



2025

University of California
Division of Agriculture and Natural Resources
Strategic Vision



Healthy Food Systems

Healthy Environments

Healthy Communities

Healthy Californians



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Introduction

In 2025, California will be home to a rapidly growing, highly diverse population of 49 million people that will need goods, services, and resources supporting widely different lifestyles, cultures, ages, and economic levels.

California's future depends on

- sustainable, nutritious, safe food
- clean, healthy, sustainable places to live, work, and grow
- resilient, biologically diverse, healthy ecosystems
- clean, secure, sufficient water
- cleaner, more secure energy
- educated, engaged, resilient people
- leaders prepared for and capable of making strategic decisions
- innovative solutions and informed choices
- economic opportunity and jobs

To thrive and prosper, Californians must have solutions to a wide range of existing and new challenges. The University of California, and its Division of Agriculture and Natural Resources (ANR), can play a key role in improving California's future by providing leadership and innovation through research, education, and service. Despite the many challenging trends facing California (detailed in appendix 1), the Division of Agriculture and Natural Resources has a bold vision for California of 2025.

ANR envisions a thriving California in 2025 where healthy people and communities, healthy food systems, and healthy environments are strengthened by a close partnership between the University of California and its research and extension programs and the people of the state.

The University remains connected and committed to the people of California, who enjoy a high quality of life, a healthy environment, and economic success in a global economy.

The people and resources of the UC ANR system serve every county in California. These professionals connect and deliver resources from the entire University of California, forming integrated teams to work on complex issues and develop innovative multidisciplinary solutions. ANR professionals have a unique, proven, respected

ANR envisions a thriving California in 2025 where healthy people and communities, healthy food systems, and healthy environments are strengthened by a close partnership between the University of California and its research and extension programs and the people of the state.





ANR professionals have a proven ability to bring together the resources needed to solve tough problems.

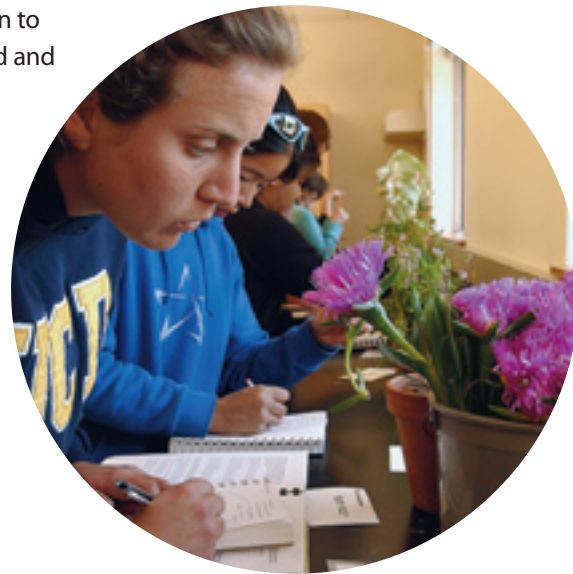
ability to bring together the resources needed to solve tough problems. They connect with the faculty from the California State University system; private colleges and universities; the staff and resources of federal, state, and local government agencies; agricultural, natural resource, and nongovernmental organizations; and others, including leaders and citizens representing environmental, agricultural, youth, and nutrition interests and issues.

The Division of Agriculture and Natural Resources

ANR people, programs, and science-based solutions bridge conflicting interests by bringing new knowledge, targeted research, and local education to complex problems and by preparing common ground for informed and responsible decisions.

Within UC, ANR's mission is to

- maintain and enhance connections that fully engage UC with the people of California
- achieve innovation in fundamental and applied research and education that supports
 - sustainable, safe, nutritious food production and delivery
 - economic success in a global economy
 - a sustainable, healthy, productive environment
 - science literacy and youth development programs



The UC ANR system currently has offices, programs, and academics in every county in California through Cooperative Extension (CE), providing direct connections to the people of California. Campus-based faculty have research and teaching programs in four colleges or schools on three UC campuses as part of the Division's Agricultural Experiment Station (AES). Ten research and extension centers (RECs), located in a variety of ecosystems across the state and connected with multiple field facilities on the three campuses, provide a core research and extension base. Sixteen statewide programs focused on specific issues such as water, food, nutrition, pests and diseases, wildland fire, and energy connect faculty from ANR campuses and counties with UC faculty from all the other campuses, allowing integrated teams to work on complex issues that need multidisciplinary approaches.

ANR Makes a Difference for California

Making a Difference: Healthy Food Systems

For nearly a century, California farmers and ranchers have stayed competitive and sustainable by being early adopters of cutting-edge research, new technologies and innovations, and best management practices developed on UC campuses and in the field. California agriculture has a farm gate value of over \$35 billion, produces 350 commodities, accounts for 50 percent of the nation's fresh produce, and generates over 1 million jobs in food production, processing, transportation, and marketing. UC has produced new varieties of strawberries, walnuts, citrus, grapes, and other crops, while improving food quality and nutritional value for consumers. ANR has introduced California farmers, processors, and marketers to new crops and varieties that have created profitable niches and successful new industries, from California-grown blueberries to the UC-patented strawberries that represent 80 percent of strawberries produced in the United States.

California became the largest dairy-producing state in 1993, currently producing 41 billion pounds of milk annually. Average production per cow has increased by 15 percent over the past decade, with advice from UC's animal scientists, veterinarians, and agronomists.

With ANR's help, agricultural producers have increased yields, improved water efficiency, reduced pesticide loads, become more sustainable, and made food safer.

ANR research has helped agriculture stay ahead of new introductions of invasive insects, pests, and diseases, saving producers millions of dollars per year and keeping export markets open. UC AES scientists pioneered the concept of integrated pest management and classical biological control. ANR's Integrated Pest Management Program revolutionized pest management practices in the state, resulting in substantially reduced pesticide use over nearly three decades.

No, a thousand times no; there does not exist a category of science to which we can give the name "applied science." There are science and the application of science, bound together as the fruit to a tree that bears it.

—Louis Pasteur, 1871



The challenges facing California are numerous and will require multiple strategies to ensure ANR's Vision for California becomes a reality.



Making a Difference: Healthy Environments

ANR academics are seeking solutions to problems facing the Sacramento and San Joaquin Delta exemplified by declining ecosystems, reduced water exports to farms and urban areas, risk of levee failure, and competing demands for land and resources. A recent policy review of alternatives for the Delta, coordinated with the Public Policy Institute of California, was led by ANR faculty.

ANR is researching and developing sustainable farming, livestock production, and timber harvest practices to maintain the economic viability of these businesses, while improving environmental quality and conserving natural resources. As an example, a local CE office in the North Coast coordinated an innovative acquisition of redwood forestland by a conservation trust organization that provided cash flow through sustainable timber harvesting that benefitted the timber industry, fisheries, and ecosystem services.

ANR is providing dairies in the San Joaquin Valley with science-based tools and practical methods to meet new waste discharge regulations and implement cost-effective nutrient management and monitoring practices for environmental protection. ANR academics are working closely with producers and agencies such as Cal EPA and CDFA, as well as with nongovernmental organizations such as The Nature Conservancy, to develop management strategies that maintain water and air quality.

Rice growers, with the help of ANR scientists, solved a rice straw disposal problem in the Sacramento Valley while creating more than 100,000 acres of seasonal wetland habitat for migratory waterfowl through research showing the benefits of winter flooding of harvested fields. These strategies also dramatically decreased the open burning of rice straw in the fall, improving air quality in this heavily populated airshed.

Landowners, government and nongovernment agencies, and emergency responders are working closely with ANR to develop new tools to predict and control wildfires, reduce risks to wildlife, property, and lives, and speed up post-fire revegetation. ANR's proactive educational efforts are credited with reducing confusion during the 2007 firestorms in San Diego and aiding in post-fire restoration efforts.



Research underway by ANR academics in biofuels, wind and solar power, and other alternative energy sources will help Californians reduce their dependence on oil and other fossil fuels.

Making a Difference: Healthy Communities

UC has a physical presence in each of California's 58 counties, providing access to the research and education within UC as well as the direct delivery of knowledge and services at the community level.

ANR academics contribute to the health and viability of agriculture and natural resources by providing direct services at the community level. These direct services are augmented by thousands of associated volunteers.

For example, supported by campus faculty in youth development, ANR houses the 4-H Youth Development Program, one of the largest youth development programs in the nation. In California, 4-H teaches youth (ages 5 to 19) through after-school and classroom enrichment programs, science literacy, and traditional club programs delivered in every county. Twenty thousand 4-H volunteers serve as official agents of the University of California in virtually every community in the state. 4-H alumni have learned valuable science, citizenship, and healthy lifestyle skills that serve them in their adult lives. This linkage between human development and physical and life science faculty ensures strong science-based curriculum and effective delivery to youth in all parts of the state.

ANR is also responsible for the Master Gardener Program, which is supported by environmental horticulture faculty from the campuses. ANR academics train volunteers with the most advanced information on landscape management and horticulture. UC Master Gardeners interact directly with communities by providing homeowners, and backyard gardeners with research-based information and advice on plant selection, alternatives to pesticides, water conservation, and environmental sound solutions for pest problems. In 2007–08, over 4,100 UC Master Gardeners volunteered over 300,000 hours, which represented 145 full-time positions.

Healthy ecosystems provide services such as nutrient cycling for productive soils, natural filtering for clean water, and carbon sequestration, which help mitigate climate change, ecosystem services that are essential for human well-being.



Making a Difference: Healthy Californians

ANR's work contributes to healthy Californians through teaching, research, and outreach education programs focused on nutrition and healthy lifestyles, and through its work on animal and ecosystem health.

ANR helps Californians learn about healthy food choices. The alarming frequency of childhood obesity, inactivity, food insecurity, and poor food choices in California affect all segments of our population. The future health impacts of these issues on California will be staggering unless we can reverse this trend. Childhood obesity can best be prevented with a multifaceted approach; a coordinated, comprehensive school health, nutrition, and physical activity program, created through partnerships with school site personnel, regional growers, and ANR, can help meet this need. ANR campus and county researchers are making inroads into developing science-based strategies to prevent childhood obesity and diabetes and to promote wellness.

ANR has a robust research and education team that addresses many of the most urgent issues facing food safety. As an example, ANR's rapid and effective response to the leafy greens *E. coli* outbreaks in the Salinas Valley, and the continuing basic and field research, monitoring, and investigation, positions UC as the key agent in protecting consumers and California's economy. Globalization of the food supply and the number of imported food ingredients will create even more need for science-based solutions in the future.

The Planning Process

In order to prepare for the future, ANR has embarked on developing a **Strategic Vision** to be followed with a **Strategic Implementation Plan**. Projecting the future is a difficult task, and ANR has drawn on some of the best minds from the University of California as well as leaders in agriculture, nutrition, human and community development, and natural resources. Under the general guidance of a steering committee, five teams were charged with identifying general themes and issues anticipated for California in the year 2025 and ANR's capacity to address these trends and issues.

The five areas were:

- the future demographics and infrastructure of California
- the future of agriculture and food production
- the future of natural resources
- the future of health and nutrition
- the future of human development



These teams drew on scientific literature and surveyed leaders in their respective areas to document the issues and challenges facing California in 2025. They reported their findings in White Papers. In addition, an independent consultant surveyed stakeholders outside the University to determine their opinions about the major challenges and issues. Members of the steering committee, working groups, and information about the consultant can be found in appendix 2.

The ANR Program Council, comprised of four associate deans at Berkeley, Davis, and Riverside, three regional directors, four program leaders, and other ANR leaders, synthesized the five reports and survey data into a draft strategic vision document. After incorporating considerable internal and external input, this Strategic Vision identifies multiple opportunities for integrated, strategic initiatives that address the overlapping challenges facing California. The Strategic Vision realistically pictures a future where thriving people of California and communities partner with the University of California to use science and education to achieve safe and secure food, economic prosperity, and an enduring, productive, high-quality environment where the land, air, and water resources, as well as the benefits they provide, are enjoyed by all.





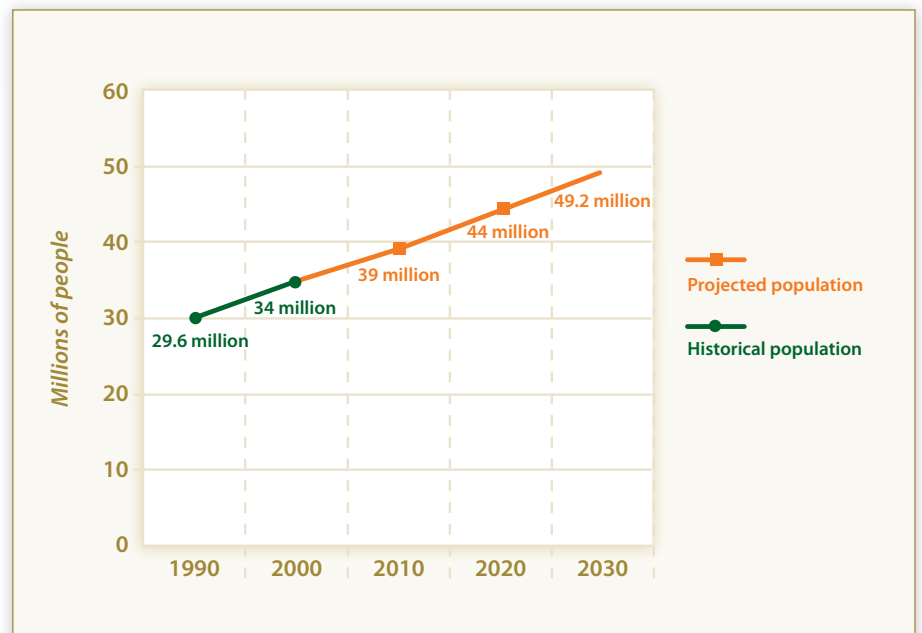
Challenges

California faces many complex challenges. ANR's vision for California proposes multiple strategies, new collaborations, and stronger partnerships to address these challenges.

Increasing global and domestic populations will need sustainable, safe food.

As the global, state, and local population increases, people will occupy a larger urban footprint, and many of the most fertile lands available for agricultural production in the world will be lost. Innovative research and education programs must increase crop production to meet the increased population demands and make less-fertile land productive with limited water. Existing crops must be improved, new crops developed, better nutrient management employed, and pest and disease management strategies improved to create sustainable production. Enlightened land use policy must be based on an understanding of the role fertile land plays in sustainable food production around the world.

Not only must food supplies increase, they must be safe. While one in four Americans reports a foodborne illness annually, the rate is even higher in California, partially due to the state's rich diversity of cultures. With increasingly more of our food and food ingredients imported from countries with a wide



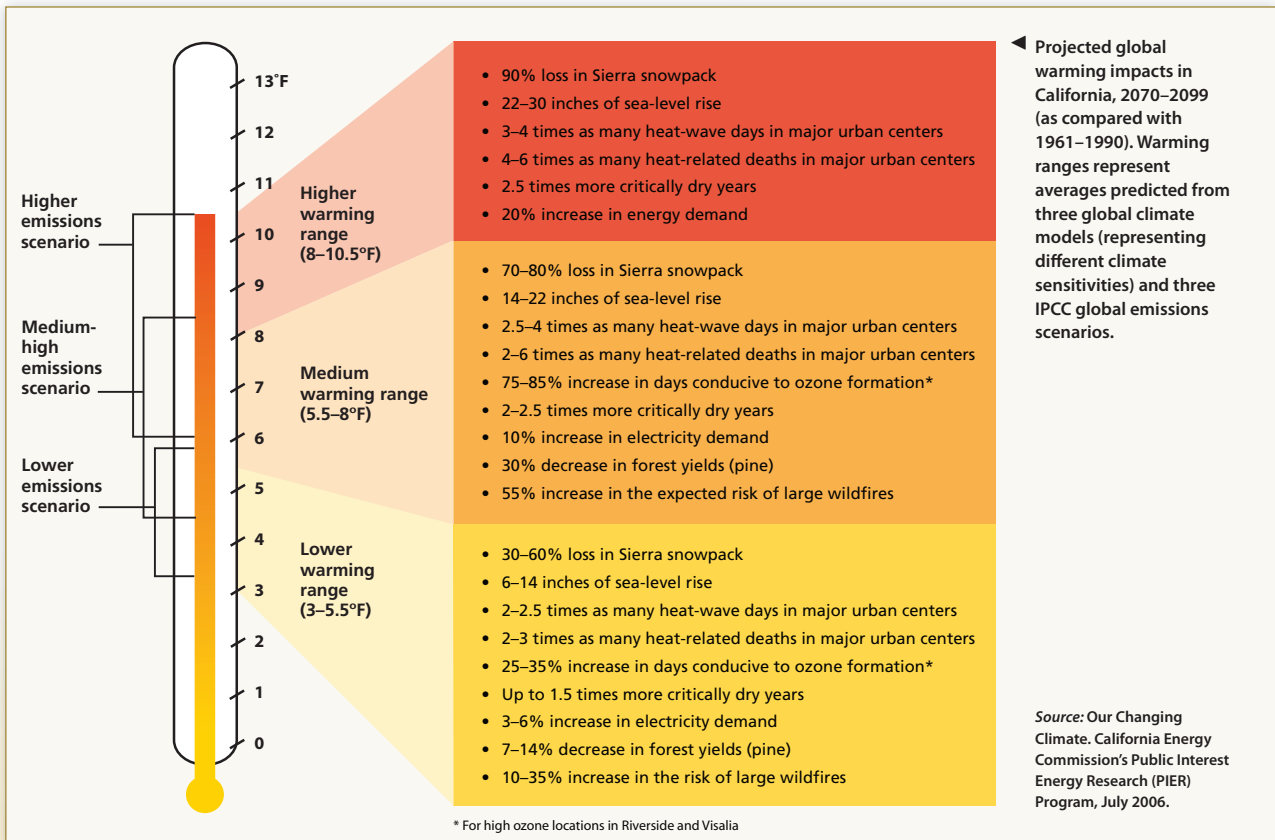
California Population. *Source:* California Department of Finance.

variety of production practices, we can anticipate more food recalls. Older Californians, young children, pregnant women, and those with chronic illnesses will continue to be at heightened risk.

To meet these challenges, we must develop new plant and animal varieties that are adapted to globally sustainable production methods and global food and marketing demands. To expand production sustainably, we must develop and field-test new technologies, new methods to manage diseases and invasive species, and innovative cultural and husbandry practices. Effective solutions can be found only through research and testing in the diverse soil, water, and weather conditions across California.

Increased population, coupled with changes in climate and land use, will intensify competition for water and land resources among urban, environmental, and agricultural uses.

The state’s expanding population, increased water allocations for environmental purposes, and changes in timing and distribution of precipitation will decrease water availability. At the same time,





urban development on prime agricultural land will push production to more marginal land, which will need more water to produce the same yield. Together these trends will create a need for systems that use less water and lower-quality water.

Poor water quality and increased pollution come from many point and nonpoint sources, including storm water runoff, land development, stream and shoreline modifications caused by agriculture and forestry, atmospheric deposition, marinas, and sewage and septic discharges. These sources often contain high levels of toxins and pathogens that are harmful to humans, animals, and plants, while introducing excessive nutrients that can disrupt the delicate balance within ecosystems.

Poor water quality and pollution damage the health of people as well as the health of the ocean, coastal, and inland ecosystems, and can lead to reduced revenue from recreation, tourism, and inland and ocean fisheries.

Addressing local and regional water and land policy issues and developing innovative solutions with so much at stake for so many will not be easy. We must create the infrastructure for new integrated research and educational programs to investigate short-term and long-term approaches to water and land conservation. We must ensure the capacity to conduct research in water use efficiency, deficit irrigation, and management strategies to reduce water needs. We must engage in alternative crop and husbandry research to identify new crops and production methods that require less water. And we must research land use policy that identifies the linkages among urban, environmental, and agricultural demand with probable climate change and population effects.

Increased population and changes in climate and land use will endanger the resilience of natural, managed, and human communities.

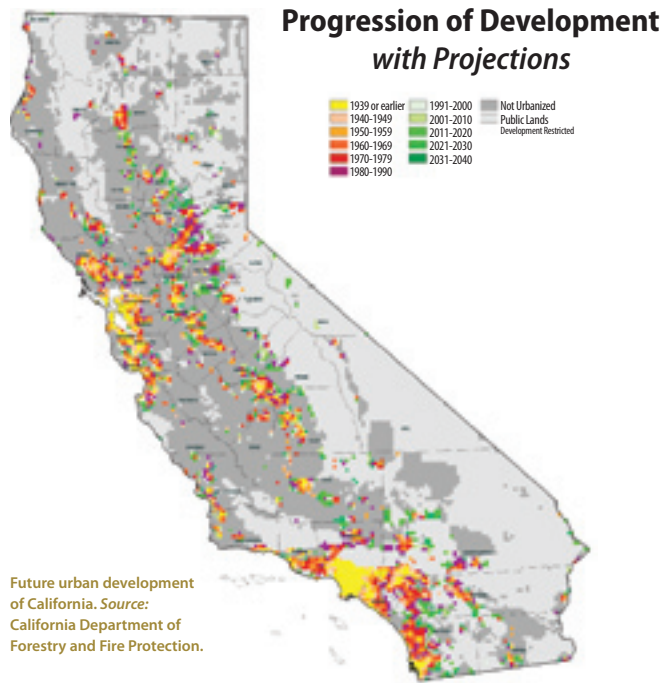
Population growth, coupled with land use and climate change, will impact the resilience of every facet of natural, managed, and human communities. A resilient system or community proves sustainable in the face of change. Only social or ecological systems and communities that are flexible and adaptable can absorb slow or catastrophic change without losing their identity, structure, and key functions.

For social systems, resilience involves the capacity to adapt in the face of threats, to be flexible in the midst of challenge and change, and to transform risk into positive development. Community resilience, for example, requires a robust infrastructure to support transportation, public health facilities, and a variety of institutions to collaboratively plan for, adapt to, and respond to change.



For natural and managed ecosystems, resilience is associated with diversity of habitats and species, adaptability, connectivity, and functional redundancy, all of which increase the variety of possible responses to change.

Studies around the world on resilient and sustainable systems offer knowledge that can be applied to California. Locally specific education programs must help communities build resilience. The capacity to respond locally and autonomously will be especially critical when catastrophic events leave communities without access to outside resources.



Future urban development of California. *Source:* California Department of Forestry and Fire Protection.

Increasing population and changes in climate and land use will stress natural ecosystems, reducing biodiversity and the capacity to provide essential ecosystem services.

More Californians in more communities will face difficult trade-offs between urban growth and natural lands caused by population growth, urban expansion, and a larger wildland-urban interface. Habitat loss and fragmentation will reduce biodiversity and ecosystem services. Air pollution and lowered water quality and quantity will degrade natural resources and reduce the sustainability of human communities.





Maintaining biological diversity benefits agriculture, medicine, and ecosystem services, and also provides recreational and aesthetic value.

Climate change will likely cause species that are unable to adapt to changes in temperature and precipitation to die out or migrate. Oceans will become more acidic and less healthy, ecosystems less dynamic, fisheries less productive, and sea levels higher. The ecology and composition of forests and rangelands will be changed, and their economics will suffer.

California's environmental regulations, already the most comprehensive in the country, will affect agricultural and natural resource production. Multiple stakeholders will need new ways to compare the efficacy and impacts of regulatory and land use decisions. We must develop and deliver new and creative methods for protecting the environment while simultaneously producing goods and services.

The mixture of regional crops and animal products grown in California will change.

Taken together, climate change, population growth, water and land availability, technological change, and global demand will accelerate changes in the type and distribution of crops, animal production, and other products grown in California. Changes in temperature, rainfall, and snowpack will shift production areas, while the loss of prime agricultural land will force additional changes. Population growth and the increasing municipal demand for water will change water allocation in many areas, resulting in further shifts that force agricultural operations to relocate. Shifting demographics will also increase demand for crops that appeal to diverse consumers.

Fundamental and applied short- and long-term research will be needed to investigate how California adapts to these changes. A variety of locations and environments suitable for long-term controlled research, represented by the existing ten research and extension centers and private agriculture and natural resource collaborators, will be essential for California to adapt and thrive.

The capacity to use nutrition to positively impact human health will be a reality.

Obesity, diabetes, heart disease, stroke, hypertension, cancer, and bone disease are just some of the human health threats related to poor nutrition and lifestyle choices. Today, 14 percent of Californians are born with low birth weight or high birth weight due to poor maternal nutrition. Societal influences, including production and marketing of high-fat and high-sugar foods, lack of physical activity, and quick fixes in the form of supplements, fad diets, and other nutrition products, fuel the problem. Individual factors such as cultural practices, consumer misinformation, and socioeconomic status compound these problems.



New cross-disciplinary partnerships must discover and develop solutions to nutrition-related human health issues. Research as well as new educational programs must inform the public about diseases associated with nutrient deficits and excesses, imbalances, and food sensitivities. Current and future research and technologies based on genetics, genomics, proteomics, and other methods must contribute to the creation of designer foods and the ability to determine individual nutrient needs to reduce health risk and health costs. California food producers, from farm to fork, must be more tightly linked to health and medical science professionals.

California's youth will need new and enhanced opportunities for engagement.

It is projected that only 7 of every 10 students will graduate from high school in four years and only 1 in 4 will be ready for college. Because a lower percentage of the population will achieve college degrees in 2025, there will not be enough college graduates to meet the needs of the state's employers. Our society will continue to lose science literacy. For more than a decade, national and international assessments of science education and literacy have shown that U.S. youth perform at levels below those achieved by their peers in many developed countries. The lack of community and civic engagement by our youth threatens the sustainability of California.

The California economy will need talented people with the very best training in environmental, natural resource, agricultural, and nutrition. It is critical that we develop new approaches to increasing science literacy in our society. New partnerships must reinforce skill sets that prepare youth for higher education, future career opportunities, and informed participation in civic affairs and public policy. These future leaders, scientists, educators, entrepreneurs, and professionals will require an outstanding education.

California relies on a steady stream of bright, motivated undergraduate and graduate students. ANR faculty educate approximately 2,300 undergraduate students per year in environmental, natural resource, agricultural, and nutrition at UC Davis, UC Berkeley, and UC Riverside. From the 2,200 graduate students, approximately 200 PhDs and 130 doctor of veterinary medicine degrees are conferred each year. These students are the future leaders, scientists, educators, and professionals who will tackle the toughest challenges facing California.





California will face less-secure and more-costly energy supplies.

The demand and cost for energy will continue to rise, driven by population growth, climate change, and other challenging factors. Innovative strategies for carbon sequestration, development of carbon markets, and management and use of the state's natural and agricultural resources will help create a more sustainable energy future. California agriculture will need new production technologies and practices that minimize energy consumption and use renewable energy sources. Innovative partnerships must provide technological, marketing, and policy advancements that will enable expanded use of forest, range, and agricultural resources for renewable energy production.

The availability of energy will impact our ability to address all of the challenges we face; our very best scientific talent must conduct innovative multidisciplinary research and development on energy production and use. Delivering the benefits of these innovations will require integrated multidisciplinary teams working together to ensure our energy future.

Meeting California's Challenges: Strategic Initiatives for the 21st Century

California must address our challenges to ensure a high quality of life, a healthy environment, and economic success for future generations. The following multidiscipline, integrated initiatives represent the best opportunities for ANR's considerable infrastructure and talent to seek new resources and new ways of partnering within and outside UC to find solutions for California.

Initiative to Improve Water Quality, Quantity, and Security

Water is the life blood of California's economy. As such, water supply and quality for agricultural, urban, and environmental systems is a critical issue facing the state over the next 20 years and beyond. Several issues are paramount:

- The supply of water will be limited for all users.
- Competition for water will intensify among agricultural, urban, and environmental users, with water being transferred from agriculture to the latter two groups.
- Short- and long-term climate trends will exacerbate the problems associated with water availability.

- Degradation of water quality will become more important as a major public issue.
- Legal and regulatory decisions will have significant impacts on water use and quality among all sectors.

The availability of traditionally-relied-upon sources of water is expected to decrease. For example, California will have to reduce its use of Colorado River water by 0.8 million acre-feet, a reduction of about 20 percent. The current drought has severely decreased reserves, and climate change is expected to reduce the Sierra snowpack. Coupled with the aging of the infrastructure for water delivery (e.g., the 1,100 miles of levees on the Sacramento–San Joaquin Delta), it will take a coordinated effort at the state, regional, and local levels to meet the projected increases in water demand.

ANR's role in improving watershed and water management practices and policies:

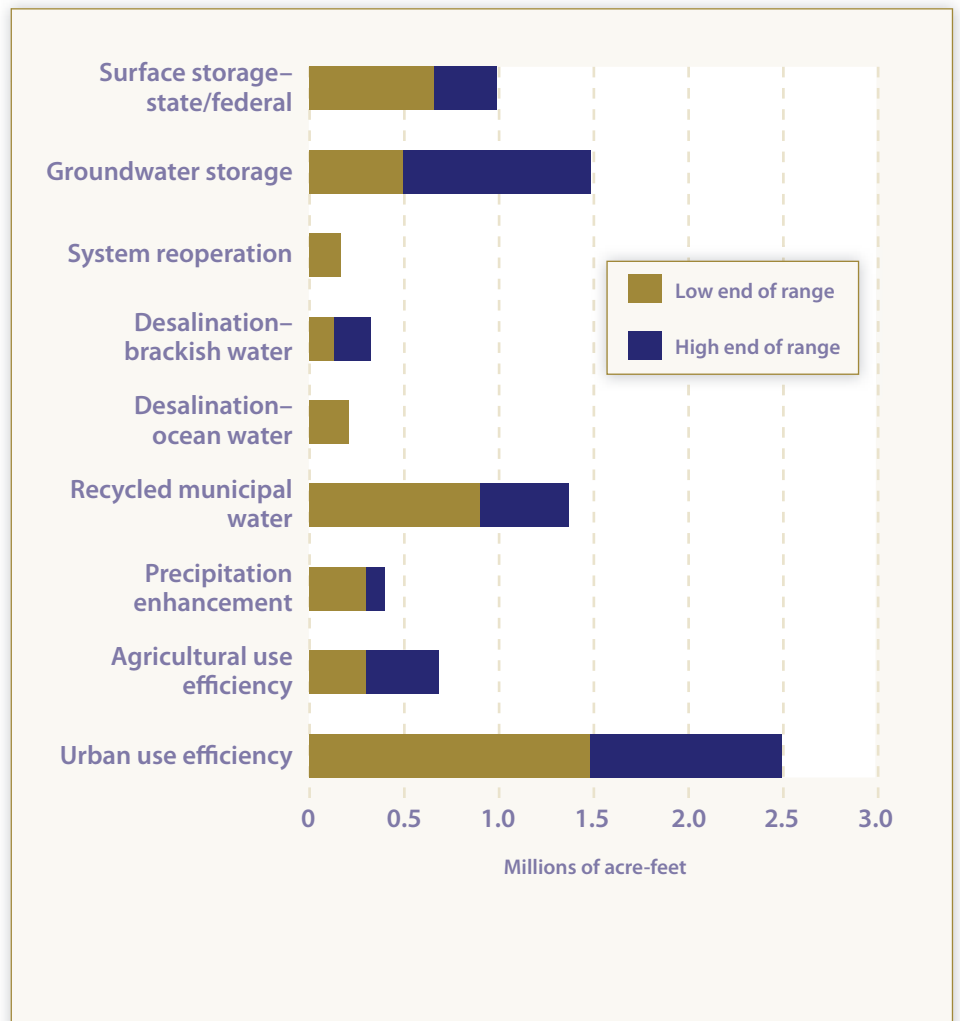
- develop innovative scientific techniques, products, and processes to improve water use efficiency and water conservation management practices
- develop and encourage the adoption of management practices that prevent degradation of watersheds and water resources caused by pesticides, salinity, chemicals, animal wastes, nutrients, sediment, and pathogens, such as:
 - techniques to improve irrigation efficiency and management so that irrigation more precisely matches crop requirements to water supply (both quantity and quality), including monitoring, delivery, uniformity and scheduling
 - genetically improved crops to increase yields, introduce novel traits, and adapt plants to water-limited conditions
 - methods to use degraded water sources (e.g., saline water, urban and agricultural wastes)
- assisting in the development of flexible and effective water policies and strategies using UC's econometric, hydrological, and policy expertise
- science-based research and educational approaches to address these issues in partnership with others, including agricultural groups, environmental groups, and regulatory entities

Initiative to Enhance Competitive, Sustainable Food Systems

California agriculture's competitiveness will critically depend on adopting new scientific and technological innovations derived from new knowledge in agriculture and nutrition. The future promises an information- and knowledge-based economy, and food systems are no exception. Maintaining a strong California food production system and the resources necessary to do so has national security implications. California has been an innovation leader in food production for more than a century, a major factor in enabling the state to become the nation's premier food producer and to adapt to ever-changing challenges and opportunities. Investments in fundamental and applied agricultural research and development have yielded benefits worth 20 times the cost.

Protecting water quality is an essential component of managing California's water resources, since water quality and water quantity are inseparable. Matching water quality to its intended use is not widely practiced; it will become critical in the future.

The economic viability of California agriculture depends on local, national, and global markets. UC scientists have a key role to play in introducing new crops and enterprises and developing new uses for existing crops and animals. Future research and educational efforts must enhance the opportunities for markets and new products. Examples include innovations such as new biofuel crops, new crops such as blueberries, improved processing techniques, new strawberry varieties, unique quality traits of wine grapes and dairy products, improved grass-fed beef, organic melons, and new uses for existing products such as rice straw. UC and ANR will harness new biological knowledge in genetics and genomics to address new markets, unique traits, and market opportunities. To ensure the sustainability of the state's agricultural and food production, California must adapt to the changing nature of both the underlying demand and the competitors in those markets.



Potential new water supply sources in California, 2000–2030. *Source:* California Department of Water Resources.



ANR's role in enhancing the food production system:

- develop and encourage innovations in genetic, genomics, biotechnology, and traditional breeding approaches, producing
 - new varieties of crops, animals, and forest species that thrive in California as the climate changes
 - crops with drought tolerance and tolerance to suboptimal soils (e.g., saline)
 - plants for biofuels, plants with unique applications, plants of improved quality, and plants that produce value-added products
 - new crops to enhance nutrition and reduce chronic diseases and specific health conditions
- encourage innovation in a wide range of new technologies that impact the California agricultural, food, and natural resource economy, including
 - mechanization in agricultural production
 - irrigation water management
 - postharvest quality and value-added products
 - new forest products and use of forest byproducts
- explore the potential of new commodities, expand the uses and markets for existing commodities, and extend information on production and marketing practices
- develop and disseminate science-based practices for production, including organics, for local marketing to help ensure continuation of California's competitive advantage
- generate science-based information and marketing strategies to develop international markets for existing and new California agricultural commodities in developing countries, where population increases will be largest and where world income growth is likely to be concentrated over the next 20 years
- develop and disseminate knowledge on the role of consuming products associated with healthy diets
- identify agricultural crops and systems that share mutually beneficial uses for wildlife and recreation





Initiative to Increase Science Literacy in Natural Resources, Agriculture, and Nutrition

California is undergoing a profound social transformation driven by two forces that have shaped the state throughout history: dramatic demographic changes in the number, age, and diversity of the population, and the impact of science and technology. Education will be a key contributor to the successful outcome of this transformation, providing the principal means of making informed decisions about complex issues, creating policy based on knowledge rather than values, and fueling upward social mobility.

Today, science literacy in the United States is alarmingly low. We are falling dangerously behind other nations in developing a future workforce of scientists, engineers, and technology experts. Widespread ignorance exists about where food comes from, how to make healthy food choices, and why and how to care for the environment and conserve our natural resources. Our collective future depends on policy decisions anchored in good science and an electorate that appreciates and understands science-based information.

ANR's role in increasing science literacy and youth development:

- deliver education programs at the community level, including serving a wide range of audiences from youth (4-H); volunteers (Master Gardner, Master Canners, 4-H); low-income families (EFNEP program); and food stamp eligible populations (FSNEP program) and culturally diverse groups
- develop youth programs that use active learning strategies, including formal and nonformal education, to increase civic engagement, healthy living, and self-directed learning, while incorporating a range of approaches that engage youth with community service and service learning
- strengthen science and math skills to prepare youth for jobs and opportunities in higher education
- expand the science education and literacy programs through nutrition and physical activity programs
- develop, test, edit, and validate effective education tools, materials, and curricula for use in UC ANR programs and in the general education setting
- create, validate, and disseminate innovative methods of evaluating the effectiveness of programs



Accurate science-based information is the cornerstone of making sound personal decisions and public policy. The California public needs a greater understanding of science to make informed personal choices and public policies regarding food production, diet and health, and the natural and human-made environment.

Initiative for Sustainable Natural Ecosystems

Population growth is one of the most important issues that will affect California's natural resources. Future urban and suburban growth is projected to shift more toward rangelands and forests. The larger impacts of urban expansion will also be seen: as urban centers expand, the wildland-urban interface also expands, highlighting trade-offs between urban growth and natural lands (particularly forests and rangelands) in a much larger area. This will impact biodiversity in the form of habitat loss and fragmentation. It will also impact coastal and marine resources in the form of degraded water quality, as well as the sustainability of coastal communities. Water quality and quantity will be impacted as the demand for water increases.

ANR academics will provide fundamental and applied research and information to ensure sustainable natural ecosystems for future generations by addressing issues related to the provision of ecosystem services, such as wildlife habitat and clean air and water, and to the sustainable provision of products such as fish, food for grazing animals, and wood products. Research and education programs must develop science-based approaches to improved land use planning, restoration of degraded ecosystems, and the sustainable supply of natural-resource-based products.

ANR's role in maintaining and enhancing sustainable natural ecosystems includes developing research and educational information on

- ecosystem management systems to ensure that they provide clean air, carbon sequestration, water, and wildlife and plant habitat to guide land use planning
- ecosystem restoration methods for degraded natural ecosystems
- fire-resilient ecosystems
- new production and harvest technologies and practices that provide for sustainable supplies of products while preserving environmental quality
- methods for determining the impacts of climate change on natural ecosystems and resulting changes in the provision of services and products





- minimizing agriculture's adverse environmental impacts and maximizing the environmental benefits yielded by farms and ranches while preserving their economic sustainability
- new production technologies and practices for California agriculture that conserve natural resources and preserve environmental quality
- technology, marketing, and policy advancements to enable expanded use of agricultural and natural resources for the production of ecosystem services such as carbon sequestration, waste recycling, wildlife habitat, and renewable energy generation
- science-based information for regulators to inform the development of policies and regulations that protect environmental quality while sustaining economic viability

Initiative to Enhance the Health of Californians and California's Agricultural Economy

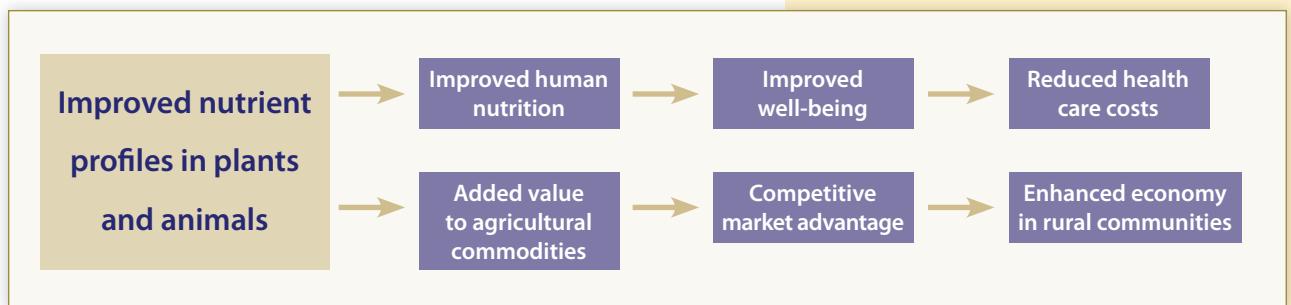
Improving the health of Californians, enhancing their quality of life, and, importantly, reducing their health care costs are critical to the future of California. Research and nutrition education through adult and youth programs must help people make the healthiest food and lifestyle choices. ANR is positioned to address this issue through its statewide network of researchers and educators dedicated to creating, developing, and applying knowledge in agricultural, natural, and human resources.

California is the nation's major producer of vegetables, fruits, and nuts, which are healthy but underconsumed sources of nutrition for Californians and people nationwide. Recent advances in the biological, agricultural, and medical sciences, including genomics, proteomics, and metabolomics, have made it possible to improve the nutrient profiles in plants and animals. At the same time, promising breakthroughs have been made in recognizing an individual's specific nutrient needs and potential adverse reactions such as food allergies, which may be but are not always associated with the individual's ethnic background. We are able to identify food components that have health benefits and determine their mode of action. We are learning how to transfer beneficial food components from one plant or animal to another, making the substances available in foods people like to eat.



Working with producers, we can improve the nutritive value of California commodities and also design a specific diet for individuals at specific stages of their lives. California agriculture will benefit by the value added to its commodities and its competitive advantage in national and international markets. Agriculture's enhanced economic viability will improve the quality of life, education, and other services in rural California and will contribute to the state's overall economy as well.

A weekly meal of fish such as salmon, with its abundant, bioavailable omega-3 fatty acids, provides well-documented nutritional benefits.



Basic concepts of the initiative to enhance California's health. Source: Adapted from the Food for Health Initiative Committee Report.

ANR's role in enhancing the health of Californians:

- conduct fundamental and applied research to provide solutions for food-related health challenges
- form collaborations among ANR faculty, industry, school personnel, and state and county agencies to deliver nutrition education programs to California's population
- identify effective strategies for preventing obesity and chronic diseases related to food
- equip consumers with the tools to make informed decisions about food choices, nutrition, food safety, and food handling





Initiative for Healthy Families and Communities

As we project into the future of human development in the third decade of the 21st century, the one thing that is certain is uncertainty itself. The major challenge for human development systems—our families, schools, and communities—will be to remain or become resilient settings for promoting the positive development of the children, youth, and adults within them. The effects of unprecedented changes in the world, such as global warming, exploding population levels, and the transition from a carbon economy to renewable, reliable sources of energy, will be felt in California and will create challenges for our families and communities.

The concept of resilience is critical to the issue of human development in the face of these massive changes. Resilience involves the human capacity to adapt in the face of threats and stressors, to be flexible in the midst of challenge and change, and to transform risk into positive development. It is a capacity of all human development systems, including individuals, families, schools, and communities.

In fact, resilience may be described as the human capacity for transformation and change. How we tap into and nurture this capacity will be vital knowledge as we move into the next two decades of transformational change.

Coordinated, comprehensive school health, nutrition, and physical activity programs, created through partnerships with school site personnel and regional growers, can help families and communities thrive. ANR is positioned to address this issue through its statewide network of researchers and educators dedicated to the creation, development, and application of knowledge in agricultural, natural, and human resources.

Community sustainability will depend on the ability of community leaders to gather information on and continually monitor a consistent set of key indicators of social and economic vitality.

ANR's role in promoting healthy families and communities:

- conduct research on identifying the factors that contribute to resilient communities
- coordinate active collaborations among UC faculty, specialists, food and agricultural industries, school site personnel, and state and county agency representatives to deliver programs that promote healthy families
- identify effective strategies for prevention of health issues such as childhood obesity, focusing on high-risk populations and the aging population's nutritional issues, including food choice, food handling, and use of supplements
- deliver effective education to individuals and families, who, with improved management skills, would have the resources to make informed decisions



- equip consumers with the tools to make informed decisions regarding food choices, nutrition, food safety, health, agriculture, and environmental issues
- work with community leaders in developing key social and economic information on the economic viability of communities, and develop strategies to enhance community economic development

Initiative to Ensure Safe and Secure Food Supplies

Foodborne illness affects 1 in 4 Americans annually, with higher rates in California. These foodborne illnesses place a burden on our health care system and reduce the productivity of our workforce. Globalization of the food supply, combined with the lack of international food inspections, increases the risk. Older Californians, young children, pregnant women, and those with illnesses will continue to be at heightened risk for foodborne illness.

Californians expect a safe food supply. Three related concerns predominate: inadvertent microbial contamination of food products, such as with *E. coli* or *Salmonella*; chemical contamination, such as the recent tainting of imported products with melamine; and concern about the impacts of potential terrorist attacks on our vulnerable food system.

Food security involves the ability of people to reliably obtain and afford nutritious food. Lack of food security affects communities and the entire state, as poor nutrition is directly related to numerous human diseases and increased health care costs. Food insecurity, which currently affects 1 in 10 California households, will continue to challenge millions of Californians in the year 2025, as the populations proven to be the most vulnerable to food insecurity are projected to grow much faster than those who are not. Only an interdisciplinary approach can effectively address the severe challenges food insecurity presents to social and environmental justice.

ANR's role in ensuring food safety and security:

- develop methods to prevent, detect, respond, and recover from outbreaks of foodborne illness, including trace-back and trace-forward labeling to identify contaminated food products






- develop methods to identify contaminated products
- create and apply technologies to eliminate contamination from the farm to the processor, handler, and consumer
- develop strategies for food producers and handlers to respond and recover from outbreaks
- foster direct marketing options such as farmers markets in low-income communities
- teach people better ways to manage resources to maximize their food purchasing power
- educate community organizations and consumers on safe food handling practices

Initiative for Managing Endemic and Invasive Pests and Diseases

Increasing kinds and numbers of pests and diseases affect agriculture, natural resources, and the quality of life of the people of California. Pests, including native and exotic insects, nematodes, plants, and vertebrates, have a dramatic, and often negative, impact on agricultural and natural resource productivity and ecosystem functioning. Diseases, including those associated with viruses, bacteria, protozoans, fungi, and other agents, decrease production efficiency and product quality, adding significantly to the cost of production. Exotic diseases, those that are not native to the United States or those that have been eradicated, pose a huge threat to the nation's vulnerable livestock and poultry resources.

The speed and frequency of international travel today, combined with the volume of imported food, commodities, and materials, has increased the introduction of invasive pests and diseases into the state. As global climate patterns shift, the distribution of endemic pests will change, and many habitats will become more susceptible to new threats. To ensure the sustainability of the state's food and agricultural production and its natural resources, as well as the health of the economy, California and the world must constantly update the exclusion, detection, eradication, and control of invasive pests and diseases.

Economic impacts from endemic and invasive pests and diseases can include direct and indirect costs to agriculture and the livestock industry, as well as to fisheries and water delivery systems. Annual estimated damage and the control cost of invasive species in the United States alone has been estimated



to be more than \$138 billion. These economic costs of invasions do not consider the equally important impacts to natural ecosystems. Biotic invasion is one of the five top causes of loss of global biodiversity, and it is increasing because of tourism and globalization. Worldwide, an estimated 80 percent of endangered species could suffer losses by negative interactions with invasive species.

Human health threats associated with pest and disease organisms are also of serious concern. This includes the direct introduction of invasive species, such as poisonous plants, rodents, insects, and waterborne diseases, as well as the indirect introduction of invasive organisms as vectors of other species, such as West Nile virus and highly pathogenic avian influenza. The full range of impacts of existing and invasive species and their control goes beyond the immediate effects and can have long-term public health implications.

Integrated pest management is an ecosystem-based strategy developed by ANR scientists that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. This systems-based approach has been embraced and enhanced through ANR's statewide network of academics who address invasive species issues.

ANR's role in managing endemic and invasive pests and diseases:

- provide science-based information to support exclusion strategies and policy, including knowledge of invasion biology to better assess risk, prediction, and intervention
- develop innovative technologies for rapid identification through surveillance and detection systems
- develop effective and economical technologies and tactics for use in diverse agricultural, natural, and urban systems to mitigate or control organisms for reduced environmental impact
- develop economical control or management strategies to maintain price competitiveness in the global economy
- increase the knowledge of invasion biology to better assess risk, prediction, and intervention
- increase our understanding of how changing environments influence the emergence of endemic pests and diseases and the introduction of new species and vectors
- build a spectrum of interdisciplinary expertise from field to bench, whole-organism to molecular, ensuring effective translation of scientific advances into practical applications





Initiative to Improve Energy Security and Green Technologies through Innovative Science Linking Engineering, Agricultural, Biological, and Environmental Sciences

California faces diminishing and more costly supplies of energy even as the demand for energy continues to rise as a result of population growth and increased world consumption. Demands from the public for renewable sources of energy and more energy-efficient agriculture and food production will have a major impact on our food production and transportation. Innovation is needed to efficiently manage energy resources in agricultural and food systems and to explore and develop environmentally sustainable conversion of biofuels.

ANR's role in improving energy security and green technologies:

- research and support innovative new production technologies that minimize fossil fuel energy consumption and use renewable energy sources throughout the California food production system
- develop innovative new technologies and marketing, genetic, genomic, engineering, and agronomic techniques to produce sustainable biofuels from forest, waste, and agricultural resources for renewable energy production, including genetic and biotech innovations from UC scientists
- form highly interdisciplinary teams across UC, agency, and private-sector partners to generate energy savings in food and water systems and create innovations in biofuel production
- develop science-based policy-relevant research and information to guide lawmakers on issues related to energy



Conclusion

California is the most innovative, diversified, and efficient agricultural producer in the world. Our natural resources are unparalleled, with 1,000-year-old redwoods, prime productive forestlands, and vast expanses of beautiful grasslands, deserts, and coastlines. The state is home to a greater diversity of species than any state in the nation. California abounds with culturally diverse, creative people living in a land of majestic mountains, meandering rivers, rich and productive soils, abundant and diverse wildlife, and supreme natural beauty. No other region in the world comes close.

UC ANR is at the heart of California's unique position as a world leader in agriculture and natural resource research and innovation because of UC's unparalleled scientific capacity. Given the future demands on resources, who other than ANR is better suited to meet the needs of a growing state, or for that matter, a growing world?

UC ANR leads UC's rich history of research, education, and creative development in agriculture, natural resources, and nutrition to feed more people, offer more environmental protection, conserve more resources, and improve the health and quality of life of all Californians. Discoveries by ANR to adapt to and mitigate the challenges facing California now, in 2025, and beyond will improve the quality of life for Californians, the nation, and the world. ANR makes a difference.



Appendix 1 California Trends to 2025

People

Population

- California will have 8.5 million more residents by 2025, an increase of more than 22% from 2008, giving the state a population of 46.7 million. Inland areas will experience the most rapid rates of growth, up to 45% in some counties. The Central Valley will experience a faster rate of population growth than employment growth, with consequent transportation infrastructure, and housing challenges.
- California will be a more pluralistic state, with no one ethnic group representing more than 50% of the population. Whites and Latinos will each comprise roughly 40–45%.
- The state's population will be significantly older, with the proportion of seniors age 60 and older increasing from approximately 1 in 7 to about 1 in 5.
- Youth (age under 20) will continue to constitute a large proportion of the population, about 1 in 3.
- Single-parent households are expected to continue rising in number.
- Because of population increases, impacts of urban expansion will also be seen. As urban centers expand, the wildland-urban interface also expands, highlighting tradeoffs between urban growth and natural lands (particularly forests and rangelands) in a much larger area. This will impact biodiversity in the form of habitat loss and fragmentation. It will also impact coastal and marine resources in the form of degraded water quality, as well as challenges to the sustainability of coastal communities. Water quality and quantity will both be impacted as the demand for water increases and more recycled wastewater augments the water supply.

Education

- It is projected that only 7 of every 10 students will graduate from high school in four years, and only 1 in 4 graduates will be ready for college. A lower percentage of the population will achieve college degrees in 2025; there will not be enough college graduates to meet the needs of the state's employers. The shortfall of college graduates will be more than 10% of what will be needed.
- The loss in science literacy is expected to continue. For over a decade, national and international assessments of science education and literacy have shown that U.S. youth perform at levels below those achieved by their peers in many developed countries.
- Currently there is roughly a difference of 150 to 200 points between the California Academic Performance Index (a scale with a range of 800 points) for White and Asian students versus African American and Latino students, and there is no evidence that this pattern will substantially change in either direction by 2025.

Workforce

- The baby boomer generation will be retiring, and many projections indicate that, as a whole, California's replacement workers will have lower levels of educational attainment.
- Currently, many California industries face shortages in critical skills, and recent studies warn that soon more of the state's employers may be unable to find workers with the skills they need to remain competitive. Projections for California's economy indicate that even more highly skilled workers will be required in the near future.
- Economic disparities are increasing among geographic areas due to unequal access to quality jobs, schools, transportation, and affordable housing.
- Employment will shift from manufacturing, natural resources, and mining to service industries.
- Access to a stable agricultural workforce will continue to be uncertain, pending resolution of immigration policy issues.

Food Production

- World population will rise by approximately 30%, creating significantly greater net demand for agricultural products, including food, fiber, and renewable biofuels. This will require more intensive farming practices and higher yields for many crops.
- Shrinking water and land resources will further necessitate higher yields and more efficient farming systems.
- The demand for higher-quality foods will increase due to globalization, increased buying power, and the rise of the world middle class, particularly in China, India, and Russia. California, as the nation's premier food-producing state, will be particularly impacted, as demand for fresh vegetables, fruits, nuts, milk and meat products, specialty crops, and higher-value crops increases worldwide.
- An aging farm population and continued erosion of scientific expertise in food production will challenge food system sustainability unless steps are taken to reverse the trend, including educating young people in this area.
- Emerging technologies (genomics, bioinformatics, molecular genetics, computer science, and engineering) coupled with classical approaches (plant and animal breeding, agronomy, soil science, and animal nutrition) will facilitate innovation in the search for new and nutritionally enhanced food production systems and food products.

Natural Resources

California is characterized by a complex physical geography, tremendous natural biodiversity, and an intricate ownership pattern that juxtaposes private, municipal, state, tribal, and federal land parcels. Land use and human development as implemented across this diverse ecological and social landscape can lead to increasing

fragmentation, which in turn threatens the ecological integrity of vital natural resources. Rapid increases in human population density and changes in climate will only accentuate the need to coordinate regional planning efforts to promote conservation while also meeting the needs of all Californians.

Land Use

Future urban development in California. *Source:* California Department of Forestry and Fire Protection.

- Continuing urbanization of agricultural land will encourage additional conversion of marginal lands to produce food and fiber. If projected development continues to grow in low-density development (with only 10% infill), it will consume 5.1 million acres of previously undeveloped land; high-density development (with 30% infill) would consume 2.6 million acres.
- A confluence of forces is placing the future of California forests at risk. For example, private forests in California are being converted at a rate of 76,600 acres per year largely due to real estate development. Not only do these conversions reduce ecosystem services, they also tend to increase the fragmentation of the remaining forests. Fire suppression policies of both state and federal agencies have increased the extent of high-severity forest fires in California. Harvesting does not imperil forests, but management regimes do tend to homogenize species composition and age. Such practices can exacerbate the risks of pest and pathogen outbreaks.
- California will continue to lose farmland to urban uses in the Central Valley, several coastal valleys, and places within commuting distance of the Bay Area as the population continues to grow. Noticeable strains on farming will occur at the interface between urban and rural land use. This will include rural sprawl on prime agricultural land.
- Currently most urbanization and suburbanization has occurred at the expense of agricultural lands. Future urban growth is projected to shift more toward rangelands and forests, increasing the wildland-urban interface issues:
 - More private forests will be converted at the projected rate of 76,600 acres per year, largely due to real estate development, reducing ecosystem services and increasing fragmentation of the remaining forests.
 - Biodiversity will be suffer increased habitat loss and fragmentation.
 - Coastal and marine resources will experience degraded water quality.
 - Coastal communities will become less sustainable.
 - The demand for water will increase, and more recycled wastewater will be used to augment the water supply.
 - Conflict over alternative uses of rangeland will continue to escalate.

- Introduction of non-native species will impact biodiversity of animals or plants in any environmental setting—marine, freshwater, forest, or rangeland.
- Sustainability of the environment is also an important issue facing coastal and marine systems, frosts, and rangeland watersheds.
- Management of fuel and wildfire risk will continue to be an important issue facing the state.

Water

- Population growth will require an additional 5.9 to 7.4 million acre-feet of water per year, assuming agricultural use rates remain constant. Half of California's population growth is expected to be in hotter areas with high water demand for landscaping, such as- Riverside and San Bernardino Counties, the Central Valley, and the Sacramento metropolitan area.
- California must reduce its use of Colorado River water by 0.8 million acre-feet by 2015. If the environmental and water issues in the Sacramento and San Joaquin Delta remain unresolved, they will continue to challenge the use of water throughout the state. Few new sources of water have been identified.
- Projected efficiencies in water usage by agriculture may mitigate the need for additional irrigation water. The scarcity of water will slow the conversion of cropland to permanent crops, encourage shifting to crops that generate more value per unit of water, and hasten conversion to production technologies that use less water.
- New water will be needed to support aquatic wildlife. California's adult wild salmon need sufficient water in our rivers and streams to migrate and spawn, and young salmon need sufficient water to rear and grow in our streams until they reach 4 to 12 months of age, after which they need enough water in our rivers and estuaries to migrate to the ocean. Large native sturgeons represent another important natural resource. Many sport fishers enjoy fishing for these magnificent fish, which contribute to their families' healthy diet. These sturgeons also need adequate water for their migration and reproduction.
- New water sources will be needed to reverse the trend of overdrafting of groundwater basins. This is estimated to add another 1.5 to 3 million acre-feet to the demand.
- The loss of water from leakage and evaporation during storage and transport in California's aging infrastructure of reservoirs and canals will require a coordinated response by state, regional, and local agencies.
- Water quality will be affected by global climate change, causing more intense storms and increased losses from surges in runoff and sedimentation.
- Decreased water quantity will increase contaminant concentrations, which will impact aquatic life as well as the ability of drinking water and wastewater treatment plants to adequately treat water to meet federal and state standards.

Air Quality

- Population increases will cause further degradation of air quality throughout California, particularly in the San Joaquin Valley region. Sources of air pollution include transportation, power generation, and agriculture.
- Particulate matter (PM2.5 and PM10) will continue to seriously threaten human health, increasing the risk of lung disease and asthma. Several California airsheds are among the worst PM regions in the nation. Particulate matter as well as ozone precursors (VOC and NOx) will continue to pose threats to air quality and human health.
- State and federal regulations will require reduction in air pollution from agricultural sources in California, including ammonia and hydrogen sulfite, to address public health concerns. California agriculture will need to reduce nuisance pollutants such as odors, dust, and flies in order to mitigate agricultural-urban conflicts.

Energy

- Fossil fuels are likely to remain the dominant transport energy source beyond 2025, although electricity will emerge as a more important source of transportation energy.
- Climate change will impact the timing and variability of hydrological flows for hydropower generation, summer demand for electricity, and the potential for power outages.
- Despite potential expansion of reservoir storage capacity, shortfalls will persist that will most likely be met through a mix of natural gas and other energy sources.
- Regulatory constraints on motor fuels are likely to raise the costs further for California agricultural producers relative to other regions, affecting the whole production and marketing chain.
- The physical infrastructure for energy supplies, transport, and handling of inputs and outputs will continue to be concerns for California agriculture.

Infrastructure

- California will continue to face difficulties in maintaining the state's existing transportation system, with 38% of road miles in mediocre or poor condition and 29% of road bridges structurally deficient or functionally obsolete.
- Continuing population growth will require expansion of transportation capacity in both passenger and freight travel.
- Aging sewer systems, if not improved, will lead to failing sewer lines, increasing environmental and health risks from contaminated water. Improving the wastewater infrastructure may also support increased recycling options.
- New water conveyance systems will be required to efficiently transport water from natural watersheds to areas of high demand while simultaneously protecting ecosystems.

Climate Change

- Anticipated weather extremes and changes in the pattern of precipitation and snowpack will degrade water quality and quantity.
- Anticipated changes in temperature, rainfall, and other environmental parameters will
 - increase the impacts of endemic and new invasive pests and diseases
 - cause some native species to disappear in certain geographic regions and new species to emerge and dominate
 - necessitate changes in agricultural cropping patterns across the state
- Anticipated changes in terrestrial plant and animals ecosystems will adversely impact coastal and marine ecosystems.
- Some species will be lost, and other species that can adapt quickly enough may migrate from one region to another to survive the effects of changes in temperature and precipitation. Numerous impacts are forecast for coastal and marine systems, including general impacts on ocean health, changes in ecosystem dynamics, changes in fisheries production, ocean acidification, and sea level rise on coastal communities. Forests will experience alterations of composition, structure, and function. Climate change will also affect the ecology and economics of forest systems.
- Forests and rangeland watersheds will both play an important role in the management of carbon emissions. In rangeland watersheds, climate change will have effects on the composition of the plant community and production of forage. It will also change the dynamics of invasive species by creating new habitats and eliminating existing ones. Climate change is also anticipated to affect the risk of wildfire due to changes in temperature and precipitation patterns.
- California will have increased regulation related to climate change.

Governance and Policy

- California faces the threat of increasing political gridlock and potential citizen disengagement as larger numbers of youth enter adulthood lacking the decision-making skills and knowledge base to participate in informed public policymaking.
- California policymakers and the public at large face emerging legislative and regulatory issues for which science-based information will be critical for effective, equitable, and transparent policymaking.
- California agriculture and natural resources will continue to face a stronger and more costly set of regulatory environmental constraints than those in most competitor regions. These costs will result in higher prices to consumers and a less favorable market position for producers.
- California faces continuing challenges for coordination and integration of public policy due to the multiplicity of regulatory authorities, such as the hundreds of entities involved in the allocation and delivery of water for agricultural, urban, and environmental needs that operate independently and impose differing regulations even within common geographic regions.

- The fragmented nature of many of the systems that regulate California's natural resources will make it increasingly difficult to manage the issues that our natural resource systems will face. For example, hundreds of entities are involved in allocating or delivering water for agricultural, urban, and environmental uses. Land ownership patterns in California are a complex mixture of private, state, federal, and other public entities. Coastal and marine resources are regulated by dozens of different federal, regional, and state agencies. This can make it very difficult to holistically assess a system and make decisions about the best course of action to resolve a problem.

Economics and Marketing of Agricultural Products

- California agriculture faces uncertainty about its economic viability at the individual farm and industry-wide levels, requiring updated data, models, and techniques for monitoring and predicting economic trends.
- Intense global competition based on price and quality will force farmers and marketers to continually innovate to stay abreast of market forces, requiring both reduced costs and improved value-added products.
- Increased consumer interest in organically grown and locally produced products is creating a growing market for some California products. The organic share of the food budget has grown rapidly from a tiny base to a few percent of the total. California is by far the most important producer of organic food in the nation.
- Population trends suggest that there will be greater challenges in access to affordable, nutritious food by lower-income groups.
- The greatest potential for growth for California agricultural products in the next 20 years will be in exports to developing countries, where population increases will be largest and where world income growth is likely to be concentrated. Population growth in these countries and the emergence of a new middle class will create markets for higher-quality foods.
- California's success in future export markets will depend in part on trade policies and market competitors. Significant competition exists, and production innovations, as well as careful consideration of policy, are needed to keep California competitive.

Endemic and Invasive Pests and Diseases

- Insects, weeds, diseases, and vertebrates have a dramatic direct impact on agricultural productivity and natural resources. Insects alone are thought to be responsible for reduction of the world food supply by 20 to 30%.
- The homogenization of our world through international travel and shipping is contributing to the introduction of exotic pests and diseases that pose new threats to California.
- Invasive species not only directly affect our agricultural economy through direct losses or quarantines, they also impact urban systems and can displace native species from wild habitats.

- Climate change will impact the distribution of pests and diseases as new habitats are created.
- The widespread introduction of exotic species is a threat to biodiversity. As exotic species are introduced to ecosystems and establish self-sustaining populations, endemic species may not survive. These exotic organisms may threaten native species as direct predators, competitors, vectors of disease, or by modifying the habitat or altering native species dynamics. With improvements in transportation and the globalization of trade the introduction of non-native species (both intentional and inadvertent) to new habitats or ecosystems has greatly increased.

Food, Human Nutrition, and Health

Consumer Demand

Concurrent with the demographic changes and the increased prevalence of chronic disease and food safety problems, consumer demand is expected to increase for the following:

- a variety of convenient, portable, portion-controlled food products, ethnic foods, fruits and vegetables, and other foods for which California is a dominant producer
- innovative, functional foods that target specific health conditions or promote health
- home-grown and home-preserved foods
- access to farmers markets and other alternative forms of fruit and vegetable marketing, particularly those that support local and regional food systems and provide organically grown foods
- credible information on agriculture, food safety, nutrition, and consumer economics, especially information that is tailored to individual needs and available through convenient media such as the World Wide Web.
- better point-of-purchase labeling information of food products in the supermarket, school lunches, and restaurants, particularly to meet the needs of consumers with food allergies
- assurance of safety of the food supply—particularly for fresh produce, tree nuts, meats, and dairy products—and more reliable knowledge about the sources of food ingredients.

Nutrition and Health

- Related to the rise in obesity rates, diabetes diagnoses in California are expected to more than double by 2025. More children will develop type 2 diabetes, heart disease, and risk factors related to chronic disease due to poor nutrition and lack of physical activity.
- Food allergies will continue to be a concern.
- Other health problems will include those associated with poor prenatal and postnatal nutrition and toxicity associated with excess levels of vitamins and minerals from supplements and other biologically active products.

- Health disparities will persist. One out of every two Latino females born in the year 2000 is projected to develop diabetes. African Americans will have the highest cancer rates.

Food Access and Security

- Food security and food access will remain a challenge for millions of Californians.
- Increasingly limited and more costly agricultural water and energy will place greater upward pressure on food prices.
- Income disparities will increase as economically disadvantaged segments of the population grow, resulting in greater inequities in access to safe, nutritious, and affordable food.

Food Safety and Food Defense

- Globalization of the food supply and consumer demand for year-round food products that must be imported will increase the risks of foodborne illness due to poor and unsafe agricultural practices in many countries and the lack of international food inspections.
- The segment of the population at greatest risk of foodborne illness—older adults, young children, pregnant women, and those with chronic illnesses—will increase.
- The continuing rise in foodborne illness outbreaks and food recalls will lead to lower consumer confidence in the food supply.
- Chemical adulteration, such as with melamine, will continue to result in domestic and international food safety concerns.
- Consumers are becoming increasingly concerned about the vulnerability of the food supply to bioterrorism.

Appendix 2 Initial Contributors

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Survey of Opinion Leaders by Kerry Tucker of Nuffer, Smith, Tucker, Inc.

59 personal telephone interviews and 43 e-mail interviews

Appendix 3 UC ANR

ANR is a statewide network of UC researchers and educators dedicated to the creation, development, and application of knowledge in agricultural, natural, and human resources. Programs are delivered through two organizational units: the Agricultural Experiment Station and Cooperative Extension. To help understand the organization, this section describes the roles of ANR administrative leaders and components of the organization. A basic premise of ANR is that all operations are driven by priority needs and opportunities, which are identified by programmatic leadership in consultation with key stakeholders.

Agricultural Experiment Station

The Agricultural Experiment Station (AES) in California is located on three campuses within three colleges at UC Berkeley, UC Davis, and UC Riverside; the School of Veterinary Medicine at UC Davis; and on ten statewide research and extension centers. Although all three colleges and the school have deep roots in agriculture, their missions also include environmental, natural resources, and human and community development. This breadth of mission is reflected in the college names: the College of Natural Resources at UC Berkeley; the College of Agricultural and Environmental Sciences at UC Davis; and the College of Natural and Agricultural Sciences at UC Riverside.

Within the UC system, AES is formally categorized as a multicampus organized research unit (MRU). Organizationally, the California AES is located within ANR. Authority for its programs lies jointly with the chancellors and deans on the UC Berkeley, UC Davis, and UC Riverside campuses and with the ANR vice president. The vice president is officially the director of the AES, and the four deans are designated as associate directors. AES comprises some 711 faculty members housed in 38 departments. These scientists represent a variety of disciplines and are charged with conducting fundamental and applied research that fulfills the mission of the AES.

AES scientists are one of the driving forces behind California's \$35 billion agricultural industry. AES also provides worldwide leadership in the environmental sciences, nutrition, and youth development. Its faculty collaborates with CE specialists and county-based CE advisors in their research and in extending their findings to the public.

Cooperative Extension

Today, the Cooperative Extension (CE) system represents a national, publicly funded, nonformal educational system that links educational and research activities and resources of the U.S. Department of Agriculture (USDA), land grant universities, and county administrative units. This educational system includes professionals in each of America's original land-grant universities created in 1862 (now in the fifty states, Puerto Rico, the Virgin Islands, Guam, Northern Marianas, American Samoa, Micronesia, and the District of Columbia); the historically black land-grant universities added in 1890; and tribal land-grant colleges added in 1994.

CE in California is staffed by 111 CE specialists attached to campus departments and 219 CE advisors working out of a statewide network of county CE offices serving every California county. CE advisors

work closely with local clientele, communities, and cooperators to identify critical and emerging needs in agricultural, natural, and human resources, and with campus partners to develop research-based approaches to solve local problems. CE specialists are integrated into academic departments at UC Berkeley, UC Davis, and UC Riverside, where they conduct research and develop new technologies. CE specialists work to connect local CE advisors to the campus-based AES and other resources that may provide appropriate research and new technologies to address myriad issues and needs throughout California.

CE provides California residents who may never set foot on a UC campus with local access to UC resources. Local CE advisors often work with teams of nonacademic staff and volunteers to deliver services through programs such as 4-H youth development, master gardeners, master food preservers, and master composters.

Three regional ANR offices administer county-based CE programs: the North Coast and Mountain Region, the Central Valley Region, and the Central Coast and South CE Region. The organizational units of county-based CE are described at the UC ANR Web site, <http://ucanr.org/ce.cfm>. Campus-based CE programs are administered by the deans and department chairs in departments to which CE personnel are assigned.



Statewide Programs and Campus ANR Centers

More than twenty unique statewide programs were established over the past thirty-five years to focus on specific high-priority areas of special concern to Californians. They have covered such topics as mosquito research, integrated pest management, sustainable agriculture, integrated hardwood range management, and agricultural policy issues. Some statewide programs have been closed, reorganized, or merged with other programs to make a total of sixteen statewide programs administered by ANR today.

Many of the statewide programs were initially established by the Legislature or by Congress, either through direct legislation or budget language. Statewide program functions focus on multidisciplinary issues that cut across campuses, departments, and counties. Some programs provide competitive grants and technical support to leverage departmental and county resources.

Several statewide programs have directors who carry split appointments between statewide ANR and a campus academic department or county CE office. Directors are responsible to one of the four ANR program leaders programmatically, and their budgets are administered through the Office of the Vice President. Some statewide program directors report to a department chair or county CE director for the portion of their appointment that relates to their faculty AES or CE assignment. Each statewide program undergoes a review approximately every five years to assess accomplishments, needs, goals, future plans, and continuing need for the program.

Current Statewide ANR Programs

Agricultural Issues Center (<http://aic.ucdavis.edu/>)

Analyzes issues important to California and western agriculture and conducts applied research.

California 4-H Youth Development Program (<http://www.ca4h.org/>)

Helps young Californians become responsible adults.

California Communities Program (<http://groups.ucanr.org/CCP/>)

Fortifies local governance, builds citizenship capacity, and enhances economic development.

Center for Youth Development (<http://cyd.ucdavis.edu>)

Conducts research and evaluation that increases understanding of youth development and extends knowledge to UCCE and other youth development professionals.

Center for Water Resources (<http://www.waterresources.ucr.edu/>)

Engages the resources of the University of California with other institutions in the state to develop ecologically sound and economically efficient water management policies and programs in California.

Expanded Food and Nutrition Education Program (<http://efnep.ucdavis.edu/>)

Teaches low-income families (particularly those with young children) how to make the most of their food resources and meet their nutritional needs. EFNEP is a federally funded program.

Integrated Hardwood Range Management Program

(<http://danr.ucop.edu/ihrmp>)

Dedicated to the conservation of California's oak woodlands.

Statewide Integrated Pest Management Program (<http://www.ipm.ucdavis.edu/>):

Develops and promotes the use of integrated and ecologically sound pest management programs in California.

Kearney Foundation of Soil Science (<http://kearney.ucdavis.edu/>):

An endowment-supported program that funds research and sponsors outreach activities directed to a five-year mission.

Master Gardener Program (<http://cemastergardeners.ucdavis.edu/>)

UC-trained volunteers extend research-based information to the public about home horticulture and pest management. The information is provided to the public in classes, via telephone hotlines, at community events, through Web sites, and in demonstration gardens.

Mosquito Research Program (www.vetmed.ucdavis.edu/ucmrp)

Develops an understanding of mosquito biology and ecology and the epidemiology of vectors and diseases, along with environmentally sustainable and effective management strategies for vectors of diseases.

Office of Pesticide Information and Coordination (<http://www.envtox.ucdavis.edu/research/opic.html>)

Coordinates and reviews ANR activities pertaining to pesticide research, experimentation, and use.

Renewable Resources Extension Act Program (<http://ucce.ucdavis.edu/freeform/RREA/>)

Addresses educational needs in managing the nation's renewable resources. RREA is a federally funded program.

Sea Grant Extension Program (<http://www.csgc.ucsd.edu/ABOUTUS/Advisors.html>)

Supports advanced research and extension related to marine issues of vital concern and is the California branch of a national program.

Small Farm Center (<http://www.sfp.ucdavis.edu/default.asp>)

Develops and delivers production, marketing, and management information pertinent to small-scale, limited-resource, and family farmers.

Sustainable Agriculture Research and Education Program

(<http://www.sarep.ucdavis.edu/>)

Integrates three main goals related to agricultural sustainability: environmental health, economic profitability, and social and economic equity.

ANR Research and Extension Centers

In addition to the ANR-administered statewide programs, each campus has established research and extension centers that link CE and AES resources to solve specific problems.

The University of California operates the largest system of agriculture and natural resource research and education field stations in California. The ten-center system annually manages more than 375 research projects and conducts over 600 education-outreach programs per year, reaching 16,000 adults and 8,000 K-12 students. The centers are geographically located throughout California, and are focal points for community participation in UC programs and for active UC involvement in identifying and addressing regional agricultural and environmental problems and issues. The centers currently support more than 35 county-based cooperative extension academics and 80 campus-based academics, as well as researchers from land-grant institutions in other states, the CSU system, and USDA, in conducting their research and education programs.

The REC system is the only statewide program in UC that provides a premier research management organization that delivers services to academics that are not available elsewhere. For example, the centers are known as one of the last group of people in UC that can actually grow a crop, mend a fence, and fabricate tools and equipment that allow researchers to conduct manipulative field research in a protected, managed environment. The centers are often the public face of UC in rural and urban environments.

Not only do the centers have the land, facilities, equipment, and staff capable of supporting cutting-edge research, they also have directors who are CE specialists and advisors and who serve as catalysts for initiation of innovative, collaborative research, and educational programs that involve AES and CE colleagues, as well as conducting their own independent research and educational programs.



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