Climate change and soil loss threaten food production around the globe. Regenerative agriculture, with its robust, straightforward, and cost-effective practices, is uniquely poised to address these momentous threats to civilization. It has the ability to sequester significant carbon levels in the soil, leading to a healthier, more abundant, and water-efficient food supply.
The Future of Agriculture is Regenerative

The Chico State Center for Regenerative Agriculture and Resilient Systems (CRARS) is the first comprehensive university-based program devoted to regenerative agriculture in the United States. Our mission is to investigate, develop, demonstrate, and educate about regenerative practices that both restore and enhance the resiliency of living systems and communities. Our reach is local, regional, national, and global.

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Meet Our Team

Co-Founders & Faculty Affiliates

Cynthia Daley, PhD
Co-founder and Director; Organic Dairy Program supervisor; College of Agriculture professor

Tim LaSalle, PhD
Co-founder; Director of Research and Development; Adjunct Professor

Garrett Liles, PhD
Co-founder; Faculty Affiliate; Soil Scientist; College of Agriculture Professor; Director of RAD Lab

Lee Altier, PhD
Co-founder; Faculty Affiliate; College of Agriculture Professor Emeritus, Organic Vegetable Cropping Systems

Jim Pushnik, PhD
Faculty Affiliate; College of Natural Sciences Professor Emeritus; Plant Pathology; Director of the Institute for Sustainable Development

Maria Giovanni, PhD
Faculty Affiliate; College of Natural Sciences Professor

Betsy Boyd, PhD
Faculty Affiliate; College of Agriculture Professor

Hossein Zakeri, PhD
Faculty Affiliate; College of Agriculture Assistant Professor

Logan Smith, PhD
Faculty Affiliate; College of Agriculture Assistant Professor

Jamal Javanmardi, PhD
Faculty Affiliate, Organic Vegetable Project Director; College of Agriculture Assistant Professor

Jake Brimlow, PhD
Faculty Affiliate; College of Agriculture Professor

Noelle Ferdon Brimlow, JD
Faculty Affiliate; Political Science and Criminal Justice, Professor

Mollie Aschenbrener, PhD
Faculty Affiliate; College of Agriculture, Professor; Lead Teacher Educator & Graduate Coordinator

Christine Carroll, PhD
Faculty Affiliate; Assistant Professor, College of Agriculture

John Knowles, PhD
Faculty Affiliate; Assistant Professor of Ecohydrology, Department of Earth and Environmental Sciences
Robin Donatello, PhD
Faculty Affiliate; Associate Professor of the Department of Mathematics and Statistics

Patricia Stock, PhD
Faculty Affiliate; former Dean of the College of Agriculture

Patty Oikawa, PhD
Faculty Affiliate; Assistant Professor and Chair in the Department of Earth & Environmental Sciences, CSU East Bay

Hannah Gosnell, PhD
Faculty Affiliate; Professor in the College of Earth, Ocean, and Atmospheric Sciences, Oregon State University

Sandrine Matiasek, PhD
Faculty Affiliate; Associate Professor of Geological and Environmental Sciences, Center for Water and the Environment
Personnel

A. Michele Auzenne, MA
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Raquel Krach, MS
Project Manager, Data and Publications and Graduate Student Coordinator

Sheryl Karas, MA
Communications and Outreach Support Specialist

Sue Mylin Silvera
Office Manager

Darby Heffner
Organic Dairy Manager

Scott Grist
Organic Vegetable Project Manager; Community Supported Agriculture Management and Student Training Support

Aquanette Burt, PhD
RAD Lab Manager

Hope Coulter
Staff Research Associate

Devin Pike
Staff Research Associate
The Leadership Council’s purpose is to collaboratively think, strategize, plan, communicate, support and help create productive alliances that can significantly contribute to addressing these global needs. As leaders from the industry and aligned fields, the Council’s potential to advocate for the CRARS as a significant and primary contributor to help create a more resilient and ecologically healthy food production system is without limits.

CRARS Structure

The Center was established at Chico State in 2019 as a research and education center. Guided by the talents and experiences of the CRARS Leadership Council, Executive Director Cynthia Daley oversees all aspects of the Center. Driven by an ethic of servant leadership and collaboration, Daley works with a diverse team of faculty, researchers, and staff to support and collaborate with farmers, ranchers, and community members through research, education, and networking. The University provides physical space, IT support, administrative support, University Farm access, and other resources, including consultation and collaboration to advance Chico State’s goals to achieve climate neutrality by 2030; remain responsive to additional sustainability needs; accelerate research and educational efforts to equip students, faculty, staff, and community members for a sustainable and resilient future.
Graduate Students and Student Research Assistants

Graduate students in the interdisciplinary master’s degree program are involved in research related to regenerative agriculture. Master’s thesis projects vary depending on the student, and can be of their own design or follow the design of a funded research project already underway. Student research assistants work on a variety of research projects initiated by CRARS.

Raquel Krach, Spring 2023: Committee chair Cynthia Daley. Research in almond orchard systems, cover crops and compost

Dana Yount, Fall 2023: Committee chair Kasey DeAtley. Research in livestock mortality compost in California.

Justin Vigil: Committee chair Kasey DeAtley. Research in livestock mortality compost in California.

Tyler Burke: Committee chair Cynthia Daley. Research related to the Soil Carbon Accrual Project.

Anusha Bathula: Committee chair Cynthia Daley. Research related to the Soil Carbon Accrual Project.

Steve (Jake) Wallin: Committee chair Hossein Zakeri. Research in orchard intercropping with legumes in these systems

Daniel Rodriguez: Student Research Assistant

Alex Lee Woodward: Research Intern

Karla Ahumada Regalado: RAD Lab Student Intern

Valentina Giron: RAD Lab Student Intern

Christabel Siemens: Project DA-FANH (RAD Lab Student Data Intern

Yazmin Chiquito: Project DA-FANH RAD Lab Student Data Intern

Jasmin Mejia-Mejia: College Corps Fellow working on on special projects related to local food production

Elijah Zazueta: College Corps Fellow working on on special projects related to local food production
First Snider Memorial Award Recipients

This award was created in memory of longtime farmer and agronomist John E. Snider via donations and gifts from his friends, family, and colleagues, to honor his lifetime of work and dedication to sustainable farming. Funds were given with the intention to support Chico State students in their education in soil health and regenerative agriculture.

The awards are competitive and require applicants to write an essay on soil health and regenerative agriculture which were reviewed by a committee. This year five students received awards of $1500 each. They were:

Riley Taylor, Agricultural Business
Linda Figueroa, Animal Science
Daniel Rodriquez, Plant and Soil Science
Jade Dorfman, Plant and Soil Science
Natalie Ernandes, Agricultural Communication and Leadership

Faculty Honored for Their Work

Logan Smith

CRARS Faculty Affiliate Logan Smith was the College of Agriculture’s 2023 Faculty of the Year Awards recipient. Well-known for his trademark enthusiasm, encouragement, and dedication to student success, he was also recently recognized by Chico State Student Organizations and Leadership Education as the 2023 Outstanding Advisor for his work with the Pre-Vet club.

Don Hankins

Don Hankins, who taught “Ecological & Cultural Stewardship of Natural and Working Lands” in our last Professional Course Series, was one of five faculty selected for Chico State’s Professional Achievement Honors. It was for exemplary teacher-scholar achievement on the Chico State campus.

Our New Mentor Farmer

Tyler Dawley of Big Bluff Ranch (regenerative chicken) has joined our list of mentors willing to help others in transitioning to regenerative methods. Tyler believes he is running the largest regenerative chicken operation on the west coast. Not only did he share his experience with regenerative practices with us but also what he has learned about business that he thinks is essential for farmers and ranchers to keep in mind to be profitable.

Read our article:
CRARS, with the Colleges of Agriculture and Natural Sciences at Chico State, together with multiple collaborating partners, is pleased to announce that we have received a California Climate Action Matching grant totaling approximately $6 million through an historic partnership between the University of California and the state of California. Over $80 million in climate action grants were awarded to support the implementation of solutions that directly address state climate priorities.

The grant received will fund the California Soil Carbon Accrual Project and Workforce Training Program designed to conduct on-farm research, remote sensing modeling technologies, and provide professional workforce training throughout California. In explaining the impact, project lead and CRARS director Cynthia Daley said, “We are thrilled to have been awarded the California Climate Action grant. These funds will be instrumental in moving our climate goals forward as a campus, and as a regional partner working toward a higher degree of preparedness. Climate change is upon us, and no one feels the effects more than production agriculture. It’s imperative that we develop more effective farming strategies that build resilience for future food security, and create a work-force that is climate literate, with the skills and knowledge to manage these changes into the future.”

The purpose of the project is to address soil erosion, degradation, and diminished water availability, all critical issues facing California agriculture. The evidence suggests that regenerative farming practices can reduce soil disturbance, increase soil organic matter, improve water-holding capacity, reduce crop inputs, enhance soil biological function and microbial diversity, and support the accumulation, or accrual, of soil carbon. This multi-sector, multi-disciplinary project will tackle these issues through three interlocking activities:

1) The Soil Carbon Accrual Project (SCAP) is designed to holistically compare carbon cycling associated with the standard or conventional farming system (full tillage; herbicide; fertilizers; pesticides; no cover) to a regenerative farming system (cover crops; no-till or conservation till; crop rotations) using eddy covariance tower technology and soil microbiological DNA probes to quantify the impacts on soil carbon accrual, soil microbial diversity, water use efficiency, nutrient density, and economic return.

2) The California Agriculture Resiliency Index uses sustainability factors (e.g., water resources; soil quality; water use; erodibility factors; groundwater recharge value; existing land uses; wildlife habitat potential; endangered species habitat) to predict long-term resiliency for agricultural regions and suitability for
diversified farming systems within the state. The model is being collaboratively developed with the Chico State Geographical Information Center.

3) The online Technical Assistance Provider Certification Program in Climate Smart/Regenerative Agriculture Practices & Implementation is designed to increase the availability of technical assistance to support rapid transition of California farms and ranches to climate-smart agricultural practices. New courses will include Carbon Farm Planning, Pollinator Habitat, and Traditional Ecological Knowledge.

Project Participants from Multiple Disciplines, College Campuses, Organizations and Businesses

Principle investigators include CRARS director and professor at Chico State College of Agriculture (CoA) Cynthia Daley; Chico State CoA Associate Professor of Soil Science Garrett Liles; Chico State CoA Associate Professor of Agricultural Business Jacob Brimlow; Chico State CoA Assistant Professor Logan Smith; Chico State College of Natural Sciences (CoNS) Assistant Professor of Ecohydrology John Knowles; Chico State CoNS Associate Professor, Earth and Environmental Sciences Sandrine Matiasék; and CSU East Bay Assistant Professor & Chair in the Department of Earth & Environmental Sciences Patty Oikawa. Our farmer partners include Hay Day Farm in Blythe, Bowles Farm in Los Banos, Josiassen Family Farms in Richvale, and the Chico State University Farm.

Other project collaborators include the Chico State Geographical Information Center, the California Association of Resource Conservation Service, the Carbon Cycle Institute, Metropolitan Water District, Buzz’s Bees, the Honeybee Discovery Center, and the Modoc Nation. The Modoc Nation partnership will be instrumental in carrying our shared climate goals into the most northern regions of the state on Tribal lands.

The Importance of the Technology

The eddy covariance tower technology (also known as flux towers) are an important capability provided by the funding for this project. Chico State professor John Knowles explains that “they allow us to monitor the ‘breathing’ of agricultural systems in real time. In particular, this project will apply them to test how regenerative vs. conventional management practices affect the potential for these systems to function as carbon sinks that remove and store CO2 from the atmosphere, which could really help out in the fight against climate change.”

Daley reiterates that point. “By establishing on-farm direct contrasts between farming strategies we will collect critical soil carbon accrual data to better inform the agricultural industry and our policy makers. More directly, this field data will inform participants in our Climate Smart Technical Assistance Program so that it can be disseminated immediately to those individuals working directly with California farmers and ranchers.”
At the end of 2022, the Center for Regenerative Agriculture and Resilient Systems in partnership with the College of Agriculture at Chico State was awarded a $5 million grant over five years from the USDA Partnership for Climate-Smart Commodities program to launch the North Valley Food Hub for Climate-Smart Agriculture. This was part of a second round of awardees for projects deemed to be “particularly innovative” in supporting the effort to combat the climate crisis by partnering with agriculture, forestry, and rural communities to provide climate solutions that strengthen rural America.

One of the largest challenges for farmers considering conservation practices is financial, both in terms of putting the practices in place and finding markets for the products they produce. According to the most recent USDA Census of Agriculture, considering just Butte County—one of the largest counties in the Sacramento Valley—63 percent of farms in the region make less than $49,999 in sales per year; and 66 percent of farms are less than 49 acres. At least 38 percent of all producers are socially disadvantaged (identifying as women, American Indian/Alaska Native Asian; Black or African American; Native Hawaiian/Pacific Islander; or Hispanic); and 23 percent of producers are new and beginning farmers. This is reflective of the Sacramento Valley, with a substantial number of producers in the region small or socially disadvantaged producers.

Given the small size and financial scale of these farms, the costs to implement Climate-Smart Agriculture and Forestry (CSAF) practices; the lack of technical assistance to support producers in practice implementation; and an inability to comprehensively and independently monitor and verify benefits are substantial barriers to producers adopting CSAF practices on their farms. This also inhibits the ability for these producers to realize premiums for their commodities that may come from marketing and promoting these commodities as climate-smart.

The intention of the North Valley Food Hub is to provide farm-to-fork integration through marketing and sales support for
climate-smart commodities (such as almonds, walnuts, rice, tomatoes, peaches, and prunes) by consolidating transaction costs, creating a one-stop shopping platform for buyers, and a marketplace for growers to post and promote their products. The project will support producers in implementing a variety of climate-smart cover crops; no-till or minimum-till practices; nutrient management; enhanced efficiency fertilizers; planting for high carbon sequestration rates; and soil amendments.

**Specific project goals include:**

- Establishing the North Valley Food Hub for Climate-Smart Agriculture focused on training, education, and marketing services for small and underserved farmers and ranchers engaging in climate-smart production practices. This will include technical service provider training, online farmer education and networking tools, and on-farm field days.

- Incentivizing underrepresented growers to use climate-smart production practices and participate in the Hub marketing and distribution through technical support, educational programming, and economic incentives.

- Establishing monitoring systems for each cooperator farm/ farmer to track soil carbon accrual through regular and standardized soil carbon assessment. Soil carbon is how carbon drawdown from the atmosphere and sequestration in the soil is determined.

- Developing markets/sales for producers participating in the North Valley Food Hub for Climate-Smart Agriculture through climate-smart product marketing language and strategy.

The benefits of this project should be substantial. Initial projections assume GHG mitigation and carbon sequestration benefits alone of 3,000 metric tons CO2e annually from the adoption of new CSAF practices. Though it is difficult to estimate annual incremental market returns to Sacramento Valley producers as a result of this project, given the varied crops and volumes anticipated, ongoing market premiums per producer are anticipated to be $15,000 annually with continued CSAF practices post-grant. Perhaps most importantly, though, efforts will build and sustain a longterm viable market channel for producers to market their commodities through.

This year’s focus was on building the infrastructure to support the project. Three new project managers were established:

**Project Manager—Data Management**

This project manager will perform data management duties and administrative support and coordination of grant-funded regional conservation planning and education programs as assigned. Following USDA or other guidelines and requirements of the funded program, the position will work with federal and state agencies, and conservation partners to develop and maintain program data collection and reporting tools; assist the project director to manage administrative aspects of the grant (e.g., project scheduling and accountability).

Resources to support this project are considerable. CRARS has longstanding existing partnerships with the California Association of Resource Conservation Districts, the Carbon Cycle Institute, California Climate Action Network, the Regenerative Agriculture Network Web Forum, and others, that will be leveraged through this project to reach and support Sacramento Valley producers. Furthermore, project outreach and engagement efforts will be conducted in partnership with the Farmer Veteran Coalition; National Black Farmers Association; National Latino Farmers and Ranchers Trade Association; National Latino Farmers and Ranchers Association; Young Farmers & Ranchers Association; Women for the Land - California: Council for Native American Farming and Ranching.

Additional project partners and supporters of this project include Butte County Farm Bureau; North State Hulling Cooperative, Douglass Ranch; GRUB Farms; Chico State Organic Vegetable Project, and Chico State’s Basic Needs Hungry Wildcat Pantry.

The North Valley Food Hub for Climate-Smart Agriculture is supported by USDA Partnership for Climate-Smart Commodities program grant #NR233A750004G110. USDA is an equal opportunity provider, employer, and lender.
Technical Assistance Provider Certification Program, Continuing Education Courses, and Minor in Regenerative Agriculture

In 2021-22, CRARS in collaboration with a large number of conservation partners was using a USDA National Institute of Food and Agriculture (NIIFA) grant to develop a Technical Service Provider (TSP) training program for professional development and an Agricultural Management Systems Learning Collaborative for farmers and TSPs. The part of the program that really took off was the technical service training program. A distinct state-wide need for technical assistance was identified as crucial for the success of multiple programs supporting agricultural producers in California. Many of those programs do not require NRCS TSP certification, but having a professionally trained group of people to fill these needs is necessary.

To this end, the original model was changed. We now provide, through Chico State Professional & Continuing Education, a full Technical Assistance Provider Certification Program and individual courses that can be taken by professionals for continuing education purposes or by producers. We are also in the process of developing a minor in regenerative agriculture through the College of Agriculture.

Technical Assistance Provider Certification Program

This program can stand on its own for professionals interested in working with a variety of agencies throughout California or serve as a useful gateway for those who decide to pursue full NRCS TSP certification. Trainees gain in-depth knowledge on different aspects of systems-based regenerative agriculture. They then use that background to learn how to create conservation plans (soil health management plans, carbon farm plans, etc.) to address specific resource concerns with various conservation practices.

Additionally, various NRCS Aglearn (NRCS’s online educational platform) courses are integrated into the CRARS TAP Certification Program. Participants receive an in-depth look at the NRCS nine-step planning process, including how to complete resource inventories, assessment and evaluation tools and monitoring strategies for different resource concerns, and land use types. Graduates can then seamlessly continue on to earn NRCS TSP certification, if desired, after completing the additional learning modules and activities NRCS requires.

The certification program is fully online for flexibility and convenience and includes weekly live discussions between students and faculty. Optional in-person field days are included with video recordings available for those who live too far away to attend. Participants are required to take the following three classes plus 1 elective.

- Regenerative Agriculture Systems: Theory & Practice
- Introduction to Soil Health Management
- Whole Farm/Ranch Planning & Design

1 elective is chosen from the following choices:

- Ecological Range Management & Adaptive Grazing
- Carbon Farm Planning
- Pollinator Habitat

Two of these electives, Ecological Range Management & Adaptive Grazing and Pollinator Habitat were added this year. Another course in Traditional Ecological Knowledge is under development. CEUs for specific courses are currently available from the Society for Ecological Restoration, Certified Crop Advisors, Society for Range Management, and NRCS.

Response to this program has been enthusiastic. In the first two years, we had a total of 94 individuals enrolled across the four courses, for a total of 242 enrollments. (The number of courses offered has grown since then.) We have attracted mainly TAPs or TAPs in training that come from RCDs, Extension or other non-profit organizations. We’ve also had a few NRCS professionals participate looking for continuing education. Two things seem to draw people to the program: the extensive knowledge in regenerative agriculture that comes from the diverse array of individuals teaching the courses, and that the program is offered as hybrid (asynchronous and synchronous) learning, allowing people to participate who may otherwise not be able to. The NIFA grant helps provide scholarships for tuition for underserved groups, and interest in that assistance has grown to be competitive with more applicants now than recipients.

The certification program has already directly led to some of our TAP graduates finding jobs in related fields. Graduate Delia Hitz reports that her participation has led to multiple projects. She wrote “I have been very busy and none of this would have happened without taking the CRARS courses! . . . I am so grateful to all of you for the amazing educational opportunity that is already leading me in exciting new directions.”

Various aspects of these new educational programs are funded by a California Climate Action Matching grant and with USDA NIIFA Award #2023-70001-49989. USDA is an equal opportunity provider and employer. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the U.S. Department of Agriculture. In addition, any reference to specific brands or types of products or services does not constitute or imply an endorsement by the U.S. Department of Agriculture for those products or services.
In collaboration with 12 other conservation partners, CRARS was previously awarded a coveted Regional Conservation Partnership Program (RCPP) award through the USDA’s Natural Resources Conservation Service to support a five-year project called “Soil Health Management Systems for Northern California.” The purpose is to help orchard/vineyard, rangeland, dairy and row crop producers in Northern California build food and fiber production resiliency to counter climate change challenges.

This project will bring close to $5 million to producers via producer incentives over 5 years in the Northern CA region to implement conservation practices. The grant also funds four California Resource Conservation District Hub positions to support the development of producer-based Soil Health Management Plans, implementation strategies and protocols. The project integrates carbon farm planning activities and supports Agriculture Communities of Practice to disseminate adaptive management knowledge, training and exchange of ideas. Working together with CRARS, the intention is to build plans that conserve and regenerate soil while sequestering carbon and building resilience through water use efficiency.

**Our First Year of Implementation**

Practices including cover crops, soil carbon amendments (including compost), mulch, whole orchard recycling, conservation crop rotation and prescribed grazing have been funded to be implemented on over 1,000 acres of production agricultural land.

**Totals:**
$784,314 allocated to 9 producers in Glenn, Yolo, Humboldt, and Butte Counties.

**Practices:**
1. Cover crops: 979.17 acres (number will increase when info for one additional producer is known)
2. Soil carbon amendment (including compost): 281.8 acres (This number will increase when information for one additional producer is known.)
3. Mulch: 0.3 acres
4. Whole orchard recycling: 20.82 acres
5. Conservation crop rotation: 22.8 acres

There is an additional producer in batch 2 who has been funded for livestock pipeline, pumping plant, spring development, two stock trough watering facilities, three above ground storage tanks and interior fencing (prescribed grazing).

**Evaluation of Social, Economic and Environmental Impacts:**
We hope to be able to draw conclusions about how implementation of conservation practices impacts these three areas by the end of the project. As of this date we have begun soil sampling, and we plan to begin interviewing/surveying producers about social and economic aspects soon.

RCPP is supported by USDA-NRCS grant #2338. USDA is an equal opportunity provider and employer.
Regenerative Agriculture Events 2023

Webinars in Regenerative Agriculture Research Topics

As part of our Graduate Seminar in Regenerative Agriculture, we were pleased to host a number of esteemed researchers presenting their latest findings in this series of free webinars, open to the public. The webinars were received with interest and numerous requests for recordings to be made available. A page was created on our website so the webinars could be accessed at any time.

October 4, 2023: Impacts of Regenerative Practices on Organic Almond Production Systems

Raquel Krach, Research Associate V, Center for Regenerative Agriculture & Resilient Systems, Chico State

October 11, 2023: Management, Metrics and Monitoring of Grazing Systems

Jason Rowntree, CS Mott Professor of Sustainable Agriculture, Director of the University of Missouri Center for Regenerative Agriculture

October 18, 2023: Cover Crops as a Key Strategy for Resilient Farming Systems

Robert Myers, Director of the University of Missouri Center for Regenerative Agriculture

November 1, 2023: Impacts of Regenerative Practices on Soil Health and Soil Carbon Accrual in Western Regional Farming Systems

Cynthia Daley, Director of the Center for Regenerative Agriculture & Resilient Systems, Chico State

October 25, 2023: Exploring the Effects of Cover Crops in Orchard Ecosystems

Vivian Wauters, Post Doctoral Fellow, UC Davis, Agroecology Laboratory.
Soil Health Academy

This year’s Soil Health Academy on March 14-16 at the University Farm was focussed on growing healthier soil, food, and profits with instructors Allen Williams, Eric Fuchs, and Shane New. It brought 80+ producers/growers, the largest number of participants yet. They came from all cropping systems and backgrounds and included agency personnel from nearby RCDs and NRCS. Another new addition was a group of agriculture teachers, obviously working ahead of the curve to develop relevant/important content for their students—a sign that the industry is shifting in a very positive way, toward regeneration.

The three-day event examined all aspects of regenerative farming and ranching, soil health, plant health, and animal health. Hands-on experience was heavily emphasized. Participants worked in teams to solve real-world grazing problems and sharpen their skills. Activities included a Regen Ag 101 course (completed prior to the first day of in-person class); digital course materials and lunch each day; two follow-up Zoom meetings with a consultant within the first year after the SHA school; and access to future scheduled conference calls with the instructors.
Cover Crop Planting for Growers & Partners

This event, co-sponsored by Glen County Resource Conservation District and California Olive Ranch, provided an opportunity to share results and insights from a three-year study we did at California Olive Ranch. Cover crops were planted in December 2020, October 2021, and September 2022 on approximately half of the olive orchard’s acreage. Treatment and control rows were used to help monitor the impact of the cover crops on soil health.

Presentations included:

- Deep rooted cover crop profiles and how it improves water infiltration
- Slake Testing to determine soil structure
- On-Farm Water Infiltration Testing and how it works
- Timing of winter cover crop seeding, best management practices.
- Preliminary data from the three year study

The event on March 28 was presented on Zoom starting at 9:30 a.m. and also in person at Glenn Success Square, 131 E. Walker St., Orland, CA.

Innovations Tour: Cover Crop in California Ag Systems 2023

We joined CRARS mentor-farmer Rory Crowley of Project Apis m. for their annual farm tour at the beginning of March when the almond groves were in bloom. Participants were treated to presentations at several farms and ranches including Nic Nut, Comanche Creek, and the almond orchard at the University Farm at Chico State. CRARS director Cynthia Daley joined Rory for presentations on the latest research there. There was also an optional Beeyard Tour extension at Heitkam’s Honey Bees.
The 2nd Annual Regenerative Almond Field Day at Burroughs Family Orchards

CRARS founders Rosie and Ward Burroughs and their family now sponsor a Regenerative Almonds Field Day on their property in Ballico, California every year. This year’s event on February 21-22 was an amazing convening of farmers, industry leaders, researchers, technical service providers, land and livestock managers, policymakers, and others working toward a healthy and truly regenerative food system. CRARS co-founder Tim LaSalle was a guest speaker.
2023 California Plant and Soil Conference

We’re proud of Hossein Zakeri, Kyle Brasier, and the students who attended this year’s conference February 7-8 in Fresno, California on sustainable farming practices. CRARS director Cynthia Daley was among the invited speakers and presented during the Organic and Regenerative Session. Twelve College of Agriculture undergraduates and three Plant and Soil Science graduate students presented during the poster competition. The following students received awards:

1. Aubrey Teckam, 1st place poster presentation in Plant Science
2. Maia Crummett, 2nd place poster presentation in Soil Science
3. Kimberly Holguin, 3rd place poster presentation in Soil Science
4. Erik Spitzer, 1st place Graduate Student poster presentation
5. Maia Crummett received an undergraduate scholarship

Western Society of Crop Science Annual Meeting

The College of Agriculture was well represented by students and faculty members at the 2023 Western Society of Crop Science Annual Meeting in Honolulu, Hawaii in June. Students Aubrey Teckam (undergrad, pictured at right) and Gabe Worthington (graduate student) of Chico, Harman Sharma (graduate student) from Fresno, and Curtis Bierely (undergrad) from CSUMB presented the results of a multi-campus project, funded by the California Department of Food and Agriculture. In addition, Erik Spitzer (graduate student) from Chico presented the results of his master’s thesis and won a presentation award. Kyle Brasier and Hossein Zakeri also presented the results of an ARI project.

The project in the photograph is “Interaction of Fava Beans and Oat in Cover Crop Mixes With and Without Mycorrhizal Inoculation” by Aubrey Teckam, Kyle Brasier and Hossein Zakeri.

2023 North Valley Nut Conference

The Honeybee Discovery Center presented this event in collaboration with West Coast Nut on January 19th at Silver Dollar Fairgrounds in Chico. Featured speakers included Patricia Stock and Cynthia Daley along with CRARS mentor-farmer Rory Crowley from Project Apis m. The event included a cover crop demonstration, a beekeeping demonstration, and discussions of pollinator health management, pollinator habitat and why it matters, irrigation strategies in a drought year, naval orangeworm management, walnut mold management, phytophthora management in almonds and walnuts, and other key management lessons. There were also updates from Butte and Glenn County Agricultural Commissioners Louis Mendoza and Marcie Skelton.
“Deeply Rooted: How Soil Connects Us” Exhibition at the Valene L. Smith Museum of Anthropology

Under the instruction of museum director, William Nitzky, and in partnership with soil scientist Garrett Liles, exhibition design students presented the incredible universe of soil and the vital role it plays across global ecosystems and cultures starting January 26, 2023. The exhibition was designed to take visitors through three themes of Adaptation, Innovation, and Regeneration to call attention to the living soil network, our use and management of soil resources and ecosystem services, and ways for improving environmental quality and the protection of our human and planet health. With our museum’s focus on inclusion and personal narratives of the human experience, the exhibition brought together a collection of perspectives from archaeology, biology, art, Traditional Ecological Knowledge, and underground creatures, thus allowing visitors to explore how essential soil is to our lives and our environment, past, present, and into the future.

As part of the exhibition, soil artist and soil scientist Kirsten Kurtz drew on her artistic background and love of soil science to present a more creative perception of soil as a natural resource, combining soil science with art on May 4. This was followed by a Community Paint using local soil pigments.
Impact of Compost and Multispecies Cover Crops on Almond Production and Soil Health

Climate smart agricultural practices that build soil organic matter provide benefits to farmers by improving agroecosystem productivity and resiliency as well as to the environment by sequestering carbon and improving water use efficiency. Two such practices are the application of compost and the growth of multispecies cover crops.

Objective of the study: To determine the impact of compost and multispecies cover crop on almond and forage production and on soil health in a mature organic almond orchard.

Methods: Study Site and Design

The study used a 2x2 factorial/randomized complete block design of four treatments with four replicates. Application of compost was at the rate of 8 tons per acre. A 15 species cover crop mix was seeded between tree rows.

Methods: Sampling and Data Collection

This research took place in the almond orchard of the Massa Organics farm, located in Glenn County, California. Funded by a CDFA Healthy Soils grant, compost and multispecies cover crop treatments were applied each Fall from 2019-2022 in a 2 x 2 Randomized Complete Block Design with four replicates of each treatment: compost, multispecies cover crop, compost + cover crop and control. Understory vegetation was sampled for biomass production and forage quality; soil was sampled and analyzed for nutrient content, microbial community composition and physical characteristics. Almonds were harvested by plot to determine yield and kernel nutrient densities by treatment. Soil was also sampled and compared to the neighboring conventional almond orchard.

Results

Figure 1. Comparison of quantity (A) and quality (B) of the organic almond orchard understory biomass production in April 2022 by treatment (control, compost, cover crop and compost + cover crop). Values for quantity are means (± standard errors) in pounds of dry matter per acre, with different letters indicating significant differences (p = 0.03). Relative Feed Value is an index for ranking forages based on digestibility and intake potential, and values represent means (± standard errors) with different letters indicating significant differences (p = 0.02).
Conclusions

The application of compost and the seeding of a multispecies cover crop significantly increased the productivity of the orchard, both in the quantity and quality of the understory vegetation as well as almond crop yield. These practices increased the quantity and activity (data not shown) of the soil microbial community and resulted in significantly higher soil carbon accrual and nitrogen content. This translated into more, higher quality forage for the sheep that the farmers use to graze the orchard and higher almond yields, which more than covers the cost of the compost and cover crop seed.

Implications of the study: Cover crops and compost can provide multiple benefits to an orchard system, including improved nutrient cycling, increased productivity and carbon sequestration. While some of these benefits are immediate, climate smart practices also result in increased farm resiliency in the long term.

Raquel Krach, IDST: Regenerative Agriculture, California State University, Chico

Funding of this project was made possible by the Center for Regenerative Agriculture and Resilient Systems, California Department of Food and Agriculture - Healthy Soils Initiative, and Massa Organics
To dovetail with the Soil Carbon Accrual project, Logan Smith recently received an ARI grant to use the data collected by eddy covariance in that project with rigorous in-field soil sampling and remote-sensing technology to:

- Contrast net carbon accrual associated with regenerative and conventional agricultural management practices using EC and direct in-field measurements.
- Establish water use efficiency and water infiltration implications of production processes.
- Quantify the impacts of production systems on soil microbiological communities through microscopy and PLFA.
- Measure and correlate bacteria/fungi ratios and biomass changes with net carbon accrual.
- Determine the impacts of production methods on the nutrient density of forages through crop quality assessments.

Research is ongoing, but initial results indicate that regeneratively treated soil had greater microbial biomass than conventional soil and fungal-to-bacterial ratios were higher. Through metagenomic sequencing, approximately 200 bacteria and 40 fungal unique organisms have been identified in the regeneratively treated soils in this project so far. The team is still working on comparing this diversity with conventionally treated soils. Similar testing and comparisons will be done on other farm sites.

It is believed that higher fungal-to-bacterial ratios and greater microbial biomass is associated with soil that is more nutrient rich, more resilient to climate conditions, less prone to erosion, more able to infiltrate and retain water, and more likely to lead to increased soil carbon accrual. This project is designed to determine to what extent this may be true and what management practices have the most impact. We hope the information gained will assist California farmers to make decisions that will save them money and keep farms profitable and more climate resilient throughout the state.

Student research assistant Linda Figueroa created the above poster presentation. She is also helping with the research manuscript publication and using it for her AGRI 490W class project.
California is home to approximately 21,000 acres of olive orchards for olive oil production, a drought-resistant sustainable crop, but one that does not naturally attract as many pollinators relative to others that require bees for pollination. An industry-wide effort is needed to advance pollinator-friendly practices to restore habitat in key California growing olive-growing regions. This would achieve increased on-farm environmental benefits and likely increase producer returns, justifying this project. As such, the American Olive Oil Producers Association (AOOPA) is partnering with CRARS to implement pollinator supporting practices. CRARS is providing producer technical support for on-farm practice implementation, monitoring project outcomes, and providing Integrated Pest Management training. The project’s goal is to implement practices on 5-10 olive farms. CRARS will evaluate/measure results by pollinator surveys.

Counties/Locations Served: The project’s general location will be on California’s oil olive farms in the state’s key olive growing regions. Commitments to implement practices have already been secured from olive producers in the Northern Sacramento Valley and the Central Valley.

Objective 1: Provide technical assistance to AOOPA collaborators to create plans for target pollinator species and implement the installation of pollinator conservation management practices in partnership with farmers and ranchers.

A variety of pollinator habitat conservation management practices will be implemented by AOOPA members. Olive farmers that have currently committed to the program have primarily indicated interest in the installation of hedgerows and cover crops in proximity to their olive orchards. There has been some interest in the installation of other pollinator habitat options for specific attraction of certain target pollinator species. Additional recruitment of farmers is still to take place, which may further diversify the conservation practices adopted. CRARS will provide technical assistance to farmers throughout this process.

Objective 2: IPM training and identification of on-farm pollinators at habitat project sites.

CRARS will provide an IPM training meeting to collaborating farmers as part of this contract. In addition, personalized meetings with individual growers and site visits will allow for identification and training on pollinator identification. IPM training will include direct personal contact to known producers, email contacts, and outreach at annual AOOPA meetings. At these events they will share about project’s efforts and the benefits participating producers are experiencing on their farms as a result. Outreach events will be promoted through American Olive Oil Producers Association’s regular outreach channels reaching 571 producer and industry contacts in its outreach channels, including additional Socially Disadvantaged Farmers and Ranchers and small to mid-scale.

The principal investigator is Betsy Boyd.
Visiting Soil Scientist Alexandro Barbosa Orjuela

We'd like to thank Alexandro Barbosa Orjuela, a visiting soil scientist and professor from Chile, who helped us out in the soil lab for the last few months. Alexandro is an agricultural engineer who graduated from the National Experimental University of Táchira in Venezuela and has a master's degree in plant production from the same institution. He is also currently a student in the doctorate program in agricultural and food sciences at the Austral University of Chile. While he was here he went to a Latino Farmers Conference, took a class in Ecological Range Management & Adaptive Grazing, and worked on his PhD thesis on soil health and carbon storage in pasture systems. For this work he has been developing several processes, including the use of soil spectroscopy methodology which serves to quantify information in a more environmentally friendly way. He is hoping to demonstrate that pasture management in milk production systems can play an important role in mitigating greenhouse gas emissions in Chile.

Alexandro was enormously helpful in the lab after we lost a few key employees as he was already familiar with the testing we do. And, as Chico State is an Hispanic-Serving Institution with bilingual students, it was also wonderful to have someone who could work so well with these students when it was needed. Thank you, Alexandro!
We Welcome New Leadership to the College of Agriculture and University Farm

**David M. Hassenzahl** is the new interim dean of the College of Agriculture at Chico State as well as the current dean of the College of Natural Sciences. Hassenzahl brings to this role nearly two decades of experience as an academic leader and administrator, with experience building and supporting infrastructure, programs, and organizations. His accomplishments at Chico State include leadership on the new Science Building, serving as co-PI on the Chico STEM Connections Collaborative grant, and serving as acting CEO of Chico State Enterprises.

While his primary focus in Chico has been in risk analysis and environmental science, his experience includes fundraising for and creation of a teaching garden; vegetable, grain, and livestock production; heritage orchard rehabilitation; and aquaculture research and production at Chatham University’s Eden Hall Campus. He claims that being dean is his second favorite job. His first was mapping range improvements for cattle grazing in the hills east of the San Francisco Bay.

In June 2022, Dr. Hassenzahl was honored by the Association for Environmental Studies and Sciences (AESS) with its William R. Freudenburg Lifetime Achievement Award for his work in promoting interdisciplinarity in regards to environmental science. He was the founding dean of the Falk School of Sustainability at Chatham University, starting in 2010, and has continued his groundbreaking focus on sustainability as dean for Chico State’s College of Natural Sciences, where he’s been since 2014. He is a member of the Council of Environmental Deans and Directors and the Association for the Advancement of Sustainability in Higher Education. He played a role in the grant-proposal process for the California Climate Action Matching Grant for CRARS.

**Ricardo Orellana** joins us from Cornell University to be the new director of the University Farm. Orellana has overseen diverse agricultural operations, with expertise including cover crops, fruit trees, and vegetable production, high tunnel and greenhouse production, and livestock, dairy, and poultry production. He has led multicultural staff and professionals, and managed multi-year projects and contracts with national and international companies in agriculture market access, education, training, produce safety, and climate-smart practices. He also has experience managing small and large competitive funds to promote smart sustainable agriculture, new business, technology innovation, agribusiness, soil and water conservation, and natural resources management. And he has worked with diverse donors from the public and private sectors at international levels, including USAID, World Bank, International Bank for Agricultural Development, Inter-American Development Bank, and The Swiss Agency for Development and Cooperation.

Orellana earned his PhD in plant and soil sciences at the University of Massachusetts, Amherst. He also holds a PhD in rural development from Bolivarian University, Chile, where he also received an MS in sustainable human development. Additionally, he received an MBA from the Institute of Economics and Business Administration in El Salvador, and bachelor’s degrees in both rural development and agriculture, and agronomy and forestry from Zamorano University in Honduras.
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