California State University

Agricultural Research Institute

CSU

ARI

2016 - 2017 Annual Report

Submitted by: David W. Still, ARI Executive Director

WELCOME
From the Excutive Director

The future of California agriculture is dependent on individuals who have never received a paycheck from the industry, have yet to contribute to its success and may only be vaguely aware of its challenges. Its future is in the hands of people who today are university students, many of whom do not have a clear career path. Indeed, the future success of the industry is dependent on a workforce capable of addressing challenges that are increasingly complex and formidable. In addition to research training, student-faculty interactions are a critical part of the ARI mission and help shape decisions students make regarding career choices. While the ARI funds research projects, perhaps the greatest impact of the program is its impact on students, and by extension, the development of the California workforce.

ARI faculty research directly impacts those that participate in research projects but all students benefit when a professor shares insights, materials and knowledge from their research. Faculty that are engaged in research benefit from a continual revitalization of their intellectual curiosity, of creating new ideas and information, and engaging in a deeper and more critical view of the state of knowledge.

The issues facing the state's agricultural and natural resource industries are not static. Global warming and the increasingly unpredictable nature of our weather brings formidable challenges to adapt production to overcome these daunting challenges. At the same time, economic sustainability requires minimizing the environmental footprint of agriculture by using less water, fertilizers, while using targeted pesticides including plant-incorporated pesticides. While California thankfully received record winter rains, 2016 marked the third year in a row to set a new record for global warming; 16 of the 17 warmest years on record have occurred since 2001. Clearly, sustainability of agriculture depends on adapting animal and plant production to a warming environment punctuated by an increased frequency of extreme weather events.

The portfolio of projects funded by the ARI reflect the issues facing California industry today while building the capacity to address future challenges. ARI faculty are working on projects that will provide growers information on how to produce crops with lower quality water, use remote sensing to more precisely manage water and fertilizers to produce a crop. They are addressing problems of importance to the California agricultural economy; 12 of the 15 top commodities in the state are the focus of ARI projects.

A significant portion of the ARI research portfolio supports projects at the interface of human health and nutrition. A wide body of literature indicates that many chronic health conditions can be positively impacted or prevented by diets rich in fruits and vegetables. ARI research is asking what methods, including behavioral or policy, can encourage fruit and vegetable consumption? In addition to better health outcomes, increased consumption would have the added benefit of increasing the demand of California's produce.

We hope you enjoy the student profiles and their interesting backstories of how they arrived to their chosen field of study and the impact of the ARI-sponsored research on them. The research breadth of the ARI program can be appreciated by reviewing the titles of the 103 projects active over the last year. And finally, we present an overview of the program allocations and various outputs from the research program. While we share a common ARI mission, each campus is unique in how they fulfill it.

Dr. David W. Still

Mission

To support and fund applied agriculture and natural resource research within the California State University (CSU) system that improves the economic efficiency and sustainability of California agriculture.

Vision

California has diverse and abundant agricultural and natural resources. Through education and research, we envision the ARI being a valuable resource to the State on policy and informed decision-making based upon robust science to ensure the sustainability of California's agricultural economy and the preservation of its natural resources.

Strategic Objectives

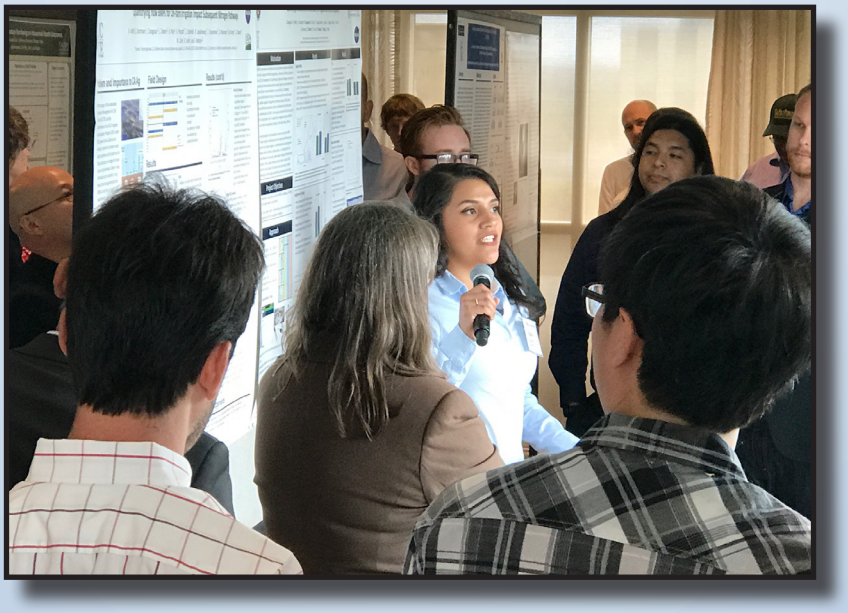
- Invest in applied research to address emerging and high-priority issues facing California agricultural and natural resource industries;
- Develop a highly-trained professional workforce for California agricultural and natural resource industries through student participation in research projects;
- Communicate research results to industry stakeholders, scientists and the public.

Contents

Deeper learning and changed perspectives through research experiences.

Students are the backbone of the research conducted by the ARI. Over the last year, students were involved in 86% of ARI-funded projects. The students profiled in this report said that they became involved in their research project through a class they had with the professor. Other common themes emerged during the interviews: students reported that being involved in research changed their perspective of both their academic discipline and their view on research; that their depth of learning was well beyond that of their classroom, and each reported that being a part of a research project helped affirm their career choice and made them want to be more deeply involved in their profession.

Students receive close personal training in science and critical thinking from their professors and many are working on projects that allow them to work directly with industry partners. While students are quite familiar with formulas and seemingly esoteric theories presented in academia, they gain a perspective of how to apply these principles to industry and learn there are practical problems that must be solved to survive as a business. This is a unique perspective for our students, and one facilitated through the structure of the ARI mission to conduct applied research.



Kigwang Baek, Humboldt State

Kigwang is currently enrolled as a graduate student in the Natural Resources Graduate Program / Forest, Watershed and Wildland Science option at Humboldt State University. Kigwang's research and classes focus on forest operation analyses. He expects to graduate in May of 2018. Prior to entering graduate school, Kigwang obtained his undergraduate degree in forestry from Chonnam National University, South Korea.

According to Kigwang, the reforestation effort in South Korea has been successful. However, to apply advanced forestry technologies in South Korea, Kigwang felt that he needed to broaden his knowledge of forestry operations and decided if he wanted to learn this he would need to study abroad. Kigwang decided to pursue his graduate studies at Humboldt State due to its reputation in forestry and his long-standing interest in forest operations, specifically in mechanized harvesting systems.

Historically, Humboldt County forests were comprised of large diameter redwoods whose trees were typically harvested by using a labor-intensive manual method. Over time, forest composition changed from old growth to third growth, with the latter typified by high density redwood stands. In response, local timber companies in northern California are beginning to apply a new harvesting system called "cut-to-length", which they believe will more effectively harvest redwood while reducing environmental impacts and improving forest health and sustainability.

The "cut-to-length" project is funded by the Department of Energy and the ARI with industry collaboration with the Green Diamond Resource Company. The project is being led by Dr. Han-Sup Han, an associate professor in the Department of Forestry and Wildland Resources at Humboldt State University. Kigwang was invited by Dr. Han to study how the new harvesting method worked in Humboldt County and was soon working on the project as a graduate student. This research opportunity provided him with the ability to further develop and strengthen his research methods and increased his in-depth knowledge of forest operations and management. Kigwang stated he learned that organizational skills are essential for success since they affect every stage of research, from determining the best way to develop the objectives to collecting and analyzing the data.

Following the completion of his graduate degree, Kigwang hopes to continue his education in a doctoral program focusing on forest engineering and operations. Given the knowledge he has obtained from the ARI research, Kigwang would like to determine if these mechanization techniques would work in the steep sloped terrain that is typical of South Korea. Kigwang also hopes to strengthen his understanding regarding the integration of all forest operations and how to successfully adapt and apply the most efficient method to various situations and terrains.

Julia Conchas, Cal Poly Pomona

Julia recently graduated from Cal Poly, Pomona with her bachelor's degree in food science and technology with a minor in microbiology. Currently she is working for a large food manufacturing company located in southern California as a research and development technician focusing on developing new products for the industry.

Julia has always had some involvement in the food industry and has a strong family background in the industry. Throughout her life she has been exposed to many aspects of food science that helped her decide that the scientific part of the industry is where her strongest interests were. Through coursework in biology and microbiology she concluded that obtaining a minor in microbiology would nicely compliment her major.

As an undergraduate, Julia was heavily involved in clubs and various programs on campus that enabled her to develop strong interpersonal and networking skills. These networking opportunities led to Julia's introduction to Dr. Olive Li, an associate professor in the Department of Human Nutrition and Food Sciences at Cal Poly Pomona. Dr. Li gave Julia a tour of the lab and as she was explaining her research and listening to questions from Julia, it was apparent that Julia's interest in microbiology and Dr. Li's interest in developing new uses from California crops would be beneficial to both. Dr. Li offered Julia an opportunity to become involved in an ARI-funded research project whose purpose was to assess the antimicrobial effects of orange pomace. Oranges are either sold to the fresh market or squeezed for juice. Juice processing leaves substantial fiber and phytochemical- rich byproducts that are usually disposed of by the industry but which have the potential to be formulated into a wide variety of products.

Julia conducted experiments designed to determine if extracts from orange pomace would inhibit or kill bacteria that can cause diseases in humans. Although orange peels have known antimicrobial properties, little is known about the potential of orange pomace. Throughout the project Dr. Li allowed Julia to exercise a fair amount of independence in conducting the research and during the process, Julia developed skills during each step of the process. Dr. Li encouraged Julia to read the literature and help design experiments that would allow them to evaluate the effectiveness of the orange pomace extracts. This freedom to operate and the learn-by-doing approach provided Julia the valuable experience of learning from mistakes.

Julia is now working in the food science industry to gain additional experience which will bring into focus her long-term goals and help her decide if pursuing a graduate degree is something she would like.

Noel Fie, Cal Poly, San Luis Obispo

Noel is currently halfway through her graduate program at Cal Poly, San Luis Obispo, studying forestry sciences with an emphasis in forest hydrology. She completed an undergraduate degree in 2013 majoring in environmental management and protection with a concentration in hydrology, also at Cal Poly. While an undergraduate, Noel worked as a geographic information system technician for the City of San Luis Obispo.

Following graduation, Noel worked the next two years as a biologist for a consulting firm in the San Luis Obispo area. Noel realized she had a passion for restoration and environmental management of wetlands and decided to go back to school for a graduate program.

As often happens, a professor took note of a bright student that shows potential to think critically. Dr. Chris Surfleet (Cal Poly, SLO) asked Noel if she would be interested in working on an ARI-funded project. Fire suppression and climate change had led to an abundance of conifers in historic mountain meadows in California. Dr. Sufleet hypothesized that removing conifers from these areas would help restore the health and sustainability of the meadows through improving groundwater availability. The project had all the elements she sought: hydrology, wetland restoration and environmental management. She was immediately interested and suggested that if she took the research position she could incorporate an element of plant restoration as part of the post-conifer removal assessment since this information is largely lacking from the scientific literature.

Apart from learning how to operate scientific instruments, such as soil moisture sensors, data loggers, or the ten-foot-high weather station fitted with a snow depth sensor, she has also gained confidence in her role as a scientist. Noel has generated a lot of data from her project and by working with this data she developed a degree of patience and attention to detail. Moreover, she developed a deeper curiosity and appreciation for the natural environment and learned that doing good for the environment can be both very fun and very difficult at the same time. Noel stated that research ability does not come easily but it is very rewarding.

Noel continues to work on the ARI-funded research project as a full-time research assistant and hopes to continue with a career in hydrology or ecology after she graduates.

German Fuentes, Chico State

Over the last few summers as an undergraduate student, German has been interning at Holliday Rock, one of the largest independent suppliers of aggregate, concrete and hot mix asphalt in the United States. This fall he begins his senior year at Chico State, where he is majoring in concrete industry management. German has been quite busy with his courses while also serving as an amabassdor for the undergraduate program at Chico. As an ambassador, German explains the program and his personal experiences to help inform students and recruit them into the program.

Under the direction of Dr. Feraidon Ataie, an assistant professor with degrees in civil engineering, German is involved in ARI-funded research which focuses on developing and testing structural building products. Concrete, for example, has been used for thousands of years and today is the most commonly used building material in the world. The Romans were masters of concrete, building monuments and temples that were both aesthetically pleasing and durable. Modern concrete buildings have not demonstrated the same strength or resilience. While concrete materials are strong in compression, they are weak in tensile (stretching) strength, which is why rebar is used. Small synthetic fibers have been used to increase tensile strength, but these are expensive. Wood fibers have been used, but they degrade.

Northern California is a major rice producing region in the U.S., but everything other than the rice grain is waste and must be disposed of. Rice waste is high in silica, which unlike wood fibers, does not degrade over time. Dr. Ataie and German are conducting research supported by the ARI and the rice industry to determine if rice waste can be used in building materials to increase tensile strength while maintaining all the other positive characteristics of concrete. If products can be developed, the rice industry will have an additional use for a byproduct that previously was never used. The building industry will gain concrete products with improved performance, with the added bonus of a sustainabie additive at a favorable price point.

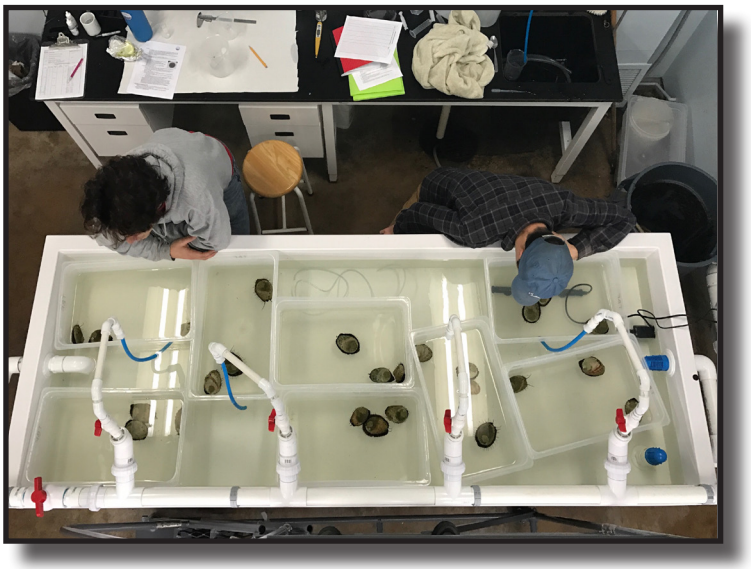
Involvement in this research project has allowed German to think about science and engineering concepts and how they may be integrated into practice. His industry internships and family background had already provided German familiarity with concrete and its uses, but few ever consider looking to agriculture for engineering solutions. German feels that this project allowed him an unique opportunity to learn more deeply about materials technology and to contribute toward solving a problem that has long vexed the building industry.

Ben Grime, Cal Poly Pomona

Ben graduated from Occidental College with an undergraduate degree in 2013 majoring in biology with a marine emphasis. Ben is entering his second year of a master's program in the biology program at Cal Poly Pomona where he continues his focus on marine biology.

After attaining his bachelor's degree, Ben got a job doing something few people would ever have imagined existed. He worked as a dive technician for the National Parks Service and was tasked with monitoring marine life as part of the Kelp Forest Monitoring Project at Channel Islands National Park. In southern California, many roads for those interested in marine ecology lead through the Southern California Marine Institute (SCMI). The institute is a consortium of 23 universities, colleges and foundations whose mission is to foster marine research and education with a focus on understanding and mitigating the impacts of urban areas on the marine environment. Ben's path too, led to the SCMI and he is currently employed there as a biological science technician.

An opportunity arose for Ben to pursue a master's degree when his SCMI advisor, Dr. Jeremy Claisse, joined the Department of Biological Sciences at Cal Poly Pomona as an assistant professor. Ben and Dr. Claisse are working on a method to develop aquaculture methods to propagate green abalone, a native species that was once abundant off the shores of southern California. The species is now listed as endangered, having been decimated from over harvesting. Ben said the ultimate goal is to use aquaculture to reintroduce the species to the coast of southern California. Ben felt that conducting this work in collaboration with farms has been a valuaable exercise in balancing theory with practical considerations to make the project commerically viable.



Brad Mendes, Fresno State

Brad obtained his undergraduate degree in animal science from Texas A&M and graduated from Fresno State in May 2016 with his master's degree in animal science with a meat science focus.

Throughout his life, Brad's parents have always been heavily involved in agriculture and his father is an animal science instructor in Modesto. Brad chose the meat science concentration because the coursework was strongest at Fresno State and it offered the most options.

Brad's involvement in the ARI-funded research focused on the evaluation of the reduction of salmonella and *E.coli* in whole intact muscles. The ARI project provided him with a deeper understanding of meat science. During his project, Brad learned that looking outside the box for solutions to problems that occur during research is incredibly important and can lead to new insights to long-standing problems. In addition, Brad could see see the value of carefully controlling multiple variables to derive a clear understanding and interpretation of research outcomes.

Brad is currently working as a lecturer at Fresno State, focusing on introductory animal science courses and livestock evaluation.

Maria Handley, Cal Poly, San Luis Obispo

Maria is a graduate student beginning her second year at Cal Poly, San Luis Obispo. Maria completed her undergraduate degree in 2015 at Virginia Tech, majoring in materials science and engineering. She is on-track to complete her master's degree in agriculture specializing in food science and nutrition with a concentration in product development and food sensory by June 2018.

How does a materials science and engineering student get inspired to change to food science and nutrition? At their core, both disciplines study the internal structure of materials and how they affect performance. Once the basic parameters are understood, the building blocks are engineered into a product. As an engineering student at Virginia Tech, Maria started working in a sensory lab where she had an opportunity to be exposed to research projects in food, science and nutrition (FSN). The professor of the sensory lab encouraged her to take FSN classes in addition to her engineering classes and see how she liked those. After taking a few courses and conversations with her FSN professor, Maria was convinced to pursue a graduate degree in food science and focus on sensory perception and evaluation.

Maria Handley, cont'd

Maria's Virginia Tech professor knew that her colleague at Cal Poly, SLO was searching for a graduate student to work on a sensory project. A sterling academic record, undergraduate research experience in a sensory lab and a strong personal recommendation convinced associate professor Dr. Amy Lammert that she had found the ideal candidate. Maria moved to California and joined Cal Poly's Sensory Lab and began working on an industry- and ARI-funded research project that is focused on evaluating products for school breakfast programs. These products are being developed for a notoriously finicky group – grade school children. The food must look and taste great, have a decent shelf life and of course, be nutritious.

Maria stated that it has been an amazing experience to incorporate skills and perspectives she acquired during engineering studies into her master's program. In addition to her thesis project research, Maria works with Dr. Lammert to evaluate a variety of food and nutrition products for outside companies. Throughout her involvement with the project, Maria has been given opportunities to interact with food companies, gaining real-life experience and an idea of how these companies work and what they value. Maria has learned an enormous amount, including measuring and evaluating consumer preferences and techniques to measure and evaluate shelf-life. She believes that sensory evaluation skills will be beneficial in her future career and can be applied to multiple fields.

Maria's experience in the Sensory Lab at Cal Poly has convinced her to pursue a career with the food industry after graduation. As an undergraduate Maria studied abroad and this experience expanded her perspective on life. She hopes to work with a global company after graduating to help develop and deliver more nutritious products to reduce and mitigate malnutrition and nutrition-related diseases such as diabetes.

Emily Krage, Fresno State

Emily graduated with a bachelor's degree in May 2016 from Fresno State, majoring in animal science-production management. Currently she is a second year graduate student at Fresno State where she is pursuing a master's degree in animal science in the Department of Animal Science and Agricultural Education and is also a student assistant in the Fresno State Meat Lab.

In high school Emily joined the Future Farmers of America (FFA) which provided classroom instruction and hands-on agricultural projects. Through the FFA she learned what skills and academic preparation are required for a variety of agricultural careers. While Emily grew up surrounded by agriculture and animals, it was her experiences and coursework in college where she found a passion for the science that supports the agricultural industry. She became involved in the meat science club at Fresno State and while attending conferences and industry tours, she realized she truly enjoyed the meat industry and decided to pursue a graduate degree.

For her thesis, Emily is working on an ARI-sponsored food safety project with Dr. Amanda McKeith, an assistant professor in the department of Animal Sciences and Agricultural Education at Fresno State. Food safety is always an important issue in the food industry. The Center for Disease Control estimates that each year, 48 million people in the U.S. get sick from a food-borne illness. According to the World Health Organization, Salmonella bacteria are one of the most common causes of food poisoning and are "ubiquitous and hardy". To minimize the risk of food poisoning, the USDA and FDA have set temperature requirements for meat preparation that minimizes Salmonella during all stages of the process. High temperatures are required to reduce or kill these harmful bacteria, but they also tend to make meat drier and tougher. Emily and Dr. McKeith hypothesize that meat held at slightly cooler temperatures for a longer period may reduce harmful bacteria to safe levels and the meat would be moist and tender. Using prime rib roast held at temperatures lower than the USDA requirements, Emily and Dr. McKeith are assessing bacterial concentrations. Instead of using pathogenic Salmonella, they use a surrogate bacteria (*Enterococcus faecium*) that is safer to handle. This research has allowed Emily to learn the basic approaches used in research, including the importance of developing an experimental design and having a plan of action ready before conducting research to minimize errors and eliminate mistakes that could ruin the experiment. She also learned that good research takes a lot of time, hard work and dedication to make sure she has good data.

Emily has already completed her experiments and is now using the statistical analyses she learned in classes to analyze her own data. Once these analyses are completed she will write up her thesis and look for the next step in her career.

Kali Prescott, CSU Monterey Bay

Kali recently graduated with a bachelor's degree in biology, where her studies were focused in ecology, evolutionary and organismal biology. Kali is quite interested in extremophiles, defined as organisms that live in environments where few other organisms can survive. Kali was accepted into the graduate program in cellular and molecular microbiology at the University of Illinois where she will continue to pursue her interest in extremophile biology.

As an undergraduate student, Kali was selected to participate in the Undergraduate Research Opportunities Center (UROC) Scholars Program at Monterey Bay. The program provides students with intensive research experiences and helps prepare them for graduate school. The UROC scholar program matches students with professors to help the student get research experience and to participate in activities designed to increase their competitiveness for graduate school. Shortly after becoming a UROC Scholar, Kali enrolled in a course with Dr. Arlene Haffa, an assistant professor in the School of Natural Sciences at CSU Monterey Bay. Under Dr. Haffa, Kali was given the freedom to develop her ARI-funded project to include her interests and to participate in designing the experiments. As part of her project, Kali measured concentrations of greenhouse gases from pore water collected across the soil horizon, including from soils and ecosystems potentially affected by agricultural runoff.

One of the most rewarding experiences for Kali was learning that you don't have to have a research background or certain lab skills to start a project. In fact, most students start with minimal research skills but are eager to learn. Kali said that you just have to learn things along the way to solve problems confronting your research. For instance, Kali's project required obtaining redox potentials by measuring voltage generated from soil using instruments they made in the lab. As a biologist, her exposure to electrical engineering was minimal, yet during the course of her research she learned enough electrical engineering basics to make sure the instruments worked and how to fix them when they did not work. Kali also stated it was extremely difficult to balance the time requirements of large-scale lab and field experiments while keeping good grades. Kali said she was surprised about the substantial time commitment required to obtain the in-depth data needed to evaluate hypotheses.

Aidan Shands, CSU Monterey Bay

Aidan graduated in May 2017 from CSU Monterey Bay with a Bachelor of Science in biology, with a concentration in molecular biology.

Aidan entered his undergraduate studies at CSU Monterey Bay intending to major in marine science. During his sophomore year he decided to switch his focus to biology, recognizing there may be more opportunities in the field while also discovering a strong interest in molecular biology through the courses he was taking.

Aidan enrolled in an inorganic chemistry course and instead of hurrying through lab like most students, he would stay through the entire lab to get additional instruction, enhance his knowledge and just generally soak-up the lab experience. During these additional hours in the lab, he developed a strong mentor relationship with Dr. John Goeltz, the faculty member teaching the lab. Dr. Goeltz introduced Aidan to Dr. Timothy Miles who happened to be looking for a student to work in his lab on an ARI-funded project.

Dr. Miles is an assistant professor in the School of Natural Sciences at Monterey Bay specializing in plant pathology. Lettuce is an important crop in California, and most of it is grown in Monterey County. All crops are afflicted with diseases that can reduce yield and if left unabated can kill the plants. Lettuce is no exception and many long-standing and emerging diseases threaten the crop.

Aiden's ARI project used molecular techniques to identify disease causing pathogens, such as those causing downy mildew. The goal is to develop "point of care" diagnostics the growers can use in the field to rapidly diagnose disease. This project gave Aidan the opportunity to develop leadership skills and operate independently in a research setting. He also learned about having to navigate multiple research and academic deadlines. Aidan stated that the project allowed him to feel a sense of contributing to something larger that had a realistic potential to impact the field. Aidan worked in Dr. Miles lab for two years gaining research experience that would make him competitive for a PhD program. This past summer (July 2017) Aidan entered the Plant Pathology Graduate program at U.C. Riverside to begin working on a PhD and received a UCR Dean's Distinguished fellowship. His goal is to understand the molecular and genetic basis of plant immunity against oomycete pathogens in the lab of Dr. Patricia Manosalva.

Wyatt Smith, Humboldt State University

Wyatt is currently enrolled in the Environment and Community graduate program at Humboldt State and expects to graduate in May 2018. Wyatt obtained his undergraduate degree at Prescott College in Arizona. The majority of his undergraduate time was spent at a biological field station in Mexico where he majored in marine conservation biology.

Currently Wyatt is working with a team to gather socioeconomic data from commercial and recreational fishing industries and the mariculture industry to develop recommendations for Shelter Cove and the Port of Eureka that will be included in the Eureka Fishing Community Sustainability Plan.

Before moving to Humboldt, Wyatt lived in coastal areas all over the United States and held jobs associated with the fishing and mariculture industries. At Chesapeake Bay, Virginia, Wyatt managed and operated an oyster farm for four and a half years.

Wyatt was living in Washington State managing a commercial oyster farming operation when he decided to go back to school. He entered the graduate program at Humboldt State and learned about a waterfront development project being led by Dr. Laurie Richmond, an associate professor in the Environmental Science and Management program at Humboldt State. Through work and life experiences, Wyatt developed a diverse outlook on marine-related industries. He felt that sound data could be used to help develop policies to support the industry and provide a positive impact in these communities. Dr. Richmond's philosophy of developing environmental management plans that are both ecologically sustainable and socially just were very much aligned with Wyatt's interests. Dr. Richmond soon found that Wyatt's background and fisheries experience were just what she was seeking and asked him to join her research team. The NOAA- and ARI-funded research project has turned out to be a wonderful collaborative opportunity. This research experience and data they collected strengthened his realization that oyster aquaculture can play an integral role in sustaining and improving the economy of the larger mariculture community and solving conservation challenges.

Wyatt recently completed the Industry interviews and will soon finish the analyses and assessment and hopes to publish the results shortly thereafter. He said the socioeconomic data will be valuable in establishing baseline levels in which to evaluate the oyster community's economic contribution to the larger fishing and mariculture industries in the Humboldt Bay area. Upon graduating, Wyatt hopes to remain in the area and continue to work with Dr. Richmond on the development of the fishing community sustainability plan for the Port of Eureka and Shelter Cove.

Rebecca Swanson, Chico State

Rebecca is currently finishing dual bachelor degrees at Chico State, majoring in agricultural business and animal science with an expected graduation of December 2017. In addition, Rebecca is currently the student herdsman in the Chico State beef unit, a job that entails managing the unit including day-to-day care, feeding, records, billing, organizing events and overseeing four to five student employees.

Rebecca became involved in agriculture at a young age and following high school she began to contemplate pursuing a career in agriculture and owning her own business one day. While an undergraduate, Rebecca began working at the Chico State beef unit and expressed an interest to Dr. Kasey DeAtley, as assistant professor in the College of Agriculture, to become more deeply involved. Dr. DeAtley asked Rebecca to work on her ARI project and has continued to serve as an advisor and mentor.

Rebecca has always been interested in beef cattle reproduction, which plays a key role in the profitability of cow-calf operations. While increasing feed efficiency is a key cattle industry goal, it also affects reproductive efficiency. The ARI research project focuses on determining the relationship between feed efficiency and reproduction in two biological types of heifers (Angus or Lowline Angus). Performance during the developmental stage affects producer profitability since reproductive soundness and relationships established in this period tend to be carried throughout the life of the animal.

Through her work on this research project, Rebecca increased her data analyses skills and greatly strengthened her writing abilities - both key to a successful research career. The project allowed her to think about the science and theories behind the day-to-day activities of producing animals. Through lab meetings and various campus presentations, she improved her presentation skills and became more comfortable in front of large groups. Rebecca thinks that the undergraduate research experience gave her an idea of what graduate school would look like. Enough of an idea that upon graduation, Rebecca intends to begin a master's program in animal science and is currently exploring institutions for the right opportunity.

System Projects

In California, water continues to be a critical issue affecting agriculture, cities, natural resources and the environment. Climate models have a good track record of accurately predicting climate change and these models indicate less water will be available in the future for California and much of the southwestern U.S. Competing demands for high quality water will further increase pressure on a limited and less-predictable resource. To sustain California's agricultural economy, production practices must be developed to mitigate the expected shortage of high-quality water for California agriculture.

In FY 2016-2017, the ARI has funded projects that directly address agricultural water issues. A project led by Dr. Gurreet Brar, will address the long term consequences on yield and tree health in pistachios irrigated with saline water. A top commodity in our state, California produces 99% of the nations's pistachios with a farm-gate value of $0.7 and $1.8 billion in 2014 and 2015, respectively.

Similarly, California produces much of the nation's vegetables, crops that depend on the availability of high quality water. ARI-sponsored researchers have developed water and nutrient management plans for several crops, but currently the data to develop these models for vegetables does not exist. A project being led by Dr. Florence Cassel Sharma will use state of the science techniques to determine water budgets of common vegetables grown in California and use those data to develop models. These models can be used by growers to provide water to their vegetable crops based on climatic conditions and stage of growth of the crop.

Dr. Gurreet Brar, Fresno State

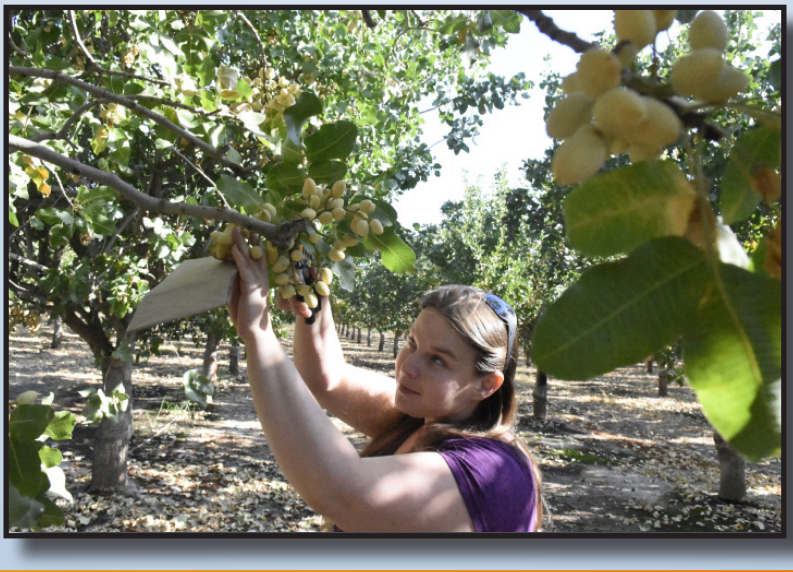
Project title: Determination of Long-term Threshold Limits for Using Saline Water on Pistachios

Co-investigators: Dr. Sharon Benes (Fresno State), Dr. Todd Lone (Fresno State), Dr. Gary Banuelos (USDA-ARS, Parlier CA), Dr. Monika Summenhalter (Cal State East Bay), Dr. David Zoldoske (Fresno State), Dr. Ray Anderson (USDA-ARS, Riverside CA), Dr. Louise Ferguson (UC Davis), Dr. Lu Zhang (UC Davis).

ARI funding commitment: $298,114; Matching Funds: $329,227.

Most crops have little tolerance to drought or saline irrigation water, both of which increase stress making the plants more susceptible to disease and insects, which often leads to lower yield and quality. Pistachios, on the other hand, appear to be relatively tolerant to saline water over short periods of time.

Global warming is expected to increase the frequency, depth and duration of drought in California and the southwestern United States. In response to the record five-year California drought, growers turned to pumping groundwater, which is not without its problems. Pumping groundwater for irrigation is expensive and the water often contains salts, including boron and selenium. Growers use groundwater without a clear idea of how long they can use this lower quality water before it will damage the pistachio trees. Dr. Gurreet Brar's group will address that issue by determining the threshold levels of Na and B that begin to disrupt cells, injure tissues and reduce pistachio yield. Experiments will be conducted in the field on trees that have been irrigated with saline water for several seasons. They will conduct controlled studies on younger trees to identify mechanisms that are disrupted by irrigating with multiple salinity levels. Their research will examine biophysical parameters affecting photosynthesis, assay biomarkers that are indicative of stress, and use scanning electron microscopy to examine the sub-cellular effects of Na and B loading as the duration of plant exposure to the low-quality water lengthens. This comprehensive study will also include economic modeling to draw out the relationship between saline irrigation and yields. Dr. Brar states the overall goal is to develop sustainability plans that growers can use to manage pistachio crops under an increasingly likely scenario where there is less high-quality water available for California.



Dr. Florence Cassel Sharma, Fresno State

Project title: Lysimetric Determination of Evapotranspiration Coefficients for Drip-irrigated Vegetables

Co-investigators: Dr. Dave Goorahoo (Fresno State), Mr. Shawn Ashkan (Fresno State), Mr. Forrest Melton (CSU, Monterey Bay), Mr. Lee Johnson (CSU, Monterey Bay).

ARI funding commitment: $449,870; Matching Funds: $464,775.

In response to prolonged drought and environmental concerns, crop production in California is migrating from flood irrigation to low-pressure drip irrigation systems. While drip irrigation has increased water use efficiency, adopting management practices that schedule irrigation based on crop water requirements by estimating crop evapotranspiration (ET) based on crop coefficients (Kc) can drive optimization further.

Determining daily ET values for site-specific climatic conditions and cultural practices is difficult, so few growers manage their crops with this method. The project being led by Dr. Sharma, will develop crop coefficients for drip irrigated fresh-market onions by implementing lysimetric and surface renewal studies.

As the crop grows, the ratio of crop cover to bare ground changes, and the crop water requirements become greater. The accuracy of crop coefficients can be improved by including estimates of crop cover, which can be estimated by remote sensing of the crop by satellites. CSU Monterey Bay/ NASA Ames Research Center scientists Melton and Johnson will provide that expertise to the project.

Once completed, the data will be integrated into irrigation programs (WATERIGHT and CropManage) that can be used by growers to schedule irrigation. While not site-specific, the Kc curves they are developing will be based on growing degree days. This should increase the accuracy in crop water requirements across different locations and climates and lead to greater use by growers.

Invest in applied Agricultural Research

The ARI program will fund the best applied agricultural science to leverage available resources to maximize impact and benefit in fulfilling the ARI mission in a way that does not dilute the mission, focus or effectiveness of the program.

Strategic objective 1: **Invest in applied research to address emerging and high-priority issues facing California agricultural and natural resource industries.**

Each year the ARI receives an allocation of $4.3 million that is matched at least one-to-one by non-CSU funds to support applied agricultural and natural resource research. An overview of FY 2016-2017 is provided by characterizing expenditures using six grant activity categories that include salaries, benefits, lab supplies, equipment, travel and "other". Following salaries, in decreasing order, the largest proportion of expenditures were lab supplies, benefits, "other", travel and equipment. The "other" category includes funds used for contracts and services to outside vendors, land rental, instrument repair and maintenance and miscellaneous.

Total expenditures of the six ARI campuses during FY 2016-2017 were $2.993 million. As a percentage, salaries were the largest category, comprising 62% of total expenditures during FY 2016-2017 (Figure 1). Salaries were paid to faculty, students and postdoctoral scholars and technicians in support of ARI research projects. The largest portion of the salary expenditures were used to support faculty additional employment (24%; primarily for summer salaries) and student salaries (16%). The remaining salary expenditures include faculty release time (6%), student tuition reimbursements (3%), and an "other" category. In this case, the "other" category comprises 4% of the salary expenditures and captures those employees that did not fall into a well-defined category, for example, those employed to work on a project on an intermittent or less than full-time basis.

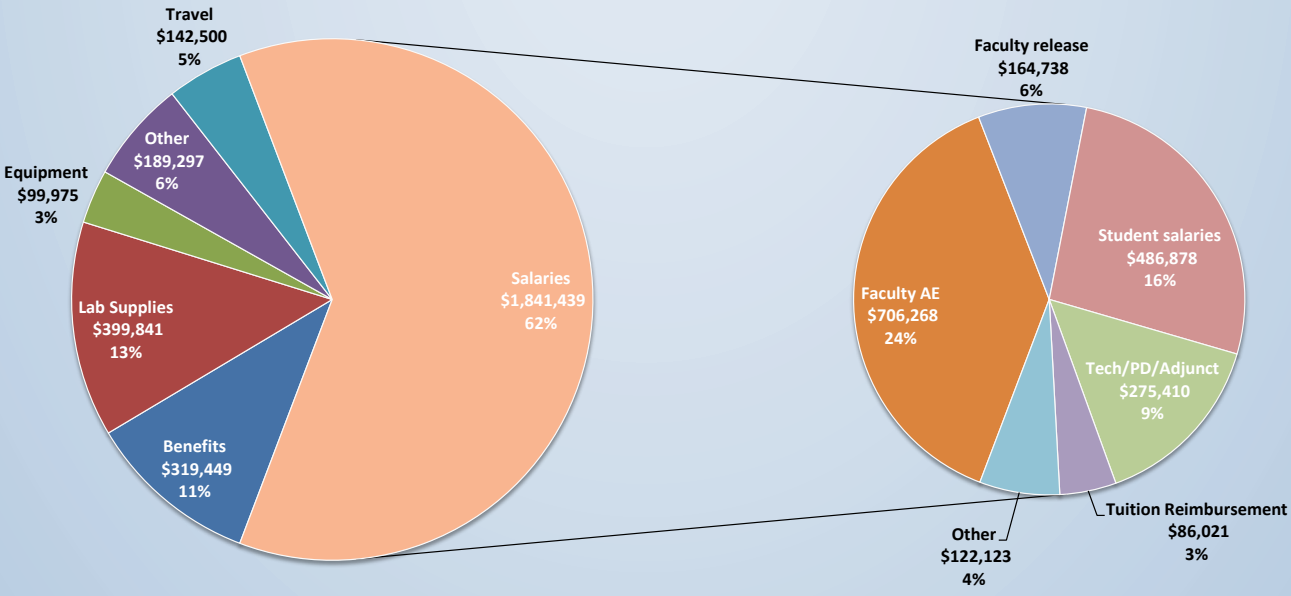


Figure 1. Expenditures for the ARI program during FY 2016-17 across Member and Associate campuses in support of the ARI mission to conduct applied research in agricultural and natural resources. Expenditures were characterized by the major grant activity categories. Inset provides details of salary expenditures.

Individual campus data (Figures 2A to 2F) provides an overview of how each campus expends their allocation in comparison to others. Within a given category, the expenditures vary widely across the six campuses with up to 10-fold variation observed. The exception to this variability is the percentage of budget expenditures for travel, which averaged 4.7% and ranged from only 3.9% to 5.1%. The inter-campus category comparisons indicate that each campus has a unique approach to implement and fulfill the applied research mission of the ARI program.

Figure 2. Comparisons of expenditures for each grant activity category across the six ARI campuses. Note that within each category the data are reported as a percentage of the total expenditures of that campus.

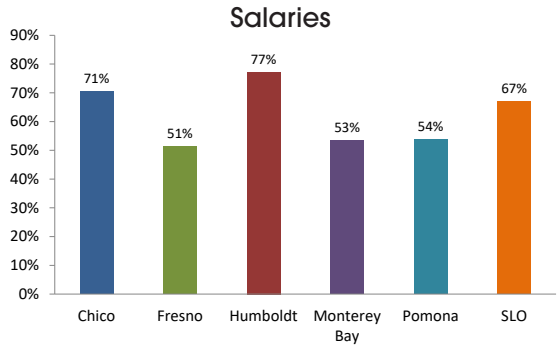


Figure 2A

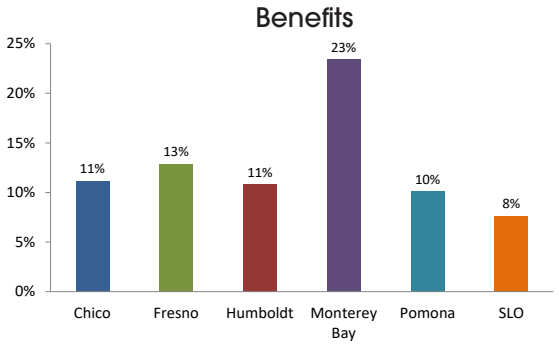


Figure 2B

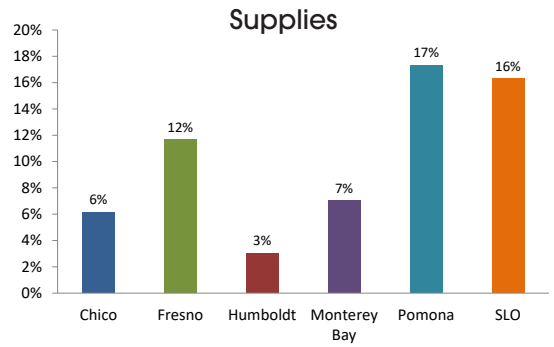


Figure 2C

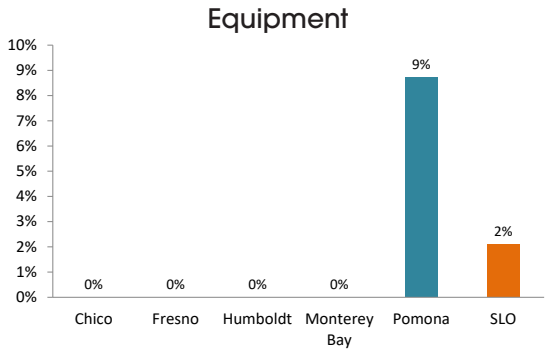


Figure 2D

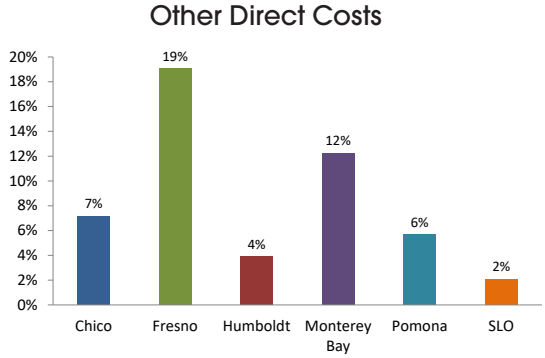


Figure 2E

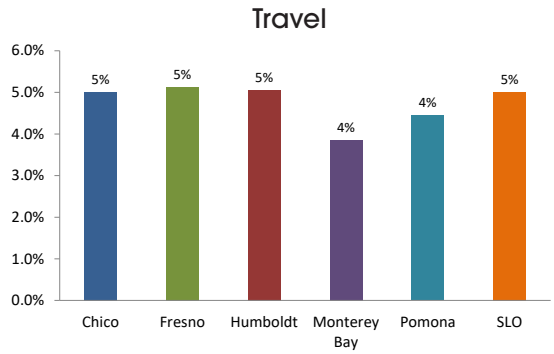


Figure 2F

Salaries represent the single greatest expenditure category and were used in multiple ways to support student and faculty (Figures 3A - 3F). ARI funds help faculty conduct research during the academic year through release time (average 6%) with Fresno and Pomona campuses reporting the highest percentage and three campuses (Humboldt, Monterey Bay and SLO) reporting essentially no release time. ARI funds can be used for tuition reimbursement, and Cal Poly, SLO used 8% of their budget for this purpose, while the other campuses reported from 0 to 2%.

A few ARI-supported laboratories have postdoctoral scientists or technicians, who often participate in student training and conduct highly technical components of the research. This year, approximately 9% of the total ARI expenditures provided financial support to those scientists which, at the same time, provides experience that will enhance the career of those scientists. Monterey Bay, at 41%, was by far, the campus with the largest postdoc/technician budget. Consequently, Monterey Bay had the highest expenditure of benefits, 23%, versus an average of 10.6% for the other five ARI campuses.

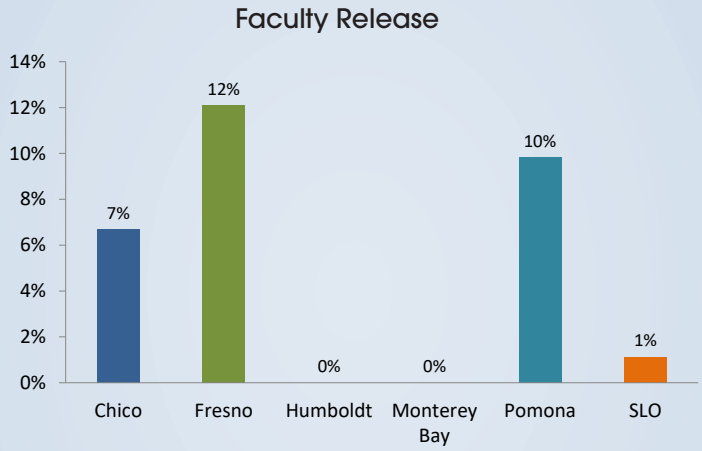


Figure 3A

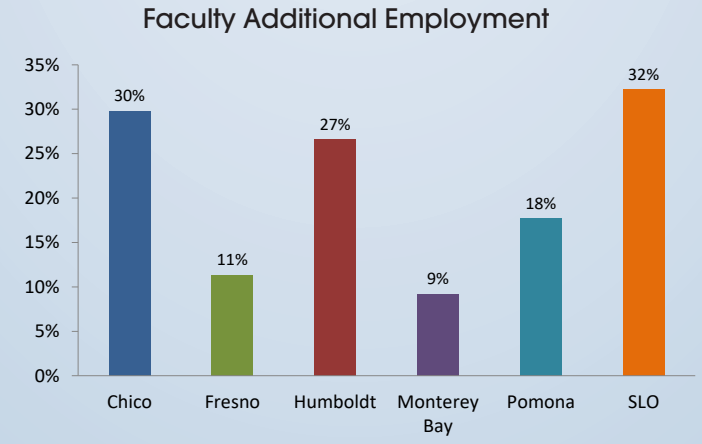


Figure 3B

Figure 3. Detailed salary expenditures of each campus that were used to support faculty and students to conduct applied research in agriculture and natural resources as part of the ARI mission. Note that within each category the data are reported as a percentage of the total expenditures of that campus.

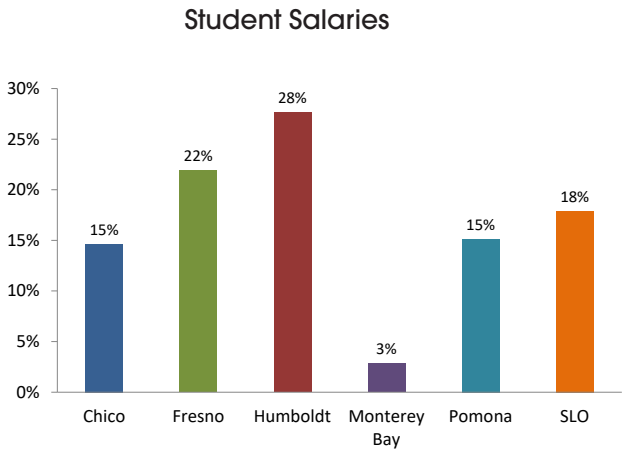


Figure 3C

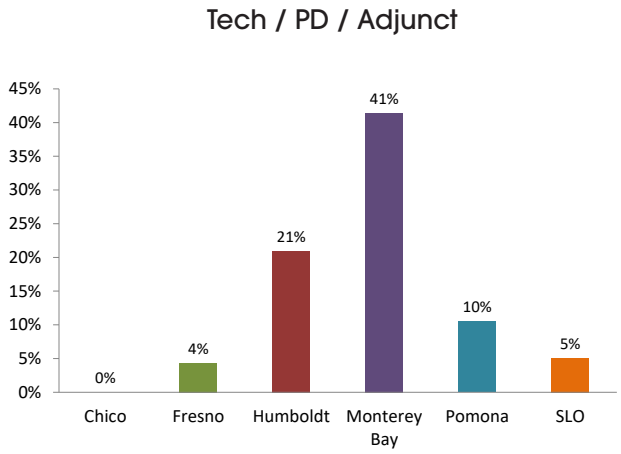


Figure 3D

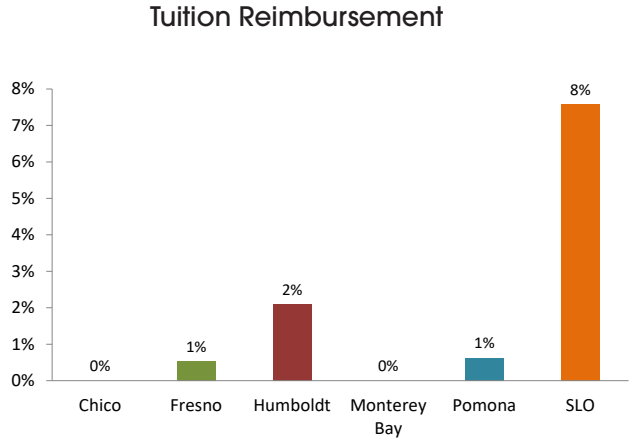


Figure 3E

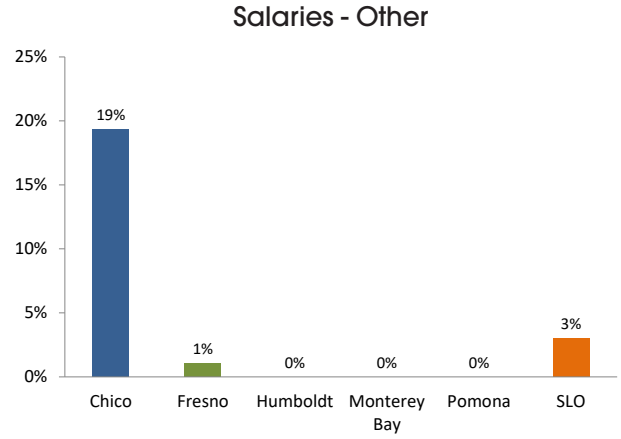


Figure 3F

Strategic objective - *invest in student research training*

The diversity of ARI projects is reflected in the variety of outputs and activities that were performed across the 103 active projects during the year (Figure 4). A list of projects for FY 2016-2017 is included at the end of this report. The most common outputs reported were conducting experiments, reported by 65 projects (average 63%, inter-campus range of 20% to 82%), and analyzing data, reported by 78 projects (average 76%, range 40% to 86%). As agricultural and natural resources industries evolve, innovation and new technologies are required to sustain that evolution. Increasingly so, that technology is coming from outside the traditional agriculture and natural resource disciplines. ARI researchers continue to collaborate with faculty and industry from other disciplines in order to adapt new technologies to agriculture. Toward that purpose, faculty reported that new technologies were created and new collaborations were established in 11% and 19% of the projects, respectively.

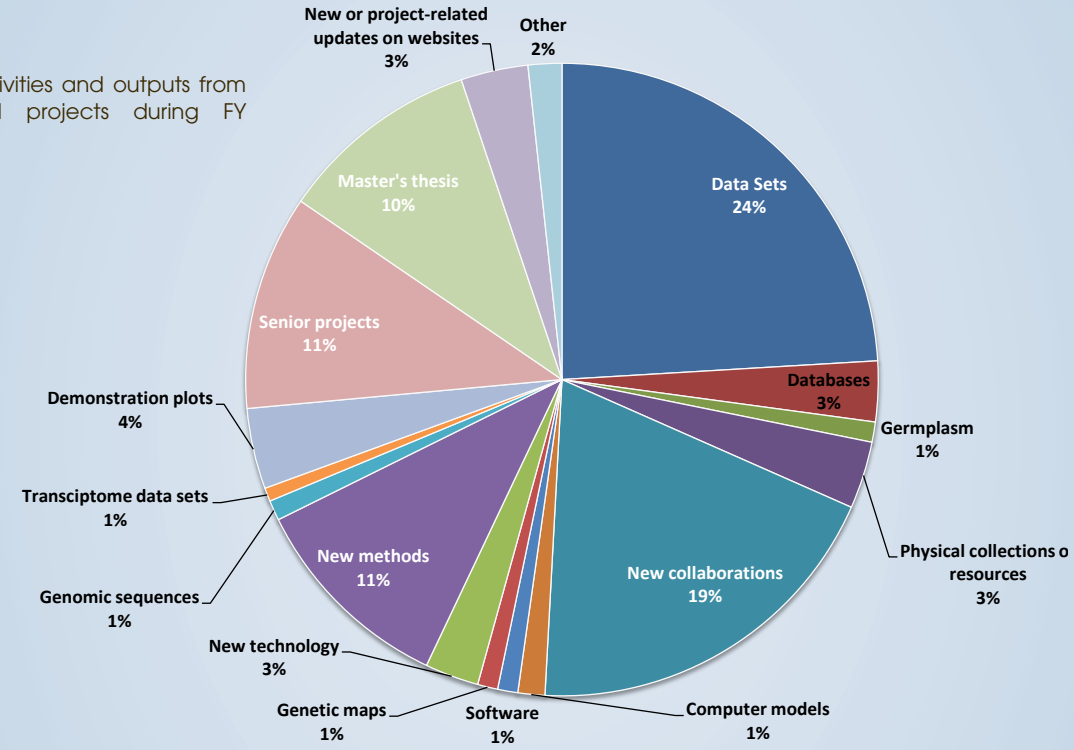


Figure 4. Activities and outputs from ARI-sponsored projects during FY 2016-2017.

Strategic objective 2: **Develop a highly-trained professional workforce for California agricultural and natural resource industries through student participation in research projects.**

Students working on ARI projects learn skills and training in problem solving approaches that prepares them for future careers in the California agriculture and natural resource industries.

A strength of the ARI is the training of students in the critical thinking skills that form the basis of the scientific method. A majority (86%) of the ARI projects provided students with scientific training and/or mentoring. Faculty reported that 424 undergraduates and 110 graduate students were trained and/or mentored.

As part of their research training, students were involved in experimental design, obtaining and analyzing data and presenting the results of their ARI research at conferences. Many also gain experience in writing a peer-reviewed manuscript. In fact, students were co-authors on 13 of the 15 papers published by ARI researchers this year.

Strategic objective - *communicate research results*

A research culture is further instilled in students when they participate in professional or grower conferences. This year, 57 students attended or presented their ARI-sponsored research results at a conference or symposium. Ideally, research generates new ideas and information that is not in text books or has not made it to a publication. In 62% of the projects, the knowledge and information generated in ARI-sponsored projects was brought into the class room, enhancing instruction and keeping both students and faculty engaged, motivated and informed.

Across the CSU system, almost 75% of CSU students work more than 20 hours per week, mostly off-campus and often in an occupation not related to their field of study. Student salaries comprised 16% of the ARI FY 2016-2017 expenditures and were used to support 236 students at an average wage of $2,063 per student. Students that get involved in ARI projects are often engaged in research that takes place on-campus and most importantly, gain knowledge and experience that is directly relevant to their future career. Faculty reported a higher number (534 total) of students were trained in their projects. The higher figure included students that volunteered and were not paid.

The CSU is one of the most ethnically and racially diverse university systems in the U.S. More than one-third of the CSU's entering freshmen are among the first generation of their families to attend college and 60% are students of color. With first-generation students participating in one-in-three ARI projects, this group is proportionally represented within the ARI.

Students under-represented in the sciences (Hispanic, African-American, American Indian, Alaska Native, Native Hawaiian and other Pacific Islanders) were employed in 33 (37%) of the projects according to faculty-reported data. Another 33 projects affirmed they had not hired under-represented students, and in 24 (27%) projects, faculty reported this information was not known by them.

By working on ARI projects, students are able to spend time with faculty outside the classroom. Importantly, they may ask advice from faculty about careers or how to get into a graduate program. For many first-generation college students, these faculty may be their best or only resource for this information. Many of our faculty were first-generation students and can personally relate to the student's background.

Strategic objective 3: **Communicate research results to industry stakeholders, scientists and the public.**

Faculty reported a total of 15 peer-reviewed papers based on their ARI-sponsored research. These were published in science journals, book chapters, books or trade journals. Faculty presented 133 posters or made oral presentations at scientific meetings, industry meetings or symposia. Clearly, professional discipline-specific conferences attended by faculty and students allow an exchange of scientific ideas and our faculty are exposed to a wide array of new theories and advances in technologies. Importantly, these meetings are a great networking opportunity allowing faculty to establish collaborations. Students attending these conferences often make a connection with a professor from another institution, enhancing the probability of ending up in their lab. While many industry personnel attend the professional science society meetings, there is much wider representation by this segment at industry meetings. It is during these grower and industry meetings where practical and actionable knowledge and ideas from ARI projects find their intended audience.

Faculty from a total of 18 projects (17% of the 90 projects in which assessments were received) reported participating or hosting a total of 24 field days or workshops for industry and the public. These faculty estimated that over 4,100 people received information or instruction through their attendance at these events. These activities are important since they target the growers or ranchers that are the direct consumers of this knowledge and whose practices may benefit from this ARI-generated data and information.

2016-17 Project titles, P.D. and funding, by campus

The ARI had 103 active projects across Member and Associate campuses. Although funding of the ARI is on a year-to-year basis, the ARI conditionally commits to funding projects for up to three years. During the last year, the average project duration was 1.7 years for Member campuses and 2.8 years for system funding. Average annual campus funding per project for Member campuses ranged from $22,726 to $57,856 for SLO and CPP, respectively. System funding averaged $133,615 per year. Total ARI commitment over the life of the project for Member campuses ranged from $68,576 to $118,000 for SLO and CPP, respectively. The average total ARI commitment for a project supported by system funding was $381,000.

ARI projects cover a wide variety of agricultural and natural resource issues. Stakeholders have not provided direct input into identifying high-priority funding areas. Instead, faculty propose projects that are based on their interests and expertise. Since each project is matched with non-CSU funds, this might indirectly indicate industry priorities and when matched with state and federal grants, attests to the grantsmanship and competiveness of faculty obtaining those grants. Below, we provide a list of projects funded through system and campus competitive grants during FY2016-17.

2016 - 17 Project Allocations

SYSTEM

Project Director	Project Title	Duration (Years)	2016-17 Allocation	Total ARI Commitment
Benes, Sharon	Irrigation and soil management tools for saline-irrigated alfalfa	2	$93,547	$179,074
Cassel Sharma, Florence	Estimating water requirements and developing new crop coefficients for drip-irrigated crops in California's central valley	3	$127,410	$382,230
Cassel Sharma, Florence	Physiological performance and nutritional quality of forages irrigated with oilfield waters	3	$150,000	$450,000
Melton, Forrest	On-farm BMP's for irrigation and nutrient management	3	$147,119	$443,720
Murinda, Shelton	Production of algae animal feed from dairy waste nutrients	3	$150,000	$450,000
		total:	**$668,076**	**$1,905,024**

CHICO

Project Director	Project Title	Duration (Years)	2016-17 Allocation	Total ARI Commitment
Ataie, Feraidon	Utilization of rice straw in concrete	2	$25,906	$46,082
Bianco, Stephanie	EASY GAP	3	$106,035	$343,194
Brimlow, Jacob	Growth & limitations: tri-county local food sales in intermediated markets	2	$32,811	$47,567
Carroll, Christine	Beyond Bt: the economic feasibility of biopesticides	1	$5,000	$5,000
Chao, Michael	Building a meat science research & teaching program at CSU, Chico	1	$5,000	$5,000
Houk, Eric	The economic contribution of agriculture & enhancing outreach in northeastern California	3	$39,866	$118,740
Houk, Eric	Understanding the economic and hydrologic imapcts of sustainable groundwater management decisions in the face of uncertain water supplies	3	$43,952	$130,968
Altier, Lee	Market evaluation of specialty crops in northern California	3	$50,970	$145,651
Johns, Mitchell	Soil, edaphic, and economic transformations in the reclamation of a degraded soil used in land application of fruit processing water	2	$98,000	$196,000
		total:	**$407,540**	**$1,038,202**

2016-17 Project titles, P.D. and funding, by campus

FRESNO				
Project Director	Project Title	Duration (Years)	2016-17 Allocation	Total ARI Commitment
Asci, Serhat	Developing forecasting systems for specialty crops production and revenue in California	1	$9,900	$9,900
Ashkan, Shawn	Managing deep percolation in drip irrigation systems	3	$37,720	$106,202
Ashkan, Shawn	Monitoring crop growth for year-round energy beet production	3	$35,076	$106,545
Brar, Gurreet	Evaluation of mechanical and chemical strategies to enhance winter chill accumulation in pistachios	1	$10,000	$10,000
Bushoven, John	Mapping and evaluation of permanent crop root systems by ground penetrating radar	3	$70,401	$233,525
Cassell Sharma, Florence	Evaluation of sorghum (*Sorghum bicolor* (L.) Moench) tolerance to varying irrigation and nitrogen fertilization regimes	3	$42,034	$126,567
Cassell Sharma, Florence	Estimating water requirements and developing new crop coefficients for drip-irrigated crops in CA central valley	3	$84,839	$254,517
Lone, Todd	Identification of guayule as a viable economical drought, salt and boron tolerant and rubber producing crop for poor quality soils and waters in the westside of central California.	3	$84,839	$254,517
McKeith, Amanda	Evaluation of the reduction of *E. faecium* and Bactiferm LHP dry in beef prime rib roasts	2	$15,000	$30,000
Pasha, Fayzul	An integrated management model to operate a farm at peak efficiency	3	$36,000	$103,020
Shrestha, Anil	Effect of shade and soil moisture of herbicides in junglerice	2	$20,129	$37,258
Tarrant, Katy	Defining broiler house influence on the gastrointestinal microbiome	1	$8,625	$8,625
Van Zyl, Sonet	Characterizing insecticide movement in grapevine using HPLC analysis	2	$74,443	$74,443
Yeasmin, Dilruba	Smart data utilization in the ag field: A compare and contrast analysis	2	$36,473	$72,946
		total:	$503,230	$1,241,318

POMONA				
Project Director	Project Title	Duration (Years)	2016-17 Allocation	Total ARI Commitment
Bhandari, Subodh	Unmanned aerial vehicles for precision agriculture using multispectral images and machine learning	1	$102,642	$102,642
Bobich, Edward	Physiological factors for performance and survival of landscape plants under water stress	1	$52,120	$52,120
Claisse, Jeremy	Green abalone aquaculture method development and technology transfer	1	$61,108	$61,108
Davidov Pardo, Gabriel	Encapsulation of lutein in multilayered nanoemulsions stabilized by grape polyphenolic extracts and maillard conjugates	1	$30,768	$30,768
Fox, Aaron	Alternative pest control methods for the invasive pest, *Bagrada hilaris*	1	$10,000	$10,000
Li, Yao Olive	Technical and economic feasibility study of utilizing orange pomace for food applications as an innovative means to reduce waste and provide nutrition	2	$65,007	$164,722

2016-17 Project titles, P.D. and funding, by campus

POMONA (cont'd)				
Project Director	Project Title	Duration (Years)	2016-17 Allocation	Total ARI Commitment
Liu, Junjun	Development of DNA aptamers specifically targeting shiga toxin type 2	2	$33,000	$75,626
Mellano, Valerie	Studies to increase field establishment of and parasitism by *Tamarixia radiata* for control of Asian citrus psyllid	3	$53,000	$110,535
Questad, Erin	Uses of southern California black walnut (*Juglans californica*) in landscaping, restoration, and control of weedy plant species	3	$98,965	$363,085
Singh, Harmit	Separation, analysis and antioxidant potential of food colors and phenolic compounds from peach processing wastewater	1	$4,232	$4,232
Still, David	Identification of physiological and genetic factors associated with higher nitrogen use efficiency in lettuce grown under limiting nitrogen	3	$148,677	$405,225
Yu, Jenny Zhen	Removal of water contaminants associated with agricultural applications	1	$34,758	$34,758
		total:	$694,277	$1,414,821

SAN LUIS OBISPO				
Project Director	Project Title	Duration (Years)	2016-17 Allocation	Total ARI Commitment
Amin, Samir	Characterization of commercially produced carrot pomace	2	$8,166	$17,666
Amin, Samir	Large lima bean flour use in pasta	1	$5,000	$5,000
Bennett, Darin	Alternative and underutilized feedstuffs for use in the California poultry industry	3	$52,177	$89,515
Bennett, Darin	Role of the gastrointestinal microbiota in poultry production: probiotics as an alternative to the use of antibiotics	2	$34,267	$85,101
Bisbing, Sarah	Effects of variable density thinning and prescribed fire on forest resilience and stand dynamics in Sierra Nevada forests	3	$70,287	$218,904
Cai, Xiaowei	The impact of produce purchasing on household health outcomes	3	$81,019	$241,651
Campos-Chillon, Fernando	In-vitro maturation and culture of equine oocytes and embryos	2	$9,027	$18,054
Casassa, Federico	Berry size and wine quality: chemical and sensory effects caused by intrinsic variations of berry size in *Vitis vinifera* L. grapes	1	$5,000	$5,000
Casassa, Federico	Wine matrix effects on tannin extraction and retention into pinot noir and cabernet sauvignon wines	2	$15,541	$33,430
Castro, Luis	The effect of alcohol and IBU levels on brewing yeast viability	2	$20,000	$40,000
Chiu, Yiwen	Developing life-cycle analysis framework for a coupled livestock-crop water recycle system	2	$19,958	$39,937
Delbridge, Timothy	Information sharing or social support? The role of spatial externalities in the organic adoption decision	1	$4,769	$4,769
Dicus, Chris	Geospatially analyzing fire risk in the wildland-urban interface of California	3	$15,524	$72,629
Dodson Peterson, Jean	Grapevine bud fruitfulness and timing of budbreak as a function of spur diameter and the position along the cordon	2	$20,000	$40,000

2016-17 Project titles, P.D. and funding, by campus

SAN LUIS OBISPO (cont'd)				
Project Director	Project Title	Duration (Years)	2016-17 Allocation	Total ARI Commitment
Dodson Peterson, Jean	The Influence of sustainable vineyard practices on soil microbial communities, scion growth and development and wine quality	2	$20,000	$40,000
Everett, David	Textural and melt functionality of natural cheese	2	$53,435	$79,907
Garner, Lauren	Evaluation of pomegranate cultivars for Coastal California production	3	$938	$26,071
Greenwood, Brian	Awakening and strengthening the connection of urban youth to the land	3	$19,660	$132,358
Hoover, Ben	Biochar use in plant propagation and production	2	$4,000	$10,666
Hurley, Sean	A technology and market feasibility analysis for using unmanned aerial systems in California agriculture	3	$44,546	$167,273
Huzzey, Julie	Acute behavior effects of regrouping Holstein and Jersey cows in pairs or individually after calving	2	$9,847	$29,847
Ivors, Kelly	Optimization of biologically active soil amendments as fumigation replacements for soilborne disease control in California strawberry production	3	$54,768	$110,941
Jung, Stephanie	From olive oil milling to the concept of an olive oil biorefinery	2	$19,769	$39,769
Kang, Ike	Improvement of processing efficiency, meat quality, and product safety by chilling broiler carcasses in cold saline solution	3	$79,888	$178,278
Lammert, Amy	Development and consumption behavior of ready-to-eat frozen oatmeal and fruit products	3	$0	$206,474
Lammert, Amy / Jimenez-Flores, Rafael	Assessment of biological activity in different fractions of phospholipids from milk and egg after supercritical CO_2 treatments	3	$0	$58,061
Lathrop, Amanda	Development of microbiologically-based intervention strategies for the control of food-borne and fungal plant pathogens that threaten CA produce production	3	$4,092	$124,061
Liu, Bo	Agriculture management based on aerial and ground robots	2	$20,000	$40,000
Malama, Bwalya	Hydrogeophysical investigation of potential impacts of groundwater abstraction on lower Scotts Creek stream flows	2	$19,971	$39,663
Manjarin, Rodrigo	Novel strategies to improve protein synthesis and muscle growth in preterm and term pigs as a translational model of premature infants	2	$20,000	$40,000
Steinmaus, Scott	Effects of seeding rate, seeding timing, and mowing height on mixed stands of tall fescue (*Festuca arundinacea*) and zoysiagrass (*Zoysia japonica*)	2	$14,880	$40,000
Surfleet, Chris	Hydrologic response to meadow restoration and upslope forest harvest in Sierra Nevada	3	$22,109	$79,790
Surfleet, Chris	Hydrologic response to mountain meadow restoration following conifer removal	3	$4,509	$40,909
Tubeileh, Ashraf	Evaluation of the effects of three agricultural wastes on organic bell pepper health, nutrition and yield	2	$20,000	$40,000

2016-17 Project titles, P.D. and funding, by campus

SAN LUIS OBISPO (cont'd)				
Project Director	Project Title	Duration (Years)	2016-17 Allocation	Total ARI Commitment
Vagnoni, David	Effectiveness of magnesium oxide sources for lactating dairy cattle	2	$20,000	$28,007
Vagnoni, David	Measurement of starch digestibility on-farm on California dairies	1	$5,000	$5,000
		total:	$818,147	$2,468,731

MONTEREY BAY				
Project Director	Project Title	Duration (Years)	2016-17 Allocation	Total ARI Commitment
Melton, Forrest	Flow and transport modeling of vadose zone leaching under different on-farm BMPs for irrigation and nutrient management	1	$57,042	$57,042
Miles, Timothy	Simplifying molecular diagnostics for field use in detecting plant pathogens	1	$39,513	$96,555
		total:	$96,555	$96,555

HUMBOLDT				
Project Director	Project Title	Duration (Years)	2016-17 Allocation	Total ARI Commitment
Han, Han-Sup	Cut-to-length thinning in northern California redwood forests; costs and impacts on soils and residual trees	2	$51,933	$51,933
Jacobson, Arne	Market assessment for biomass briquettes produced from forest residuals	2	$75,737	$75,737
Johnson, Matt	Barn owls in agriculture, videography & workshop	2	$21,650	$21,650
Richmond, Laurie	Socioeconomic research on the Humboldt Bay mariculture industry to support waterfront planning	2	$47,273	$47,273
Zald, Harold	Intergrating multi-temporal Landsat imagery and tree-rings to map forest growth responses to drought	2	$33,498	$33,498
		total:	$230,091	$230,091

Acknowledgements

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