journal articles. (Michelle Leinfelder-Miles)

A UCCE Advisor helped organize and moderate two webinars on cover cropping in the San Joaquin Valley and the annual Alfalfa and Forage Field Day, each attended by over 30 clientele. (Joy Hollingsworth) A UCCE Specialist at UC Davis and collaborators continued research on the use of steam to disinfest soil. An upgraded field-scale band steamer for vegetable crops was developed. Prior to planting lettuce, they inject steam into soil in a 4-inch band centered on the seedline. Steam injected into the soil reaching critical temperatures of 60°C can result in over 90% weed control in the seedline. Band steam application also controls soilborne diseases such as Pythium spp. and Sclerotinia minor. These findings were shared with growers and equipment manufacturers. (Steven Fennimore)

Studies on nematode management with pre-plant soil treatments and post-plant remedies were conducted, increasing the awareness of growers of perennial crops regarding the importance of proper soil preparation and continued crop monitoring for nematode diseases. (Andreas Westphal)

A UCCE Advisor in the Central Valley completed the second year of data collection in a large-scale, Western Sustainable Agriculture Research and Education (WesternSARE) funded project with five ranches, which involved spreading 1,000 cubic yards of compost on rangeland. The project examined the effects of compost on soil health, water infiltration, soil nutrients, noxious weed populations, forage quality and quantity, and the economics of the application. One of the benefits of the WesternSARE program is the expectation of producer recipients to disseminate the information to their peers. This exchange of information has played a significant role in the project's success and the implementation of more acres of rangeland being treated with compost. Since the start of the project, the California Department of Food and Agriculture has implemented the Healthy Soils Technical Assistance Program, which provides funding to spread compost to annual rangelands. (Scott Oneto)

As a result of UC ANR research, outreach, and education, growers learned and adopted practices that demonstrated improved soil quality and conservation practices. Outcomes with specific measured indicators follow.

**Outcomes**

**Participants learned about or intended to adopt recommended soil management practices.**

* A measured outcome of Delta soil health research and extension work was that 96% (120 of 125) of survey respondents learned useful information about soil health practices, and 97% (112) intended to use what they learned in the next 12 months. Anticipated impacts also include agency personnel awareness of the link between water and soil in irrigated agriculture, and therefore, water supply policies that consider soil health practices. (Michelle Leinfelder-Miles)
* Participants of the San Joaquin Valley webinars who responded to a post-meeting survey reported that they learned relevant, new information (100% of 10 survey respondents) and intend to use it in the next 12 months (90%). Participants of the field day reported that they learned relevant, new information (100% of 9 survey respondents) and intend to use the new information in the next 12 months (100%). (Joy Hollingsworth)
* Growers and machinery manufacturers have increased interest in band steaming, as observed by UCCE. (Steven Fennimore)
* Almond, stone fruit, grape, and walnut growers increased their awareness of the value of genetic resistance for managing soilborne diseases, and they tend to grow more of the clonal rootstocks with resistance to some soilborne diseases than previously when seedling rootstocks were the standard, as observed by UCCE through dialogue with clientele. (Andreas Westphal)

**Science-based information was applied to soil decision-making.**

* Almond, stone fruit, grape, and walnut growers increased their awareness of the value of genetic resistance for managing soilborne diseases, and they tend to grow more of the clonal rootstocks with resistance to some soilborne diseases than previously when seedling rootstocks were the standard, as observed by UCCE through dialogue with clientele. (Scott Oneto)
* As a result of UCCE’s work, one grower in Yuma, AZ, is planning to build their own steam applicator based upon our design. (Steven Fennimore)

These measured outcomes demonstrate that growers learned and intend to adopt healthy soil practices. UC ANR has contributed to improvements in decision-making and potential technologies that will have the potential to improve soil health. Through these efforts, UC ANR contributes to the public values of protecting California’s natural resources.

## Condition Change: UC ANR contributed to increased ecological sustainability of agriculture, landscapes, and forestry

**Endemic and Invasive Pests and Diseases**

**Issue**

Endemic and invasive pests and diseases cause widespread damage to agriculture, landscapes, forests, built and wooden structures, school and childcare, and urban environments. The spread of invasive pests has increased in recent decades, linked to global travel, produce trade, and climate change. In 2017, the California Department of Pesticide Regulation identified that California used over 205 million pounds of pesticide. Pesticides are often used to control weeds, insects, and other pests. However, when used incorrectly, they can cause environmental problems. Growers, land managers, forestry, and pest control experts need pest management tools and strategies that minimize the impact on natural pest enemies and pollinators, potential for water and soil quality problems, impact on aquatic invertebrates, and endangered species.

**Methods**

UC ANR partners with public, governmental, and private groups to develop and extend new knowledge about integrated pest management (IPM) for growers, land managers, and pest control professionals. Research and extension are conducted at the Agriculture Experiment Station locations and in the field through the University of California Cooperative Extension (UCCE).

A UCCE Advisor, in collaboration with the California Invasive Plant Council, continued to deliver the Invasive Species Lunchtime Talks webinar series. The 2021 series had 350 attendees and highlighted the theme of community science and stewardship related to topics such as management of am estuarine invasive crab, mapping invasive plants post-fire, looking for exotic species in Lake Tahoe, monitoring the spread of invasive shot hole borers, and restoring native tidal marshes. (Sabrina Drill)

A UCCE Advisor provided integrated pest management workshops to horticultural crop producers, farm managers, and prospective growers in the Sierra Foothills. In this region, small-scale horticultural production is often in mixed residential areas, so effective, low-impact pest management methods are required. UCCE's integrated pest management (IPM) education and technical assistance is critical in Placer and Nevada Counties as there are very few, if any, professional, licensed Pest Control Advisors (PCAs) serving specialty crop commodities in these counties. UCCE workshops extended information about identifying and managing key pests across a range of crops and sustainably managing crop pests while minimizing environmental impacts. (Cindy Fake)

A UCCE Advisor in Los Angeles County continued to deliver with UC Master Gardener volunteers an Alternatives to Citrus workshop. The UC Master Gardeners asked participants to fill out who attended a workshop or participated in a tabling activity. As of April 30, 2021, when the funding for this project ended, 3,588 adults were reached through this campaign. (Rachel Surls)

A UCCE Advisor organized the San Benito Weed Management Area’s Annual Rancher seminar. This included pivoting to a virtual format while still allowing ranchers to get their Department of Pesticide Regulations continuing education credits. (Devii Rao)

A UCCE Advisor continues to research solutions to Medusahead, one of the most problematic invasive winter annual grasses invading wildlands and rangelands in California. Medusahead provides poor forage for livestock and wildlife, crowds out desirable species, and provides fine, dry fuels which increase wildfire frequency and intensity. Dry annual grasses threaten sage grouse habitat by increasing and replacing fire regimes in sagebrush ecosystems and crowding out desirable plants grouse use as forage. Long-term research trials with industry collaborators have recently found that indaziflam is a viable option for suppressing medusahead for multiple years, longer than any other control options available. These exciting results have been extended in blog posts, newsletter articles, extension meetings, and invited talks. (Thomas Getts)

A UCCE Advisor in Sutter, Yuba, and Colusa Counties continued extending prune research results to growers through newsletters and the California Prune Board. Collaborative research projects with AES faculty in Sutter-Yuba and UC Kearney Agricultural Research and Extension Center have identified solutions to prune tree fungal pathogens and wood rot fungi, which diminish orchard sustainability in years 10-20 after planting. In 2016, data was used to support a label for the fungicide, Topsin-M®. (Franz Niederholzer, Themis Michailides)

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

**Outcomes**

**Participants learned or intended to adopt pest management practices, including Integrated Pest Management strategies.**

* Invasive Species Lunchtime Talks webinar participants who responded to an evaluation survey reported substantial knowledge gains, such as a ~25% increase in understanding the role of community monitoring in fire recovery, how suppression and eradication are linked, and the impact of an invasive wetland plant on the bird community. Between 40% and 50% said that they planned to volunteer with a community science program; and report sightings of invasive species because of the workshops. This increase in awareness, understanding, and intent to take action can help protect California’s native species and ecosystems. (Sabrina Drill)
* Sierra Foothill beginning farmers participating in a workshop on Identifying and Managing Pests and Natural Enemies in Vegetable Production reported in a survey (n=18) an increase in knowledge of identifying and managing pests by 63%. (Cindy Fake)
* Sierra Foothill farmers and ranchers who participated in a field workshop on managing ground squirrels and completed the workshop survey (n=18) reported increasing their knowledge of ground squirrel behavior by 44% and management and control practices by 67%. Almost 90% of participants stated the intention to change or implement one or more control measures. (Cindy Fake)
* A follow-up survey was sent after 1-3 months after the Alternative to Citrus workshop to see how participants used what they learned at our event. Of those who responded to the survey (n=502), 95% said their knowledge of ACP/HLB improved based on their participation in the event. Surveys showed that 87% of respondents said they were more likely to monitor and take care of their citrus trees based on what they learned. While 63% of survey respondents said they had previously been aware of ACP/HLB quarantines, in real-time, participants often commented to staff and Master Gardeners that while they had been vaguely aware of quarantines, they didn’t know what it meant or what to do. They were appreciative that they now clearly understood what they should do regarding monitoring citrus trees and considering alternative fruit trees. (Rachel Surls)
* Rancher Seminar participants were asked when they would incorporate what they learned. Out of 31 responses, 20 people (65%) said they would incorporate information they learned at the workshop within six months. In general, this would potentially lead to more effective weed management and increase ecological sustainability of rangelands. (Devii Rao)

**Participants adopted recommended pest management techniques.**

* The use of indaziflam grew immensely due to UCCE long-term research and extension on Medusahead. A national wildlife refuge increased adoption to an additional 1,000 acres of sage grouse habitat after adopting it in 160 acres in 2019 and another 160 acres in 2020. Adoption of this herbicide has been proven by UCCE research to control Medusahead, helping land managers to increase the ecological sustainability of landscapes and effectively improve management of their lands for wildlife habitat. (Thomas Getts)
* The use of Topsin-M has increased since 2016 to protect their orchards from canker infection, as observed by UCCE. UCCE informed the label of this fungicide to communicate risks to young prune trees from pruning wound infections. (Franz Niederholzer)
* When surveyed 1-3 months after their participation in the outreach event, 94% of the 244 Alternatives to Citrus workshop participants said that they had monitored their citrus trees for ACP/HLB based on what they learned. (Rachel Surls)

These measured outcomes can create, improve, and enrich the state’s ability to prevent, control, and mitigate pests and diseases. The work must continue as the amount of reported pesticide use in California increased between 2017 and 2018 by 1.28% or 2.6 million pounds, as last measured by the California Department of Pesticide Regulation. 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 its rich and diverse natural resources.

**Sustainable Natural Ecosystems**

**Issue**

Nearly 33% of California’s land is covered by forest, which provides clean air, carbon sequestration, clean water, and habitat for plants and wildlife. There is a critical need for landowners and managers to understand the impacts of a variety of different management practices, including restoration and conservation to these services. Identifying ecosystem restoration methods and ecosystem management practices is needed for California’s plants, wildlife, and other natural resources to continue to thrive.

Rangeland covers an additional 57% of the state. Range provides clean air, carbon sequestration, clean water, and habitat for plants and wildlife. There is a critical need for landowners and managers to understand the impacts of a variety of different management practices, including restoration and conservation to these services. Identifying ecosystem restoration methods and ecosystem management practices is needed for California’s plants, wildlife, and other natural resources to continue to thrive.

**Methods**

UC ANR has led collaborative research and extension efforts and provided support to develop new policies to increase ecological sustainability of forests and rangelands.

UCCE Advisors established nine rangeland monitoring and data collection sites in Santa Barbara County and six in Ventura County. The data is reported to the USDA Farm Service Agency, used when interacting with the U.S. Drought Monitor, and provided to regionally based meteorologists who seek regular, local input. The plots will also provide a rich dataset from which to understand the important but nuanced interactions between air temperature, timing and quantity of precipitation, grazing, and forage composition and production.(Matthew Shapero, Royce Larsen)

A UCCE Advisor collaborated with a UCCE Specialist at Davis to provide scientific understanding of landscape recovery post-wildfire to the US Forest Service Sierra National Forest rangeland management team. In some cases, federal landscapes have prohibited grazing in the year immediately post-wildfire. However, there is limited scientific evidence to suggest that total grazing exclusion is needed; fire has patchy impacts on landscapes, leaving much of the landscape in acceptable condition to be grazed. (Rebecca Ozeran, Leslie Roche)

A UCCE Advisor in Lassen County conducted various applied research projects and outreach efforts on grazing management, rangeland re-seeding, riparian area restoration, and other interrelated topics. A Community Education Specialist/project coordinator position was funded to increase the overall capacity within Lassen County to implement rangeland conservation and restoration projects on the ground while providing a pathway to more participatory science and stronger partnerships with land managers and conservation practitioners. Together, they conducted three hands-on restoration projects, four spring/riparian restoration projects, re-seeding to native perennial grasses projects, and expanded the future project lists. (David Lile, Janyne Little)

In addition, the UCCE Advisor in Lassen County provided critical individual consultation to private and public landowners and managers in response to the 2020 and 2021 Dixie, Beckwourth, Sheep, Hog, Gold, and Loyalton fires. The collective impact of these fires was approximately 1.3 million acres burned in Lassen and Plumas counties. Information about herbaceous and shrub vegetation for east-side Ponderosa pine, sagebrush rangeland, and mountain meadows was shared with the local and state agencies to leverage knowledge to more landowners and managers. Fires can be devastating on many levels, and UCCE has been a trusted source for people who need to discuss restoration options in a detailed and effective manner. (David Lile)

A UCCE Specialist at UC Berkeley and collaborators continued developing the California Ranching Sustainability Assessment tool, which covers forage management, soil health, drought, wildlife, and generational succession. The goal is to provide livestock producers, livestock professional societies, and Natural Resource Conservation Science partners access to best management practices and science-based information on how ranching benefits California by protecting natural resources. Feedback was obtained from ranchers about the usefulness of the prototype hard copy. Work is ongoing to transform this tool into a website that creates a report and certificate for clients. (William Tietje)

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

UC Cooperative Extension (UCCE) academics continued to deliver Forest Stewardship workshops to extend recommended actions to improve forest resilience for private landowners. With 13 completed workshops, UC ANR has engaged 254 forest landowners across California. Findings were shared with the California Department of Forestry and Fire Protection (CAL FIRE). (Kim Ingram, Susie Kocher)

**Outcomes**

**Participants learned strategies for forest stewardship.**

* Forest Stewardship workshop participants who responded to a survey (n=110) indicated interest across the range of management activities that forest landowners can take, attitudes and perceptions increased positively for each: (pre-workshop to post-workshop, 'very or definitely' interested)
  + Prescribed fire: 36% to 86%
  + Fuels reduction: 73% to 95%
  + Tree thinning: 58% to 87%
  + Timber harvest: 16% to 41%
  + Reforestation: 30% to 58%
  + Forest inventory on property: 29% to 81%
  + Forest management plan: 30% to 83% (Kim Ingram)

**Participants adopted recommended practices for forest and range management.**

* Twenty-nine Forest Stewardship workshop participants, who manage over 5,600 acres of forestland in California, adopted UCCE’s recommended practice of completing a free initial site visit by a Registered Professional Forester. This action leads to the development of a forest management plan and implementation of forest management activities, potentially improving overall forest health and reducing the negative effects of wildfire. (Kim Ingram and Susie Kocher)
* Clientele removed over 5,600 acres of phase one juniper in key wildlife habitat areas, and 75 acres of rangeland were successfully re-seeded to native perennial grasses due to UCCE’s learn-by-doing hands-on projects with clientele. (David Lile)
* Twelve private landowners and the US Forest Service land managers implemented UCCE’s recommended strategies related to post-fire restoration of land, including re-seeding, invasive species control, restoration of meadow sod, and post-fire grazing management. Collectively this represents thousands of acres of private land most heavily impacted by the fires and hundreds of thousands of acres of US Forest Service land. After fires of this magnitude, when so many people have lost so much, there is an overriding sense of being overwhelmed by the situation and what would be an appropriate response. The best choice of action is very site-specific. (David Lile)

**Science-based information was applied to forest and range management policy and decision-making.**

* CAL FIRE used information from the January 2021 California Wildfire and Forest Resilience Action Plan and UCCE Forest Stewardship workshop outcomes to inform the decision to continue offering this extension effort. As a result, workshops will continue through 2024.(Susie Kocher)
* The USDA Farm Service Agency used UCCE-collected forage data to make official determinations regarding drought severity and crop insurance payouts to producers.(Matthew Shapero)
* U.S. Forest Service personnel used scientific information shared by UCCE to return summer grazing on burned allotments, accounting for severely burned areas with small reductions (a 30% reduction in one example) in grazeable areas. This ensured that the permitted ranchers did not need to seek additional grazing lands or purchase additional hay during a severe drought year when forage was limited at lower elevations. In addition, permitted grazing ensured that the forest landscape would receive active management, potentially reducing invasive species spread, reducing the accumulation of fire fuels, and reducing brush encroachment on key meadows. (Rebecca Ozeran)
* Ranchers that have used the California Ranching Sustainability Assessment hard copy shared that it helped them make more informed decisions about ranch management and resource sustainability. Additionally, the tools prompted further discussions between ranchers and their employees and families. (Wiliam Tietje)

The aforementioned measured outcomes demonstrate how UC ANR supports the implementation of forest restoration practices and policy and regulation. Increased ecological sustainability of range and forests 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.

**Sustainable Food Systems and Healthy Families and Communities**

**Issue**

California’s growing population of over 40 million people raises environmental concerns for the state’s urban landscapes and urban-rural interfaces, such as effects on pollinator populations, green waste, and water quality and quantity issues. There is an opportunity to improve landscape management industry practices. For example, changes in fertilizer and pesticide applications can reduce negative impacts on the environment, especially surface water contamination. There is also the opportunity to conserve water, given 50% of residential water consumption statewide is applied to landscapes.

**Methods**

UC ANR translates research into actionable landscape management strategies and extends science-based information about environmental horticulture.

The UC Master Gardener Program (UC MG) has volunteers in over 50 counties sharing research-based information on environmental horticulture to help the public grow home, community, and school gardens more sustainably. The program successfully adapted to the COVID-19 pandemic with strategies such as making the help desk completely remote, offering classes and plant clinics online, expanding and maintaining demonstration gardens as allowed by public health orders, creating an online system for plant sales, and increasing the use of social media to share science-based gardening information. Over 6,100 Master Gardeners volunteered 142,200 hours. (UC Master Gardener Program)

In San Bernardino, Riverside, and Los Angeles Counties, the environmental horticulture advisor presented information on drought, heat, and pest-resistant landscape tree selection and care to over 1,500 landscapers, urban foresters, arborists, and other green industry professionals at virtual events. (Janet Hartin)

Drought has been severe in Ventura County, sometimes the worst in the state and the Western States. Typically the main reservoir is one of the lowest in capacity in California. A UCCE Advisor organized an online speaker series focused on drought-tolerant and water-efficient landscapes. Irrigation workshops for gardeners have also been offered on how to convert to drip irrigation. Partnership with the Calleguas Municipal Water District has been expanded and will offer training in water-efficient landscaping to a larger audience. (Jim Downer)

As a result of UC ANR research and extension, participants learned and adopted sustainable landscaping and gardening practices. Outcomes with specific indicators follow.

**Outcomes**

**Participants adopted recommended practices for sustainable landscaping.**

* Members of the public participating in the volunteer-led UC MG education events reported the following through a statewide follow-up survey:
* Created and enhanced pollinator-friendly gardens; for example, 78% (of 228 respondents) started or improved their use of plants that attract and support pollinators. Nearly 62% (of 226 respondents) 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 1.5 million square feet of pollinator habitat. This improves yields from home food gardens and supports local agriculture productivity.
* Used recommended green waste reduction practices; for example, 59% (of 400 respondents) started or improved using finished compost as a soil amendment. This improves soil by recycling organic matter and contributes to less green waste in landfills.
* Adopted improved landscape water use efficiency practices; for example, 69% (of 764 respondents) started or improved using mulch, and 61% (of 744 respondents) started or improved the practice of selecting low water-use plants. In addition, participants reported removing over 145,000 square feet of turf. These practices reduce landscape water use.
* Adopted integrated pest management practices; for example, 74% (of 563 respondents) started or improved monitoring for pests or diseases, and 61% (of 560 respondents) started or improved the practice of removing or not introducing invasive plants. These practices slow the spread and protect natural and managed ecosystems. (UC Master Gardener Program)
* In response to surveys, over 92% of urban foresters, landscapers, and other ‘green industry’ attendees of seminars and workshops on drought, heat, and pest-resistant trees indicated the information presented would “most definitely” result in improvements in improved tree care selection and care practices. Over 94% indicated information presented would conserve water and other resources. (Janet Hartin)
* In response to a survey, 56% of participants in the Ventura County Master Gardener Program’s educational events reported that they selected low water-use plants after attending a Master Gardener program. In addition, 50% of attendees who responded to a follow-up survey stated that they had installed home drip irrigation systems, increasing the efficiency of their home irrigation by 20-40%. These efforts have helped major water districts that partner with the program save millions of gallons of water applied in landscapes. (Jim Downer)

Together these measured outcomes demonstrate that because of UC ANR’s efforts, some landscapes are now more ecologically sustainable – supporting pollinators, reducing and reusing green waste otherwise going to landfills, protecting water quality, and saving water. UCCE research estimates that implementing best management practices for landscapes could save between 1.3 million to 2.9 million acre-feet of water per year in California. (Janet Hartin) In this way, UC ANR contributes to the public value of protecting California’s natural resources.

## Condition Change: UC ANR contributed to improved water quality

**Issue**

Poor water quality can result from a variety of point and non-point sources of pollution such as land development, land-use practices, or pollutants and sediment in runoff from stormwater in urban and agricultural sites. Inefficient irrigation systems can lead to large volumes of subsurface water drainage, increasing the leaching of nitrates into water. When nitrate in a public water supply reaches or exceeds 45 mg/l standards, costly measures are required to remove it. In California, multiple areas have elevated nitrate contamination levels in groundwater, including the San Joaquin Valley, Santa Ana Valley, and Salinas basins. Water quality regulations for irrigated lands in California require that growers monitor water use and nutrient discharges to limit the movement of fertilizers into groundwater and surface water. In addition to managing agricultural lands, protecting water quality from rangelands is also a significant concern as surface runoff and groundwater on rangelands provide essential municipal water sources for regional communities.

**Methods**

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.

A UC Cooperative Extension (UCCE) Advisor in the Capitol Corridor region and UCCE Specialist at Davis wrapped up a 3-year research trial on organic nitrogen (N) and extended findings to growers about matching application rates with crop N needs. Unlike conventional N fertilizers, N from organic amendments is made available by microbes, making N release difficult to predict. The complexity of N dynamics in organically managed soils leaves growers struggling to sufficiently fertilize, accurately report, and financially juggle fertilizer cost with yield benefits. Findings were extended in videos, leaflets, peer-reviewed publications, and five trainings to 189 growers in three locations. (Margaret Lloyd, Daniel Geisseler)

A UCCE Advisor specifically worked to address watershed pollution levels in Orange County and Los Angeles County caused by pesticides such as bifenthrin and fipronil, which have been detected regularly by the California Department of Pesticide Regulation. Two local meetings were organized in Santa Clarita to educate Pest Management Professionals (PMPs) about appropriate ways to reduce pesticide runoff in urban areas and a problematic watershed called Bouquet Canyon Creek. Every pest control company active in the region was invited to the workshop and 90 participants attended. Additionally, pesticide runoff-related content was included in many other PMP presentations in the region. (Siavash Taravati)

University of California Cooperative Extension (UCCE) conducts several nitrogen-related research and extension projects. New groundwater regulations, including the Irrigated Lands Regulatory Program (ILRP), aim to protect groundwater quality and require farmers to report Total Nitrogen Applications (TNA) and other data to regional water quality coalitions. Growers and ranchers must report the volume of irrigation water applied, the nitrate concentration of the irrigation water applied, list the crop types and acres harvested, pounds of nitrogen applied from fertilizers to each crop type, and pounds of nitrogen content of compost or amendments applied to the soil or land. Also, complying with the proposed ILRP regulations is challenging for these growers due to language and cultural barriers. UCCE academics provided one-on-one technical assistance with nitrogen reporting requirements to help farmers comply with regulations. (Qi Zhou)

A UCCE Advisor in Plumas, Sierra, and Butte Counties conducted research and extension work in regulatory compliance for livestock producers, regulatory relief for low-threat agricultural producers in the region, and implementation of best management practices. This included taking a leadership role with UCCE Specialists at UC Davis to provide education to the Central Valley Regional Water Board and interviewing every irrigated land operator in the Upper Feather River Watershed regarding their management practices. Findings included low- to zero-use of pesticides and fertilizers and low economic return, which were shared with the Central Valley Regional Water Board. (Tracy Schohr, Kenneth Tate, Tina Saitone) The advisor also served on a Technical Advisory Committee to the Sierra Valley Groundwater Management Plan and conducted a rapid study to illustrate groundwater quality in the district to prevent unnecessary costs to the district in the future. (Tracy Schohr)

UCCE academics, working collaboratively with regional conservation districts, USDA, Sustainable Conservation, and others, provided public comments on AgOrder 4.0. AgOrder 4.0 is a collection of water quality regulations proposed by the California Regional Water Quality Control Board, Central Coast Region, to ensure they align with up-to-date research. (Joji Muramoto, Richard Smith, Michael Cahn, Daniel Geisseler). A UCCE Advisor also contributed nitrogen research to the Central Coast Regional Water Quality Control Board for the AgOrder 4.0 (Margaret Lloyd)

A UCCE Advisor conducted research to develop and test infield management practices that can mitigate pollution in agricultural runoff and outreach findings to growers, farm managers, industry representatives, and governmental and conservation agencies involved with water quality regulation. This research addressed the issue of intensive farming of vegetables and berries on the Central Coast, excessive irrigation, and stormwater runoff. Sediments, nutrients, pesticides, and bacteria in agricultural runoff can impair the quality of rivers and estuaries on California’s Central Coast, potentially jeopardizing the health of the Monterey Bay Marine Sanctuary. Growers face strict water quality regulations and need to implement practices that reduce losses of sediments, nutrients, bacteria, and pesticides from their fields. (Michael Cahn)

A UCCE Advisor in Ventura County conducted a randomized complete block design study with 16 treatments replicated four times in a commercial field. The study elucidated the costs versus benefits of the major and costly biostimulants used in strawberry production. In particular, the study identified only one biostimulant that was effective in overcoming N deficiency. The results were presented with a handout at a field day event at the study site, two other local workshops, a national professional society conference, and an international conference, reaching approximately 210 people in Ventura County only. The UCCE advisor also studied N fertilizer removal and its effects on harvested produce in several fruits and vegetables in the Central and South Coast. The study included 15 fields per crop and four samples per field. Strawberry and celery data has been presented at two field day events in Ventura County, shared with local stakeholders, and a coalition group created to address regulatory requirements. In addition, the data will be used to add cabbage, cilantro, raspberry, and Summer-planted strawberries to CropManage. (Andre Biscaro)

As a result of UC ANR research and extension, participants learned and adopted practices that improve water quality. Outcomes with specific indicators follow.

**Outcomes**

**Participants learned about recommended management practices for preserving water quality.**

* One hundred percent of 35 organic N workshop participants who responded to a workshop evaluation reported improvements in N knowledge, and 85% expect this knowledge to help with regulatory reporting. (Margaret Lloyd)

**Participants adopted recommended management practices for preserving water quality.**

* Follow-up communication with the Pest Management Professionals revealed that about three out of ten (30%) people changed the way they apply pesticides as a result of attending UCCE watershed quality meetings and learning about safer and more environmentally friendly pesticide application methods. (Siavash Taravati)
* Through one-on-one technical assistance, UCCE helped 51 farmers from socially disadvantaged communities to complete the required paperwork for the Irrigated Lands Regulatory Program (ILRP), avoid costly fines, and comply with water regulations to protect groundwater quality. This affected over 250 acres of farmland, with approximately 45770.47 pounds of nitrogen application and 18,426,803 tons (585,137,700 gallons) of water application in agricultural land. (Qi Zhou)

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

* The Central Valley Regional Water Board used scientific research provided by UCCE to approve its first region for reduced regulatory restrictions, which focus on expansion to minimize compliance burdens and costs to livestock producers. When complete the project should keep over $45,000 in the hands of rural farmers and ranchers in my local community while simultaneously reducing a regulatory burden and protecting water quality. (Tracy Schohr)
* The Sierra Valley Groundwater Management District utilized UCCE’s research findings and technical advising to adopt a 500-page plan that will guide district management, planning, and research for the next five years and potentially reduce thousands of dollars in annual costs for landowners in the region. (Tracy Schohr)
* Water quality regulation AgOrder 4.0 was revised to include discount factors for organic fertilizers and cover crops and high carbon amendment application credits due to UCCE and partners’ collective efforts. These revisions eliminated a biased penalty towards organic growers in nitrogen reporting and may incentivize all growers between Santa Cruz and Santa Barbara Counties to adopt cover cropping. (Joji Muramoto)
* The Central Coast Regional Water Quality Control Board finalized and approved Ag Order 4.0 using data from UCCE’s research (Lazicki et al. 2020) to establish new targets and limits for organic nitrogen fertilizers. This policy aims to meet state goals to protect water quality and will significantly impact how organic vegetables are grown. This science-informed policy will lead to improved land management and conservation of waterway quality. (Margaret Lloyd)
* The Department of Pesticide Regulation used results of the UCCE pesticide studies to evaluate the registration of neonicotinoid and pyrethroid pesticides in California. This could potentially lead to changes in how growers apply these pesticides to prevent aquatic toxicity. (Michael Cahn)

**Change in condition: Improved water quality.**

* The Ventura County commercial field collaborator benefitted from the biostimulant research trials, specifically in the trials that used one product, an N-fixing bacteria. This product presented significant evidence to overcome approximately 40% of N deficiency. Although not commercially available yet, there has been considerable interest from growers and consultants in this product. Increased yield and reduced N fertilizer through the use of certain biostimulants is well-documented in the literature (Youssef et al., 2020; De Luca et al.,2020; El-Serafy and El-Sheshtawy, 2020; Kaya et al., 2020; Akimbekov et al., 2020), indicating significant potential for improved returns, water quality preservation, and regulatory compliance.(Andre Biscaro)
* Four large celery growers/companies, who account for approximately 80% of the Ventura County acreage, and eight strawberry growers have reported benefit from the N uptake information developed in UCCE’s study. Some reported N fertilizer use reduction, while others increased yield. Most celery and strawberry growers have used the N removal information created in UCCE’s project to comply with state regulations; that trend is expected to follow suit for the other crops once data collection is completed. CropManage administrator Michael Cahn reported that CropManage users in Ventura County created 2,130 irrigation and N fertilizer recommendations in 72 ranches in recent years. The use of accurate N uptake information to guide fertilization is well-documented in the literate to increase yield and decrease off-site movement of nitrate (Fiez et al., 1995; Dhital et al., 2016; Abebe and Feyisa, 2017; Hartz et al., 2018; Bottoms et al., 2013; Cahn et al., 2017; Feigin et al., 1982), which consequently leads to increased economic returns and decreased nitrate contamination of surface and groundwater (Zotarelli et al., 2009; Zhang et al., 2011). (Andre Biscaro)

These aforementioned measured outcomes demonstrate improved knowledge and adoption of mitigation management practices. 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. Improved practices enable managers to reduce pollutants, leading to more environmentally sustainable farming and ranching. Thus, UC ANR contributes to the public value of protecting California’s Natural Resources.

## Condition Change: UC ANR contributed to improved water use efficiency

**Issue**

More than nine million acres of farmland in California are irrigated, representing roughly 80% of all water used for businesses and homes. The state faces challenges to meet its water demands. As the state’s population expands and agricultural water uses are curtailed to meet new sustainable groundwater management guidelines, there can be 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 the urban sector in and around homes to meet increasing demands.

**Methods**

UC ANR conducts research projects throughout the state to identify more efficient water practices and extends them to growers, managers, decision-makers, and the public to transform how Californians use water.

A UC Cooperative Extension (UCCE) Advisor, AES, and other UCCE collaborators conducted a statewide walnut water use efficiency project in Stanislaus and Tehama Counties to provide regional information for the central portion of California. These trees typically receive damage from typical industry over-watering. The walnut irrigation applied research project indicates that a grower could save approximately 868,928 gallons per acre, per year, by starting irrigation in May or June, rather than starting when most growers typically do in March or April. (Kari Arnold)

A CE Specialist at UC Davis monitored evapotranspiration in three cherry orchards over three years. This information provided specific crop coefficients for irrigation in sweet cherry orchards and could also identify the potential for regulated deficit irrigation in the post-harvest period. (Kosana Suvocarev)

A UCCE Advisor in San Diego County offered six webinars on irrigation scheduling based on evapotranspiration, irrigation system performance, and runoff management. Two seminars were offered twice, once in English and once in Spanish. The advisor also collaborated with greenhouse and outdoor container nurseries to conduct an applied research project on sprinkler head efficiency. Pressure, wind speed, and distribution uniformity were measured. (Gerry Spinelli)

A UCCE Advisor in Butte, Glenn, and Tehama Counties conducted collaborative research and extension efforts on orchards, including topics like irrigation management. They focused on the plant-based pressure chamber technique that directly measures tree water status and irrigation needs. (Luke Milliron)

A UCCE Advisor in Monterey, San Benito, and Santa Cruz Counties continued research to develop accurate models for estimating crop water use of coastal crops and efficiently scheduling irrigation of these crops using evapotranspiration weather data. This information was used to expand the [CropManage](http://cropmanage.ucanr.edu/) online application to additional commodities so that growers can efficiently schedule irrigations from weather data available from the California Irrigation Management Information System (CIMIS). Results were disseminated widely to clientele through presentations, newsletters, blogs, and trade journal articles. (Michael Cahn)

A UCCE Advisor in San Joaquin County and a UCCE Specialist at UC Davis collaborated on campus-based research trials and extensive soil and tissue sampling in commercial tomato fields to improve understanding of water and nutrient dynamics in drip-irrigated tomatoes. The results of this work fed directly into the development of two different decision support tools whose development was led by the UCCE Specialist and another UCCE Advisor in Monterey County. The first is CropManage for tomato: a computer-based tool for growers to aid in irrigation and nutrient management decisions. The second is a simple online tomato nitrogen budget calculator. These tools are publically available online, and information was extended to growers and consultants via numerous extension presentations and a newsletter article. (Brenna Aegerter, Daniel Geisseler, Michael Cahn)

UCCE county-based academics and community education specialists in Santa Cruz and Santa Clara Counties delivered trainings and technical assistance to support small farmers' understanding of the requirements of and submitting Healthy Soils Program (HSP), State Water Efficiency and Enhancement Program (SWEEP), and Agriculture Resilience Incentive (ARI) grants. These grants assist growers in implementing practices that improve soil health and water-use efficiency. (Qi Zhou)

A UCCE Advisor conducted a nitrogen (N) study at UC ANR’s Desert Research and Extension Center and on 14 commercial fields of leaf lettuce, romaine lettuce, head lettuce, and processed onions. The N uptake curve and N needs and removal coefficients information were developed for these commodities. The findings were disseminated to growers and stakeholders through articles, training presentations, and media interviews. The data and demonstration trials were used to adapt the CropManage online irrigation and nutrient management decision support tool for carrots, as well as continued efforts to adopt CropManage for the low desert crops initiating with onions, different types of lettuce, spinach, and alfalfa. In another project, the advisor conducted extensive field measurements in 53 commercial fields over the last three-year for 11 agricultural commodities, including alfalfa, carrots, onions, Klein grass, date palm, lemons, olives, sugar beets, spinach, sunflowers, and wheat. The findings provide evidence about the benefits of the residual of energy balance method, water use sensors, and soil moisture sensors specifically in southern California and potentially provide significant benefits to the region by supporting enhanced water and nutrient use efficiency and drought resilience information for profitable and sustainable crop production. Findings were shared with cooperative growers, local irrigation and water districts, and in several articles. Lastly, the advisor studied seven commercial date palms with different soil types and conditions, canopy features, and irrigation practices for the major date cultivars in the region. Information on date palm's best irrigation management practices was developed and disseminated in collaboration with the CA Date Commission. (Ali Montazar)

A UCCE Advisor evaluated processing tomato deficit irrigation influence on soil salinity levels. In a replicated three-year applied research study with a cooperating grower, sub-surface drip irrigations' influence was evaluated in a commercial field. The results showed no apparent impact on salinity within the soil. Furthermore, the study reinforced that on the clay loam soil, there is no negative impact on yield or quality of tomatoes due to the reduction in applied water. Ongoing findings were shared with the cooperating grower. (Tom Turini)

UCCE was part of an effort to help qualify range managers do their own water reporting to meet California regulations, which can often be cumbersome for livestock managers to comply. The reporting includes both stock water ponds and irrigation diversions. Extension efforts included classroom certification and a hands-on water measurement field meeting. (Josh Davy)

A UCCE Specialist at UC Riverside and his water team conducted landscape irrigation field trials to investigate the effects of irrigated turfgrass and groundcover species irrigation on CO2 emissions, cooling benefits, and water conservation. Findings were extended information through their website and Twitter account, which act as a clearinghouse to reach a diverse audience. (Amir Haghverdi)

A UCCE Specialist at UC Riverside analyzed residential water consumption in California and found that it fell dramatically in the past three decades. These reductions result from various water-conservation policies and other efforts by state and local water managers. The specialist also partnered with multiple regional water agencies to investigate the effectiveness, costs, and unintended consequences of conservation programs (e.g., rebate, lawn replacement, education, and pricing programs) effectiveness using household-level water use data. Results have been widely disseminated through workshops, water agencies board meetings, professional conferences, and reports. (Mehdi Nemati)

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that improved water use efficiency. Outcomes with specific measured indicators follow.

**Outcomes**

**Participants learned and changed attitudes about the environment.**

* Both collaborating Stanislaus County walnut growers have expressed a desire to change their irrigation practices and begin using the pressure chamber for better irrigation management. If half the county acreage adopted the practice, this would amount to 15,640,704,000 gallons saved on an annual basis. Furthermore, the tree mortality rate due to over-irrigation would decrease. (Kari Arnold)

**Participants learned about recommended irrigation practices.**

* In an end-of-session survey, San Diego webinar participants reported that they plan to adopt tools presented about evapotranspiration-based irrigation scheduling and distribution uniformity (88% of 27 survey respondents). (Gerry Spinelli)
* The cherry grower that hosted UCCE’s evapotranspiration experiment shared that they intend to continue implementing an irrigation schedule using UCCE’s crop coefficient measurements. (Kosana Suvocarev)
* As a result of the UCR Water team’s extension efforts, clientele enhanced their knowledge about urban irrigation best management practices and potentially increased urban water use efficiency and resilience to climate change and variability, as observed by UCCE. (Amir Haghverdi)
* The California State Water Resources Control Board (SWRCB) utilized UCCE findings and recommendations on the effectiveness and consequences of water conservation programs in the implementation of "Making Water Conservation a California Way of Life'' regulations, in response to Governor Brown's Executive Order B-37-16 issued in May 2016. UCCE recommendations were also used by Elasonor valley, Eastern and Western municipal water districts to develop and implement conservation programs. (Mehdi Nemati)

**Participants adopted recommended irrigation or other water and soil management practices.**

* Cooperating nurseries benefitted from participating in UCCE's applied research project by adopting a new sprinkler head that was more efficient than the growers were using. Additionally, the nursery staff was trained to continue using the new sprinkler. (Gerry Spinelli)
* Evidence of grower adoption of plant-based irrigation management continued. For example, after working with a grower for a couple of years, he reported he had adopted best management practices recommended by UCCE across 500 acres. The grower also reported that his trees looked healthier and noted, "I should have listened to you and started a year earlier." This anecdote shows that adoption requires a year-after-year repeated extension to the same clientele to get adoption. (Luke Milliron)
* Grower use of CropManage increased significantly during the past three years. More than 27,000 acres per year of lettuce were managed using the online decision support tool. Additionally, 7,700 acres per year of broccoli, cauliflower, celery, and strawberries were also managed using this CropManage. This online application provided more than 2,500 recommendations per month during the growing season in 2019. Field trials testing the CropManage have demonstrated that growers can reduce average water use in celery and cauliflower production by more than 40% without sacrificing yield and quality. (Michael Cahn)

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

* Through UCCE’s water use research and technical services, the water management agency in Pajaro Valley made progress in achieving half of the water conservation goal outlined in their basin plan. Additionally, the California Strawberry Commission redirected resources towards developing an irrigation education program using the protocols developed under UCCE’s irrigation efficiency program. (Michael Cahn)
* Tomato irrigation growers adopted the use of CropManage software, demonstrated by data showing that 727 tomato irrigation recommendations were made in the first two growing seasons that the software included tomato information. (Brenna Aegerter)
* As a result of UCCE technical assistance, 26 small growers were awarded HSP, SWEEP, or ARI grants, totaling over $478,000 and affecting over 200 acres of farmland. Growers used the grant funds to replace leaking pipes, valves, and inefficient pumps to improve irrigation efficiency and water-use efficiency as well as purchase and apply compost, mulching, and sawdust to their farm to improve soil quality. (Qi Zhou)

**Change in condition: Water saved.**

* Cooperative carrot growers who switched furrow irrigation to sprinkler irrigation in nearly 500 acres and followed best irrigation and nitrogen management practices developed by this study conserved 0.8-acre feet per acre water (20%) and reduced N fertilizer application by 17%. Cooperative onion growers who switched furrow irrigation to drip irrigation and adopted the findings of this study conserved nearly 1.7 acre-feet per acre of water, increased yields by 21%, and reduced N fertilizer application by more than 32%. (Ali Montazar)
* As a result of collaborating in an irrigation study, one cooperative grower found that water use efficiency improved by 18%, puffy skin diseases of date fruits reduced, and fruit quality improved overall. (Ali Montazar)
* Eight date growers in the low desert adopted recommended irrigation management and developed tools in date palms, achieving higher fruit quality and conserving water by 15%. This provides a better understanding of crop water use and best irrigation management practices in date palms. (Ali Montazar)
* As a result of the tomato deficit irrigation influence study, the cooperating grower began applying 25% less water from approximately 50 days pre-harvest and 50% less from 30 to 15 days preharvest. He uses this schedule on approximately 5,000 acres of processing tomatoes annually. At an average evapotranspiration rate of 2.0 inches per week, this schedule resulted in a water savings of an estimated 2.4 billion gallons of water over the last five years. (Tom Turini)
* Exams in water measurement workshops demonstrated increased knowledge in water use efficiency. Operators shared that they could more easily comply with water regulations because of UCCE's efforts and developed a greater understanding of the amount of water diverted. Prior to developing water measurement skills through UCCE's hands-on learning activities, their efficiency level was unknown to them. Weather stations throughout California provide insight into the amount of water used by particular crops. By matching water use to diversions, managers can develop priorities for improving irrigation on the land they manage. In addition, without these skills producers would have been forced to hire an engineer to design and implement their reporting system, which would have cost them thousands of dollars. (Josh Davy)

These aforementioned measured outcomes demonstrate how water users better understand and adopt water use efficiency measures to help California reduce its water demand while maintaining crop yields. Ultimately, improved water management will increase water cost savings, reduce water usage, benefit the end-user, and reduce groundwater over-pumping in California. For example, it was estimated in 2019 that California growers could save approximately $147 billion gallons of water per year by using California Irrigation Management Information System (CIMIS) weather data to inform more efficient water practices (Zilberman, et al., 2019). Thus, UC ANR contributes to the public value of protecting California's Natural Resources.

## Condition Change: UC ANR contributed to increased water supply security

**Issue**

California's climate has the largest precipitation and streamflow variability in the contiguous United States. 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. Many groundwater basins have seen significant reductions in groundwater levels over time, which is increasingly problematic in the face of climate change. This trend, coupled with a growing urban population, requires more efficient management of water resources. (Ellen Bruno) The Sustainable Groundwater Management Act in California will require that pumping be reduced to bring recharge and extraction of groundwater back into parity. Failure of water users to achieve targets could lead to court adjudication, further limiting pumping and potentially the amount of land that can be farmed. Identifying new ways to ensure and secure a safe water supply is essential to California's health and prosperity.

**Methods**

UC ANR extends new knowledge using both in-person and virtual methods to increase understanding of groundwater resources and conservation.

A UC Cooperative Extension (UCCE) Advisor and Specialist extended their research findings and their case study for water budget development on Ukiah Valley Groundwater Basin (UVGB). Results suggested that the groundwater basin is not in overdraft and that a portion of the Russian River is a gaining river (approximately 18,952 AF/y) from November to June and a losing river (approximately 393 AF/y) from July to October. Based on previous work and the results of this paper, the observed later groundwater losses signify connectivity between the UVGB and the Sanal Valley Groundwater Basin. (John Harper, Samuel Sandoval Solis)

Two UCCE Advisors responded to the Lassen and Modoc County Board of Supervisors’ need for local technical assistance, assessment of agricultural irrigation water needs and potential for enhanced recharge. This included participating in weekly coordination of the groundwater planning, extension outreach, and applied research related to the Big Valley groundwater planning process. (David Lile, Laura Snell)

A UCCE Advisor in Marin County extended watershed management technical information and worked with county, state, and national agencies in policy engagement activities. (David Lewis)

A UCCE Specialist and AES faculty at UC Riverside addressed water affordability by developing a unique panel data set of prices and pricing structure across about 200 water utilities. Notably, these 200 water utilities account for roughly 80% of California’s residential water consumption (serving more than 23 million people in the state). They also partnered with multiple regional water agencies to examine water affordability using household-level water use data comprising over 50 million billing records. The main takeaway from their analysis is that different types of water services (e.g., basic needs, indoor water use, efficient water use) and assumptions surrounding the reference income level (e.g., water district level, block group level) used in calculating metrics of affordability matters substantially to the perceived affordability of water within any district or region. Results have been widely disseminated through workshops, water agencies board meetings, professional conferences, and reports. (Mehdi Nemati)

As a result of UC ANR research, outreach, and education, participants learned and adopted practices that lead to increased water supply security. Outcomes with specific measured indicators follow.

**Outcomes**

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

* The voting members of the Groundwater Sustainability Agency (GSA) were defined based on UCCE's UVGB research. The study clearly identified surface and groundwater users, and based on those estimations, the GSA's voting members were created to represent each group. It should be highlighted that the Ukiah Valley GSA is one of the few that has a tribal and agricultural seat, which is not common in the GSA throughout the state. (John Harper, Samuel Sandoval Solis)
* The Lassen Board of Supervisors used technical information provided and written by UCCE in the Big Valley Groundwater Sustainability Plan. This chapter in the plan outlined potential mitigation projects and management actions that landowners may adopt to help balance the water budget in the county. (David Lile)
* Marin County used UCCE watershed management information to approve the agriculture chapter in its Climate Action Plan update for 2030. (David Lewis)
* UCCE watershed management information was used by the US National Park Service to make a Record of Decision for the Point Reyes National Seashore General Management Plan Amendment and Environmental Impact Statement. (David Lewis)
* The Eastern Municipal Water District used UCCE's data set to inform their decision to start a new program that provides aid to its customers at or below 200% of the federal poverty line. The California State Water Resources Control Board (SWRCB) utilized UCCE findings and recommendations to develop and implement "The Low-Income Water Rate Assistance Act," established through Assembly Bill 401. (Mehdi Nemati)

These 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 supports communities as they develop groundwater management plans to bring pumping and recharge into balance by 2042 to comply with the state's Sustainable Groundwater Management Act. Thus, UC ANR contributes to the public value of protecting California's natural resources.

# BUILDING CLIMATE RESILIENT COMMUNITIES AND ECOSYSTEMS

## Condition Change: UC ANR contributed to increased preparedness and resilience to extreme weather and climate change

**Issue**

The associated effects of climate change are increasing the risk of extreme weather events that negatively impact California’s ecosystems, agriculture, and communities. Because of our changing climate, working landscapes as well as peri-urban and urban areas are experiencing the effects of intense wildfires, persistent droughts, and urban heat islands. In summer, impervious surfaces in urban areas are often more than 50 degrees F higher than nearby surfaces shaded by trees and other vegetation. Low-income neighborhoods often have much lower urban tree canopy cover and higher incidences of pulmonary and cardiovascular disease rates than wealthier communities. (Janet Hartin) Increasingly extreme and erratic weather patterns caused by climate change also threaten crop yields and farm profits across the state. Land managers, growers, and communities need effective response and adaptation strategies to prepare to deal with the growing risks.

**Methods**

UC ANR collaborates with agencies, land managers, and communities that have been impacted by catastrophic fires, droughts, heatwaves, and urban heat islands. Science-based information is provided to aid in recovery and prevention efforts and develop improved practices.

The UC California Naturalist Program conducts trainings to engage the public in the study and stewardship of California’s natural communities. The statewide program equips partner organizations to deliver Climate Stewards trainings and monitors evaluation results of participants through the use of a post- then retrospective pre- end-of-course survey. (Gregory Ira, Adina Merenlender, Sarah Mae Nelson)

In partnership with the California Department of Food and Agriculture, the UC ANR Climate Smart Agriculture Educator team has provided hands-on assistance to over 200 farmers and ranchers through grant application assistance, workshops, field days, and events. Over 120 clientele were able to receive funding after receiving technical assistance and continue to receive support from UCCE in the implementation of climate-smart projects. (Dana Yount, Emily Lovell, Caddie Bergren, Nicki Anderson, Shulamit Shroder, Samikshya Budhathoki, Esther Mosase, Kristian Salgado, Valerie Perez)

A UCCE Advisor in the Delta region supported a growing rice industry by providing growers with production and pest management advice and guidelines to be successful. Extension efforts included presentations, blog articles, one technical report, and an article in an industry magazine with over 3,000 subscribers.(Michelle Leinfelder-Miles, Luis Espino, Whitney Brim-DeForest)

A UCCE Specialist at UC Merced conducted research to enhance agricultural resilience to climate and weather risks, with a focus on studying impacts of climate on various specialty and agronomic crops. Science-based information about managing risks and adaptive management practices was extended through workbooks, workshops, locally relevant technical assistance, and policy engagement activities. (Tapan Pathak)

A UCCE Specialist at UC Berkeley and co-Principal Investigator from the Karuk Tribe continued their agroecosystem resilience work and long-term monitoring plots to assess the impact of climate change and land management on Karuk culturally significant foods and fibers. They developed and disseminated over 50 plant guides on cultural food, fibers, medicinal plants, invasive plants, and plant diseases to help with plant and disease identification. Additionally, new technologies and practices that integrate Western and Indigenous science perspectives were developed for Karuk Tribal government. Examples include a digital species distribution prediction model, mobile field data collection tools, knowledge databases, immersive visual tours, and 360-degree imagery of research plots in collaboration with the UC Informatics and Geographic Information Systems program. (Jennifer Sowerwine, Andy Lyons)

A UCCE Specialist at UC Davis conducted research projects directly funded by the grape and wine industry in response to new issues and direct requests from industry members. Topics include determining smoke exposure risk and mitigation options in the vineyard and winery. Findings are disseminated through extension programs. (Anita Oberholster)

A UCCE Specialist at UC Merced established a long-term partnership with the USFS Pacific Southwest Research Station through The Kings River Experimental Watersheds (KREW) Project. One study evaluated how forest thinning affects streamflow and forest mortality and, for the first time, demonstrated that water made available from thinning, a recommended forest management practice, can either be taken up by remaining trees (provide drought resilience) or flow downstream. These results provide key insights to forest and water managers with different management outcomes. For example, forest managers may look to increase drought resilience, while water managers may be more interested in maximizing water supply. Findings were presented at several meetings. (Safeeq Khan)

UCCE Advisors developed data on livestock and rangeland infrastructure loss from fire during the Santa Clara Unit (SCU) lightning-complex fire, which was the 3rd largest fire in California’s history. (Sheila Barry, Theresa Becchetti) A UCCE Advisor in Placer, Nevada, Sutter, and Yuba Counties continued to extend information about rangeland drought and wildfire mitigation strategies and support the six targeted grazing businesses he helped expand or establish. (Dan Macon)

A UC Cooperative Extension (UCCE) Advisor in Los Angeles and Ventura Counties conducted extension events related to maintaining fire-resistant landscapes around structures in wildland/urban interface areas, habitat recovery post-fire, and fire-related debris flow events and residential preparation for fire. Clientele includes land and public agencies, environmental NGOs, and residents and groups that represent them, such as fire safe councils. In particular, the Southern California Fire Symposium reached over 350 individuals. (Sabrina Drill)

A team of UCCE Advisors, UC faculty, and USDA Forest Service scientists continued monitoring the growth and health of twelve species of underplanted but promising heat, drought, and pest-resistant landscape trees in a ‘climate-ready landscape tree’ research study at UC Riverside. After applying adequate water during the establishment period, the irrigation system was turned off to determine how the trees would perform under extremely dry conditions. Despite the trees showing drought stress, most species recovered by January 2021 due to late fall/early winter rainfall. Results of this study were shared with over 1,500 arborists and other ‘green industry’ professionals via webinars. and seminars. (Janet Hartin, Jim Downer, Darren Haver) A UCCE Advisor also partnered on a state grant with the Inland Empire Resource Conservation District, the CA Climate Action Corps, the City of Redlands, University of Redlands, Esri, and other groups to provide over 400 of the drought, heat, and pest-resistant “climate-ready” trees identified in the study to residents of neighborhoods with low canopy cover and a neighborhood sports park. (Janet Hartin)

A UCCE Advisor in Plumas, Sierra, and Lassen Counties served on the incident management team for Prescribed Fire Training Exchanges, known as TREX. This included growing and developing the Plumas Underburn Cooperative, delivering organized prescribed fire and fuel management workshops, facilitating learning networks, and supporting forest manager and landowner efforts in hazardous fuel reduction. TREX events reached 100 land managers and landowners. In another project, the advisor continued to deliver wildfire preparedness information and assist communities in completing assessments for Firewise USA, a national recognition to empower communities on defensible space, home hardening, and evacuation planning. The advisor also developed a reporting tool to support Firewise communities. (Ryan Tompkins)

A UCCE Advisor developed and facilitated activities with theCentral Coast Prescribed Burn Association (CCPBA), which includes nearly 500 ranchers, farmers, tribal members, land management agencies, academics, students, people who live at the wildland-urban interface, and anyone else interested in prescribed burning. The association purchased a burn trailer and equipment, developed and collected pre-treatment data, built relationships with the California Department of Forestry and Fire Protection (CAL FIRE) and other agencies, and provided consultation for prescribed burns. The CCPBA’s work was extended through three Firelighter trainings, including a virtual presentation about the benefits of prescribed burning. Furthermore, the advisor engaged in policy activities by writing letters, presenting to elected officials, and participating in two legislative hearings. (Devii Rao)

A UCCE Advisor in Santa Barbara and Ventura Counties conducted policy engagement work related to vegetation management and bringing back prescribed burns on rangelands, which had ceased in the last fifteen years. After the widespread devastation of the Thomas Fire, the political climate provided a unique opportunity to resume burning in the counties. The advisor provided leadership to re-establish the Santa Barbara County Range Improvement Association, develop open channels of communication between public agencies, and form a new Prescribed Burn Association that will bring training and fire to Ventura County. residents. (Matthew Shapero)

A UCCE Specialist at UC Berkeley continued a long-term study, Adaptive Management Experiment, for which prescribed burns are an important component. Additionally, the Specialist set up field sites for research burns and mentored researchers who collected data on the impact of multiple prescribed fires on the ponderosa pine. (Robert York)

A UCCE Specialist at UC Berkeley researched water and the environment to understand ecosystem water needs and identify strategies for incorporating ecological principles in water management. An overarching research goal is to predict the effects of climate change and management actions on freshwater ecosystems and their benefits to society. Additionally, the Specialist engaged in a statewide initiative to conserve land and water resources for climate resilience and biodiversity protection and led the development of a white paper. (Ted Grantham)

A UCCE Specialist at UC Davis and several UCCE and clientele collaborators examined ranch and rangeland management decision-making in response to social, economic, and environmental challenges. They surveyed and interviewed more than 300 ranchers, rangeland managers, and restoration practitioners across California through a series of research and extension workshops. This work revealed critical research and extension gaps, produced peer-reviewed publications, and provided important data to the U.S. Drought Monitor and California-Nevada drought early warning system. (Leslie Roche)

As a result of UC ANR research and extension, participants learned and adopted practices that lead to improved preparedness and resilience to climate change and extreme weather.  Outcomes with specific measured indicators follow.

**Outcomes**

**Participants gained understanding of strategies to respond to climate change and extreme weather.**

* Based on initial results from the new Climate Stewards courses, participants reported statistically significant gains in learning climate stewardship, self-efficacy, environmental agency, and climate communication skills. (Greg Ira)
* Southern California Fire Symposium reported in retrospective pre/post surveys increases in understanding of how aquatic habitat is affected by fire (75%), how vegetation and fire regime interact (60%), how fire changes wildlife communities (53%), what drives post-fire type conversion (52%), how soil, water, and air are affected by fire (46%), the importance of habitat connectivity in fire affected ecosystems (45%) and how human health is impacted by fire (42%). (Sabrina Drill)
* CCPBA members shared in a post-training survey how the CCBPA has helped facilitate attitude change toward prescribed burns. One participant stated that the CCBPA helped with “democratization of returning fire to land management, normalizing fire in the community, building tolerance for fire and smoke in surrounding communities, getting CAL FIRE and other fire districts comfortable with the use of prescribed fire and specifically relinquishing control of all things fire.’ (Devii Rao)
* Firelighter workshop participants shared that they would use the information they learned to establish fire lines around their property, identify safety zones and escape routes, improve pump and fire hose setups, apply information while participating in prescribed burns, and continue to volunteer in support of prescribed burns. (Devii Rao)
* UCCE observed through messages from clientele that the winegrape industry has increased their understanding of smoke exposure risk and the limitations of treatment options being sold to the industry, which potentially saves growers money and prevents issues from worsening. Additionally, growers now understand strategies for crop insurance for potential contract disputes and litigation, such as storing grape samples and conducting testing. (Anita Oberholster)

**Participants adopted climate-resilient strategies.**

* An outcome of UCCE’s work in rice armyworm monitoring was the application of a reduced-risk, targeted pesticide on 1,000 Delta acres per year, which potentially reduces pollution caused by alternative, broad-spectrum pesticides. Furthermore, as UCCE helps Delta rice farmers be successful, the rice production system has the potential to sequester carbon and mitigate climate change as indicated by research that has shown that the flooded rice system staves off soil carbon loss, accreting 0.02-0.8 cm/yr (Deverel et al., 2017; Hatala et al., 2012). (Michelle Leinfelder-Miles)
* During a site visit with legislative staff, one CCPBA member said that she had three neighbors who had not been supportive of prescribed burning, but after hearing CCPBA presentations, they are now more comfortable with it. After attending a webinar about the CCPBA, one of these neighbors agreed to allow the expansion of a burn unit to include a small portion of her property. (Devii Rao)

**Science-based information was applied to fire and climate-resilient policy and decision-making.**

* The California Natural Resource Agency used science-based information from UCCE research and extension efforts in their report, which will guide the agency in future policy decisions. The UCCE Specialist served on the agency’s expert advisory panel on expanding climate action through nature-based solutions, in response to an Executive Order by Governor Newsom. This demonstrates how UCCE engages in policy implementation. Anticipated impacts include protecting and restoring practices for carbon sequestration and accelerated climate-smart land management. (Tapan Pathak)
* UCCE's research findings were also used heavily in a report by the Delta Stewardship Council, a state agency, released in May 2021 called "Delta Adapts: Creating a Climate Resilient Future." This report is used to inform future work at the agency and provide guidelines and a toolkit for the local governments. Similarly, Butte County climate change vulnerability assessment and Berkeley Law reports also referred to this research for planning and policy recommendations. (Tapan Pathak)
* Karuk tribal community members shared that they intend to utilize the plant guides to supplement lesson plans on threats to cultural plants to be conducted in local schools and make them available in the Karuk Sípnuuk Digital Library. The Karuk Tribe’s Tribal Heritage Preservation Officer utilized UCCE’s shared information about the archeology of project sites, which contributed to decisions regarding cultural management and protection of areas rich in artifacts. (Jennifer Sowerwine)
* More Karuk tribal community members and Karuk Department of Natural Resources staff are monitoring cultural plants for the effects of climate change as a result of UCCE’s collaborative agroecosystem resilience work. Furthermore, these efforts have increased the long-term capacity of the Karuk Tribe to monitor the effects of land management and climate change on 20 culturally significant species beyond the end of the project. (Jennifer Sowerwine)
* Federal counties were able to declare federal emergencies and provide evidence to CAL FIRE of the SCU fire’s potential impact by using UCCE’s data. This supported the deployment of 450 to 500 firefighters to suppress the fire. (Sheila Barry)
* Three new communities completed their assessment and received Firewise recognition status in 2021, and three additional communities initiated Firewise assessments and plans due to receiving UCCE technical assistance and support. These communities serve over 3,000 rural residences and, in 2021 alone, contributed over 5,600 volunteer hours of Firewise work and $235,000 of investments in wildfire preparedness. (Ryan Tompkins)
* The National Fire Protection Association adopted the use of UCCE’s Online Firewise Reporting tool, which supports 30 Firewise communities across Plumas and Sierra Counties. In 2021, the tool [documented](https://ucanr.edu/News/?routeName=newsstory&postnum=49021) over 14,000 hours of community Firewise volunteer hours and over $1.5 million of community investment in wildfire preparedness across two rural northeastern California counties. (Ryan Tompkins)
* Cal Poly used information from UCCE’s prescribed burn efforts to inform their decision to reassess policies and allow the CCPBA to conduct a joint CAL FIRE/CCPBA burn at Swanton Pacific Ranch. One professor at Cal Poly had been trying to get approval from the university to conduct prescribed burns at Swanton Pacific Ranch for over ten years with no success. This burn will set the stage for future prescribed burns and associated prescribed-burn research on Cal Poly lands. (Devii Rao)
* UCCE's policy engagement activities contributed to the passing of SB 332, which will make California a gross negligence state for suppression costs associated with prescribed fire. A potential impact of SB 332 is that more people will be comfortable with and therefore conduct prescribed burns on their properties as they will not be required to pay CAL FIRE for suppression costs if a fire escapes, as long as possible they meet certain safety standards. This can potentially make our communities safer, improve livestock forage, and improve habitat for a variety of native plant and wildlife species. (Devii Rao)
* The Placer County Water Agency, Yuba Water, The Nature Conservancy, other utility companies, and nonprofits have used UCCE’s Kings River Experimental Watershed project findings to convince their rate payers to implement active forest management policies. This demonstrates how UCCE contributed to attitudinal shifts from the “timber grab for water” and focusing on downstream benefits alone to a multi-benefit framework that includes improving forest health and building forest resilience to drought. (Safeeq Khan)
* The US Drought Monitor and USDA California Climate Hub utilized qualitative and quantitative data from UCCE and other rangeland professionals to inform the US Drought Monitor drought decision-making process. Local, state, and federal agencies use the USDM to trigger disaster declarations, determine eligibility for relief programs, and activate regional drought responses. These coordinated, regular reports from UCCE and partners have provided important data to national and regional mapping efforts on drought conditions and impacts across California's rangelands. (Leslie Roche)
* The California Natural Resource Agency utilized many of UCCE recommendations on how to more effectively incorporate freshwater in its “Pathways to 30x30” policy framework in response to an Executive Order by Governor Newsom. (Ted Grantham)

**Change in condition: Climate resilient land.**

* The six targeted grazing practitioners reduced fuel loads on more than 5,000 acres in the Sierra foothills and northeastern Sacramento Valley with assistance from UCCE. (Dan Macon)
* UCCE technical support for the Plumas Underburn Cooperative and local California prescribed training exchange (Cal-TREX) event in the northern sierra region educated 51 participants on local fire ecology, science, and management and contributed to the implementation of eleven community prescribed fires in Plumas County. (Ryan Tompkins)
* UCCE’s direct organizational and policy engagement led to a significant increase in the number of prescribed burns in Santa Barbara County on 1,149 acres since 2018, 493 of which were during FFY2021, and planned implementation of training burns in Ventura County. (Matthew Shapero)
* The Watsonville Slough Farm used information from UCCE's prescribed burn efforts to inform their decision to co-organize a six-acre burn on their farm. This resulted in the UCCE Advisor's first prescribed burn and the opportunity to provide CCPBA activities at a live burn. (Devii Rao)
* UCCE’s research contributed to an additional 150 acres of land on the western slope of the Sierra Nevadas being treated with prescribed burn to build resilience, sustain heterogeneity, and contain wildfires around communities. (Robert York)
* The Chino Basin Water Conservation District is now planted with four UCCE-recommended, climate-resilient tree species. Ongoing research through 2021 confirmed that the trees continued to grow in circumference, despite the spring 2020 drought when the recycled-water irrigation system was turned off. (Janet Hartin)
* Over 400 “climate-ready landscape trees” identified in the UCR study of drought, heat, and pest-resistant species were provided gratis to residents of low tree canopy neighborhoods and a municipal sports park frequented by youth. UCCE. Master Gardeners in San Bernardino County are ensuring that ecosystem benefits of the trees (shade, cooling urban heat islands, enhancing habitat, reducing energy use, etc.) are realized long-term by providing ongoing tree care information via seminars, community meetings, and at community parks. A "Trees for Tomorrow Start Today" workshop brought together over 300 municipal planners, city foresters, wholesale and retail nursery growers, landscape architects, home-owner association leaders, and Master Gardeners to discuss how to work together to enhance tree canopy cover in vulnerable neighborhoods. (Janet Hartin)

**Change in condition: Reduced greenhouse gases.**

* Through assisting awardees in the adoption of practices such as cover cropping, installing solar panels, and installing dairy manure solid separator systems, the 10 UC CSA CES have collectively supported growers in reducing 33,000 MT/CO2 per year, as measured by California Air and Resources Board (CARB) Green House Gas Emission reduction calculator ([SWEEP GHG Calculator on CDFA's website](https://www.cdfa.ca.gov/oefi/sweep/)), and the[HSP Comet planner tool](http://comet-planner-cdfahsp.com/). That's equivalent to removing 7,000 cars from the road per year. Furthermore, [research shows](https://www.cdfa.ca.gov/oefi/healthysoils/docs/CompostApplicationRate_WhitePaper.pdf) that Healthy Soils Program practices such as compost application increases the amount of organic matter in soil, amongst numerous other benefits such as increasing the water and nutrient retention capacity of soils, providing a reservoir of nutrients for plants, improving aeration, improving water infiltration, reducing soil erosion, and supporting the abundance and diversity of soil organisms, which can improve plant health. Compost application is just one fundable practice farmers can implement to help reduce greenhouse gasses on their operation. (Dana Yount, Emily Lovell, Caddie Bergren, Nicki Anderson, Shulamit Shroder, Samikshya Budhathoki, Esther Mosase, Kristian Salgado, Valerie Perez)

The aforementioned measured outcomes demonstrate participants learning about and developing new management paradigms to address the challenges of a changing climate.

Adopting mitigation strategies and new policies informed by UC ANR’s science-based research will help increase forest, rangeland, and community resiliency and decrease the impact of fires and droughts. In 2020, over four million acres burned, and over 10,000 structures were damaged or destroyed in California. Compared to 2018, this is an increase of over two million acres and 14,000 structures. In these ways, UC ANR contributes to building climate-resilient communities and ecosystems.