



Center for Regenerative Agriculture & Resilient Systems

Annual Report 2021 & 2022

Cynthia Daley, PhD, executive director, professor

Tim LaSalle, PhD, director of research and development, adjunct professor

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; Professor,
College of Agriculture



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



Garrett Liles, PhD—
Co-founder; Faculty
Affiliate; Professor, College
of Agriculture; Director of
RAD Lab, soil scientist.



Lee Altier, PhD—
Co-founder; Faculty
Affiliate; College of
Agriculture Professor
Emeritus



Betsy Boyd, PhD—
Faculty Affiliate; Professor,
College of Agriculture



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



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



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



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



Jake Brimlow, PhD—
Faculty Affiliate; Professor,
College of Agriculture



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



Jeffrey Davids, PhD—
Faculty Affiliate; Assistant
Professor, Civil
Engineering



Don Hankins, PhD—
Faculty Affiliate; Professor,
Geography and Planning



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

Personnel



A. Michele Auzenne, MA—
Assistant Director



Lindsey Hethcote—
Conservation Project
Coordinator



Aundrea Asbell—
Regenerative
Demonstration Lab
Manager



Sue Mylin Silvera—
Office Manager



Sheryl Karas, MA—
Communications and
Outreach Support Specialist



Darby Heffner—
Organic Dairy Manager



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



Devin Pike—
Staff Research Associate



Constantin Raether—
Staff Research Associate



Drew Gilberti—
Staff Research Associate



Priya Tuvell, MAgr—
Program Coordinator 2021;
Manager, Nutrient Density
Lab; Online Certificate
Program Lead 2021



**Christina Elizabeth
Pease**—Research Project
Manager 2021



Seth Myrick—
Staff Research Associate
2021

Leadership Council



Randy Record—Past Director, Metropolitan Water District



Rebecca Burgess—Director, Fibershed



Joe Morris—Regenerative Rancher



Shannon Douglass—Vice President, California Farm Bureau



Scott Park—Regenerative Farmer



Leonard Diggs—Director of Operations and Farming Education, Pie Ranch



Tom Newmark—Regenerative Farmer



Natasha Lilly—Regenerative Rancher; Founder, Full Circle Veterinary Center



Rose and Ward Burroughs—CRARS co-founders, regenerative agriculture producers

The Leadership Council's purpose is to collaboratively think, plan, strategize, 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 Cindy 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, which 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.



Clair Akin: Research in use of cover crops in an olive orchard and the effects on water infiltration and runoff.



Gabrielle Hathaway: Research in greenhouse gas emissions and lifecycle analysis of organic grass-fed dairy systems.



Clayton Handy: Research in walnut systems, cover crops, termination systems, costs of production



Raquel Krach: Research in almond orchard systems, cover crops and compost



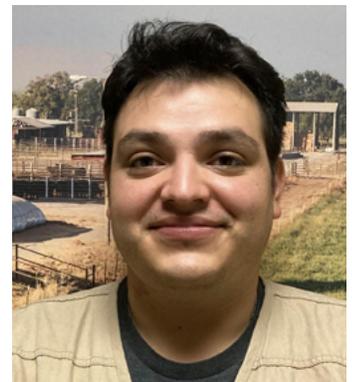
Justin Vigil: Research in the business/marketing of regeneratively sourced commodities.



Dana Yount: Research in Livestock Mortality Compost in California.



Chloe Mahan: Student Research Assistant



Melvin A. Quezada Haro: Student Research Assistant



Brandi Syfert: Student Research Assistant



Alex Lee Woodward: Research Intern



Daniel Rodriguez: Student Research Assistant



Cooper Davis: Undergraduate Research Assistant

Our New Mentor Farmers

The following farmers have now joined our list of mentors willing to help others in transitioning to regenerative methods:

- Jordon Lonborg, viticulturist at Tablas Creek Vineyard—biodynamically grown and regenerative organic certified wine
- Blake and Stephanie Alexandre, Alexandre Family Farm—certified regenerative organic dairy products and eggs
- Carrie Richards, Richards Grassfed—regenerative grassfed beef and pork
- Mimi Hillenbrand, 777 Bison Ranch—grassfed, holistically managed bison
- Thomas and Cody Nicholson Stratton, Foggy Bottoms Boys—grassfed dairy, beef, poultry, lamb, eggs, and wool products
- Alisha Taff, Rock Front Ranch—regenerative jujubes, quince, and honey

- Doniga Markegard, Markegard Family Grassfed—grassfed lamb, pasture-raised chicken and forest-raised pork
- Amy Lofting and Peter Giles, Meridian Farm—not for profit no-kill climate-beneficial wool, goat milk, eggs, and honey.
- Sarah Keiser, Wild Oat Hollow and Pengrove Grazing Cooperative—climate beneficial fiber and skincare products, cooperative fire reduction and land regeneration grazing services
- Sandy Fisher and Durl Van Alstyne, Chico Flax—regenerative fiber and plant dyes



Jordon Lonborg, Tablas Creek Vineyard



Blake and Stephanie Alexandre, Alexandre Family Farm



Carrie Richards and daughter, Richards Grassfed



Mimi Hillenbrand and her team, 777 Bison Ranch



Thomas and Cody Nicholson Stratton, Foggy Bottoms Boys



Alisha Taff, Rock Front Ranch



**Doniga Markegard and family,
Markegard Family Grassfed**



Amy Lofting, Meridian Farm



**Sarah Keiser, Wild Oat Hollow and
Penngrove Grazing Cooperative**



**Sandy Fisher and Durl Van Alstyne,
Chico Flax**



Animal integration at Tablas Creek Vineyard



Flax harvesting at Chico Flax



**Mobile chicken coop and pasture-raised chickens at Alexandre
Family Farm**

Faculty and Staff Honored for Their Work

Cynthia Daley

Chico State's Office of Civic Engagement (OCE) has named CRARS Director Cynthia Daley the 2021–22 Civically Engaged Scholar. Dr. Daley was recognized for her involvement in dozens of research projects and mentor networks of farmers across California and the country. In particular, it was noted that she currently serves as the Rawlins Endowed Professor for Environmental Literacy and the Director for the CRARS. She joined the Chico State faculty in 1997 and later founded the Organic Dairy Education & Research Program in 2006. Seeing the need to grow the ecological farming movement, Daley co-created the Regenerative Agriculture Initiative in 2016, which later became the Center in 2019. She was praised as a go-getter with an endless passion for sustainability and regenerative agriculture.



Garrett Liles

CRARS Faculty Affiliate Garrett Liles received the University's Professional Achievement Honor, which recognizes exemplary teacher-scholar achievement on the Chico State campus. He was acknowledged for his strong ability to secure grant funding for projects such as the Regenerative Agriculture Demonstration Lab for which he is now the director. He has published a number of articles in leading peer-reviewed journals, including the *Journal of Geophysical Research: Biogeosciences* and the *Journal of Food Science*. He also contributed a book chapter to the Development in Soil Science book series, Vol 36, published by Elsevier Science in 2019. Liles is an active presenter on soil health, forest ecosystems, and regenerative management strategies at national and international conferences. He was also recognized for being an avid mentor to both undergraduate and graduate students as well as serving as the Chico STEM Connections Collaborative summer research program, the graduate coordinator for the MS in Interdisciplinary Studies: Regenerative Agriculture, program lead for the College of Agriculture Plant and Soil Science, and leader of the Chico State Soil Judging Team.



Darby Heffner

Darby Heffner was the College of Agriculture's 2022 Staff of the Year Award recipient. She was acknowledged as the manager of the Organic Dairy, where she demonstrates her commitment to student success with her students at the dairy unit through her guidance, industry tours, and hands-on learning. Darby is in charge of day-to-day management of the unit as well as the teaching and training of the dairy management team, which consists of 10 to 12 student employees. She also serves as secretary for the Western Organic Dairy Producers Alliance.





Lee Altier

CRARS co-founder and faculty affiliate Lee Altier was awarded a highly prestigious Fulbright U.S. Scholar Program award for the fall 2021 academic semester from the U.S. Department of State and the Fulbright Foreign Scholarship Board. The Fulbright allowed Altier to travel to Izmir, Turkey, in fall 2021 to join Ege University's agriculture faculty as a visiting professor. His focus was on how farmers in the region address the challenges of water scarcity, soil quality, and food security through the lens of agroecology. He also shared Chico State's research on regenerative "no till" farming techniques that simultaneously maintain soil quality and sequester carbon to help fight climate change. Altier has been working in farming for nearly 40 years. He earned his MS and PhD in horticulture from Cornell University and has taught at Chico State for the last 26 years. He has been the director of the Organic Vegetable Project at the University Farm and has led students on study abroad programs in Nepal and Thailand.



\$5 Million USDA Partnership for Climate-Smart Commodities Grant



We are excited to announce that the Center for Regenerative Agriculture and Resilient Systems in partnership with the College of Agriculture at Chico State has been 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. We are one of just 141 recipients out of more than 1,000 proposals received by the USDA and were funded at the highest funding level.

On Thursday, December 15, 2022, Gloria Montañó Greene, the Deputy Under Secretary for Farm Production and Conservation at the United States Department of Agriculture made a site visit at the Chico State University Farm with a program that included an overview of the project, project partner input into the project, a discussion, and a question and answer session with the Under Secretary followed by a tour of climate-smart projects at the farm. Local farmers and representatives from organizations planning to participate in this project were there to discuss what this could mean for our region.

The North Valley Food Hub for Climate-Smart Agriculture will provide farm-to-fork integration of climate-smart growing practices with marketing and sales support for the commodities

produced (almonds, walnuts, rice, tomatoes, peaches, and prunes). This is specifically for regional small and historically underserved producers. The Center and College of Agriculture will provide technical support, online farmer training and networking tools, on-farm field days, and financial incentives for implementing climate-smart practices such as cover crops, no-till or minimum-till practice, nutrient management; enhanced efficiency fertilizers, planting for high carbon sequestration rates, and soil amendments. We’ll be establishing monitoring systems for each cooperator farm/farmer to track soil carbon accrual through regular and standardized soil carbon assessment. We’ll also be developing marketing and sales support for participating producers using climate-smart product marketing language and strategy.

Our partners in 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.

We wish to thank Jake and Noelle Brimlow for developing and being co-Principal Investigators for the North Valley Food Hub and Michele Auzenne and Toni Scott for their presentation and preparation of our grant package. We are thrilled to have this wonderful opportunity to help create a more resilient, local food production system in the North Valley.



Photos from the grant site visit program, from left to right: Deputy Under Secretary for Farm Production and Conservation for the USDA Gloria Montaño Greene; Carlos Suarez, State Conservationist for California NRCs and the Assistant Secretary for the USDA, with College of Agriculture Dean Patricia Stock; Noelle Ferdon Brimlow; Jacob Brimlow; attendees.

Regenerative Agriculture Events 2021



Lea Penniman



Bill Shireman

This Way to Sustainability Conference XV, March 25-26, 2021, “Resilience from the Ground Up: Strengthening Diversity in Soil, Communities and Economies”

We had record-breaking attendance at this year’s conference, which was held entirely online for the second year in a row. TWTS is a nationally recognized, student-run conference focusing on challenges, ideas, solutions, and resiliency in planning our sustainable future. The conference has hosted 1,400 participants or more each year with a variety of respected professionals speaking on the many aspects of sustainability. The goal of the conference is to educate students, staff, and faculty, and community members; providing attendees an opportunity to network, discuss, and become more aware of pertinent environmental and social issues we all face.

The TWTS Conference brings expertise and experience from a variety of presenters in 7 tracks:

1. Environment, Land Planning & Natural Systems
2. Built Environments, Engineering & Waste Management
3. Health, Wellness, Diet & Nutrition
4. Sustainable Food Systems & Regenerative Agriculture
5. Entrepreneurship, Marketing & Supply Chain Management
6. Social Justice & Public Policy
7. Arts, Humanities & Creative Expression

2021 Presenters:

• **Leah Penniman, MA.** Author of *Farming While Black* and co-founder of Soul Fire Farm with the mission of ending racism and injustice in the food system. Keynote: “Uprooting Racism and Seeding Sovereignty in the Food System”

• **Katharine Wilkinson, PhD.** Principal writer and editor-in-chief for Project Drawdown. More recently she co-founded and leads The All We Can Save Project with Dr. Ayana Elizabeth Johnson in support of feminist climate leadership and co-hosts the podcast *A Matter of Degrees*. Keynote: “All We Can Save: Leading on Climate with Truth, Courage, and Solutions.”

• **Jennifer Atkinson, PhD.** Associate professor of environmental humanities at the University of Washington, Bothell. Leads seminars on “Eco-Grief & Climate Anxiety.” Keynote: “Eco-Grief & Climate Anxiety: In a time when there is so much bad news, how do we learn to cope?”

• **Bill Shireman, PhD.** President and CEO of Future 500 with a focus on ending polarization and crafting bipartisan solutions to climate change and other problems. Keynote: “In This Together: How to reach across the political and economic divide toward finding workable solutions to our climate crisis.”

Regenerative Agriculture Farm Tour Generated Excitement About Projects in the North State



Sheep grazing under the almond trees at Massa Organics.

On August 20, 2021, CRARS sponsored a Regenerative Agriculture Farm Tour & Field Day for 50 people who joined us to visit multiple sites engaged in innovative regenerative agriculture research and practices in Butte and Glenn Counties. It was an opportunity for members of the leadership of Chico State and key players in the greater community to engage with members of our own leadership council while sharing the impact and potential of this work.

Stops on the tour included:

The University Farm. Tour participants were introduced to research being done with the Organic Dairy Program, the composting site including fungal-dominant compost Johnson-Su Bioreactors, the Organic Vegetable Project, the Soil Processing Area and Regenerative Agriculture Demonstration Lab, and the Farm's new systems for regenerative standard and specialty mushroom production.

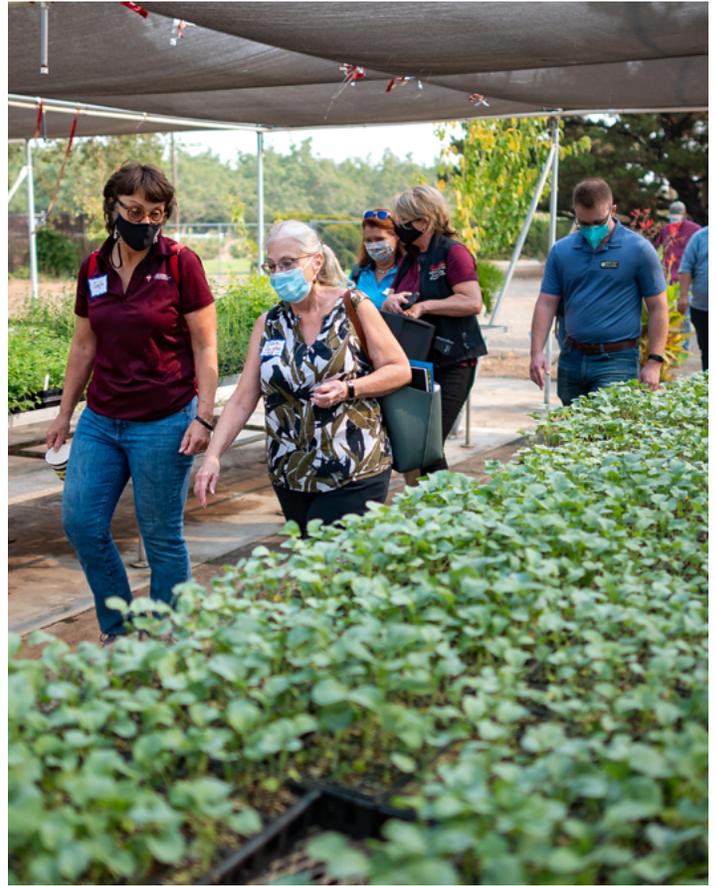
North State Hulling Cooperative. CEO Mayo Ryan provided a tour and shared their vision for a carbon neutral almond

production facility. He showed off their innovative dryer system and master plan for a net energy metering system, biochar production, and composting facility. UC Davis associate professor Amelie Gaudin and Cindy Daley are working collaboratively on a transition program for North State Hulling Cooperative members.

California Olive Ranch. Ranch manager Clayton Handy discussed their participation in the Regenerative Agriculture Transition program and Jared Geiser from the Glenn County Resource Conservation District discussed the CDFA Healthy Soils Project taking place at this site. Cindy Daley also did a water infiltration demonstration with Chico State professor Garrett Liles.

Massa Organics. Racquel Krach discussed her master's and CDFA Healthy Soils Project on the effects of compost application and cover crop planting on soil health, water use efficiency and crop production. She and Greg Massa provided a tour of their farm that employs an integrated system of rice, almonds and livestock.

Almendra Winery and Distillery. A social hour with appetizers and cocktails was enjoyed by all who could attend.



Top left: Professor Garrett Liles explains what the soil sample monoliths indicate.
Top right: President Gayle Hutchinson and other participants walk through the nursery at the University Farm.
Bottom: CRARS director Cindy Daley, College of Agriculture Dean S. Patricia Stock, President Gayle Hutchinson, and Staff Research Associate Seth Myrick in the Soil Processing Area on the University Farm.

Additional Virtual and In-Person Seminars and Workshops 2021

Carbon Farm Planning Training

Started June 1, 2021

This carbon farm planning training offered by CRARS and the Carbon Cycle Institute was for technical service providers and planners interested in carbon farm planning. Participants completed the online Carbon Farm Planning Curriculum, containing three modules. A webinar follows the completion of each self-guided module and associated task.

Soil Health Workshop: Cover Crops, Carbon & Drought for Growers & Partners

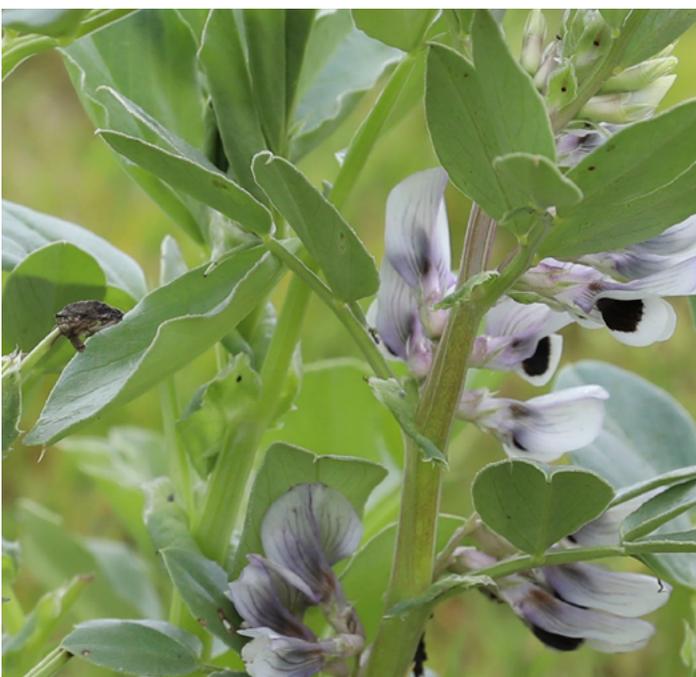
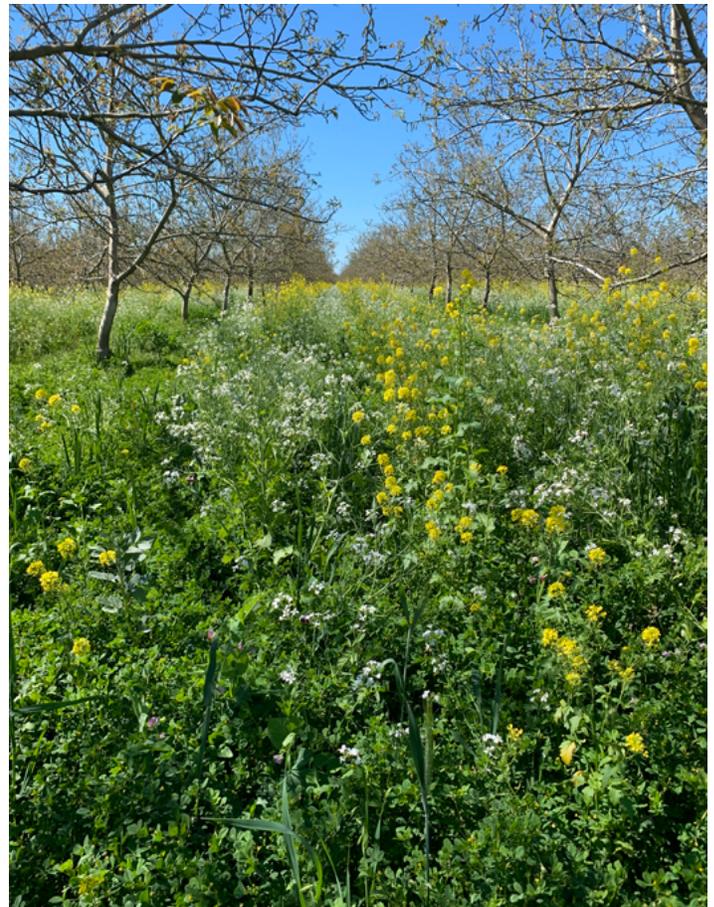
May 25, 2021

Participants learned about cover crops, compost, mulching, whole orchard recycling, and nutrient management at two different orchards in Glenn County. Sponsored by CRARS, Glenn County RCD, CDFA Healthy Soils Program, California Olive Ranch, Carbon Cycle Institute, and Patagonia.

Fava Bean Field Day

May 7, 2021

Researchers, growers, and students presented the latest research on using fava beans as both a cover and cash crop. Participants learned about alley cropping in orchards and how to work with challenges. They also learned about the proportion to use in cover crop mixes and a variety of related ideas including fava bean cooking recipes.



Regenerative Agriculture Events 2022



Soil Health Academy: Regenerative Farming and Ranching

This year's Soil Health Academy on March 15-17 brought a very enthusiastic group of 60 people from a wide variety of backgrounds who came to learn from soil health experts such as Gabe Brown, Allen Williams, and Shane New, and local farmers who are implementing climate-smart, regenerative agriculture.

The program included:

- Principles of Soil Health & Adaptive Stewardship
- Restoring Vibrant Ecosystems Through Adaptive Grazing
- Making Grazing Highly Profitable & Desirable
- Successful Marketing: Strategies for Enhanced Net Margins
- Nutrient Management
- Designing Cover Crop Mixes
- Farm Economics and Whole Farm Planning

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.

Soil Summit

This event, that took place on March 31, was co-sponsored with CRARS by the Almond Board of California and Western Region Certified Crop Advisors. It featured a wide array of panelists speaking on the following topics:

- Soils 101 – why it matters for almond trees
- Understanding soil chemistry
- The loving relationship between soil structure and irrigation
- Soil biology – what it means to you
- Digging into soil pests and disease management
- Value above and beyond the soil

The event was live-streamed, as well as recorded and posted to the California Almonds YouTube channel.



This Way to Sustainability Conference XVI

“Elevating the Many Voices of Climate Justice”

This year’s conference was March 24–25. It was held online for the third year in a row with the addition of in-person panel discussions that were simultaneously presented online. TWTS is a nationally recognized, student-run conference focusing on challenges, ideas, solutions, and resiliency in planning our sustainable future. The goal of the conference is to educate students, staff, and faculty, and community members; providing attendees an opportunity to network, discuss, and become more aware of pertinent environmental and social issues we all face.

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4. Sustainable Food Systems & Regenerative Agriculture
5. Entrepreneurship, Marketing & Supply Chain Management
6. Social Justice & Public Policy
7. Arts, Humanities & Creative Expression



2022 Presenters:



• **Lil Milagro Henriquez, MA** Keynote: “Growing Resilience in a Climate Challenged Future.” Lil Milagro Henriquez, MA is a 20-year veteran of social and environmental justice activism. In 2014, she won the Jonathan Daniels Memorial Fellowship for Social Justice award. In 2017, she founded Mycelium Youth Network, an organization dedicated to preparing and empowering frontline youth for climate change. In 2020, she received the Women’s Earth Alliance fellowship and the 2021 recipient of the Partners Advancing Climate Equity fellowship. She was recently recognized as one of the top 16 Eco-Warriors of 2021 by *Marin Magazine* and did a TEDx talk with the City of San Francisco illuminating the failures of conventional education to prepare youth for climate change. In 2017, she founded Mycelium Youth Network. Mycelium has been named as one of the only organizations actively preparing young people for climate change in the United States.



• **Robin Wall Kimmerer, PhD.** Keynote: “Braiding Sweetgrass and TEK.” Robin Wall Kimmerer (opens in new window) is a mother, scientist, decorated professor, and enrolled member of the Citizen Potawatomi Nation. She is the author of *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants* and *Gathering Moss: A Natural and Cultural History of Mosses*. She lives in Syracuse, New York, where she is a SUNY Distinguished Teaching Professor of Environmental Biology. She is also the founder and director of the Center for Native Peoples and the Environment, whose mission is to create programs which draw on the wisdom of both indigenous and scientific knowledge for our shared goals of sustainability. As a writer and a scientist, her interests in restoration include not only restoration of ecological communities, but restoration of our relationships to land. She lives on an old farm in upstate New York, tending gardens both cultivated and wild. Photo credit: Dale Kakkak



• **Tracey Osborne PhD.** Keynote: “Climate Justice and Higher Education.” Tracey Osborne PhD is associate professor and presidential chair in the Management of Complex Systems Department at UC Merced. She also serves as the founding director of the UC Center for Climate Justice. Her research focuses on the social and political economic dimensions of climate change mitigation in tropical forests and the role of Indigenous Peoples, the politics of climate finance (with particular emphasis on carbon markets), global environmental governance, and climate equity and justice. She has worked on these issues globally with extensive field experience in Mexico and the Amazon (Peru, Ecuador, and Guyana).

Programs

CRARS is leveraging our applied research, hands-on educational programs, industry partnerships, and networks to investigate, develop, and rapidly disseminate important and progressive forms of agricultural production.

Innovative Applied Research

The CRARS is a global research center, demonstration and training site, and policy think tank working to usher in a brighter future. We develop, demonstrate, and disseminate techniques and practices that rebuild and enhance the resiliency of our living systems. Through on-farm research at sites around the world, we discover and test regenerative methods and share the outcomes via our website, workshops, and online journal.

With funding from multiple sources, we are working on validating Johnson-Su Biologically Enhanced Agricultural Management (BEAM) research in corn, cotton, alfalfa, vegetables, and rangeland systems. BEAM combines a fungal- dominant soil inoculant with cover crops to enhance biodiversity. Each multi-year study is designed for peer-reviewed publication.

CRARS, University of California Cooperative Extension (UCCE), and five organic vegetable farmers are studying the impact of RA practices in organic vegetable production. With farmers leading their own experiments, we provide soil testing, nutrient density analysis, and farmer-to-farmer networking tools. A companion study, funded by the University's Agriculture Research Institute (ARI), is to study changes in the nutrient density of regenerative production systems vs. conventional practices in vegetables.

A series of research proposals support the study of regenerative cotton production. In collaboration with Guess Jeans, Bowles Farming, and Fibershed, we aim to reduce soil disturbance, improve water use efficiency, and eliminate synthetic inputs through regenerative practices. Five cotton producers participate in this work along with brands interested in developing regenerative cotton textile lines.



Engaged Outreach & Education

We seek to provide education and training to all who are involved in producing our food and managing our landscapes and to support the next generation of regenerative farmers, ranchers, and agricultural leaders. Phase I consists of:

- Interdisciplinary Master's Degree in Regenerative Agriculture: We currently offer an interdisciplinary master's degree program with an emphasis in RA.
- Professional Course Series for Technical Service Provider Training
- Agricultural Management Systems Learning Collaborative

Undergraduate research opportunities are currently available in the Regenerative Agriculture Demonstration Laboratory (RAD Lab), with additional proposals in development.

Farmer-to-Farmer Transition, Network & Educational Program:

We have developed a strategy for on-farm transition that builds upon proven techniques for achieving greater than normal rates of farmer adoption using a Communities of Practice (CoP) model that includes farmer-to-farmer mentorship/networking and collaborative on-farm research trials and demonstrations. We began the process with organic vegetables and the USDA Conservation Innovation Grant (CIG) (funded), and are expanding this approach to rangeland, almonds, walnuts, and cotton.

To achieve this goal we have created or are in the process of implementing the following resources:

- A professional course series in RA that will be available on our website, free of charge. (Currently in planning.)
- A certificate program in RA, developed in collaboration with our mentor farmers, for producers or practitioners interested in receiving documentation of completed coursework. We continue to provide conferences and field days to promote RA within the industry.
- The RAD Lab supports farmers and ranchers with relevant soil analysis and nutrient density testing. (www.csuchico.edu/regenerativeagriculture/soil-lab)
- Our website includes an extensive RA101 Learning Center, regenerative mentor-farmer information, and media resources. (www.csuchico.edu/regenerativeagriculture)

Technical Service Provider Training: Assisting Producers with Resource Management Decisions

CRARS works with a large number of conservation partners to promote and support timely resource initiatives, including forest management, soil health, and water conservation efforts. Our conservation partners include Carbon Cycle Institute, California RCDs, UCCE, land trusts, NGOs, state and federal agencies, and independent agricultural consultants. The breadth of expertise presents a unique opportunity to enhance conservation delivery in California by increasing the availability of Technical Assistance (TA) to producers, using the proven framework of the NRCS conservation approach.

A coordinated training effort that capitalizes on network expertise can increase consistency, continuity and availability of Technical Service Provider (TSP) training to provide practice-specific workshops to increase design and implementation expertise; facilitate the integration of Conservation Activity Plans to develop robust implementation, management and monitoring strategies that are co-created by TSPs and practitioners; satisfy current demands for TA; and facilitate improved conservation outcomes and adoption.

To meet this opportunity, we have created a TSP Training Program to certify TSPs in specific resource categories. Participants will be required to:

- Complete NRCS AgLearn Courses
- TSP Orientation Course
- Conservation Planning Course, Modules 1-5
- Complete modules selected from the CRARS Professional Course Series
- Develop Conservation Activity Plans (CAPs) through resource category trainings in Soil Health Management, Nutrient Management, Grazing Management, Forest Management, Wildlife Habitat & Pollinator Habitat and Carbon Farm Plans
- Submit three operation-specific CAPs to be reviewed for each category of certification pursued

Project Goals, Objectives

The TSP Training Program is designed to increase support to farmers, ranchers and others who are interested in pursuing more effective resource management on their properties. Our objectives are to:

- Increase knowledge and implementation of resource management activities throughout California
- Create a responsive network of TSPs offering diverse experience and expertise
- Provide comprehensive guidance to ensure continuity from planning through implementation
- Make practical and effective use of existing financial and technical assistance mechanisms
- Support existing and future efforts by providing accessible training opportunities



- Support progress toward NRCS Resource Conservation Planning Certification while enabling rapid on-the-ground support

Project Approach

Build on Science: We translate established conservation principles and create effective partnerships with producers and other collaborators to implement site-specific efforts in forest management, soil health, and water conservation.

Value Producers: We create participatory learning environments that support and facilitate group learning and innovation, community building, the development of shared values and producer ownership of management systems critical to sustained conservation efforts.

Assess Progress and Outcomes: We assess the environmental and economic impacts of our work by analyzing soil samples, pest/pollinator data and economic data.

Impact: Systems-level Conservation Delivery to Reinforce the NRCS Conservation Planning Process

The TSP Training program offers a comprehensive, adaptive training opportunity that provides pathways for multiple layers of TSP certification, from addressing specific resource topics (e.g., grazing management and forestry management) to developing Resource Management System level conservation plans for farms, ranches and non-industrial timber lands. The program has potential to impact resource conservation planning throughout the Northern California region. Long-term, increased adoption of soil health practices will restore and regenerate thousands of acres of working lands.

The program builds on current certification pathways that deliver conservation planning process content, by adding the diversified expertise of training partners and the practical knowledge of producers, including individuals who have successfully implemented conservation plans and practices.

NIFA NLGCA: Creating the Agricultural Management Systems Learning Collaborative



CRARS, in collaboration with the California Association of Resource Conservation Districts (CARCD), has begun the first phase of creating the Agricultural Management Systems Learning Collaborative (“The Collaborative”) to increase knowledge and enhance implementation support for the expansion of systems-based farm/ranch/forest management practices in Northern California production systems. Project activities will lay the foundation for ongoing, sustainable development that will continue to address identified stakeholder needs, as well as our long-term goals to build additional educational and leadership development capacity in systems-based agricultural management. Project activities are responsive to the results of a broadly disseminated Needs Assessment (113 responses analyzed). Our stakeholders include producers; agricultural professionals, including cooperative extension, California Resource Conservation District (RCD), and NRCS staff; and students enrolled in Agriculture, Natural Resources, Environmental Sciences, and Land Resource Management.

Project Goals: 1) Establish flexible non-credit bearing learning opportunities to address a broad range of stakeholder needs and interests; 2) Establish a cohort of peer mentors/role models in

systems-based agricultural management systems; and 3) Provide additional participant-driven support mechanisms to promote and encourage sustained knowledge building/sharing and connections across the community.

Project Objectives: 1) Develop four online courses in Agricultural Systems and Soil Health Management that will serve as a foundation for multiple education and outreach pathways; 2) Identify, support, and assess the experiences of 10 paired teams of Northern California producers and RCD technical assistance providers who will serve as peer role models and mentors; and 3) Add value to existing CRARS outreach and assistance efforts through community-driven workshops and an online AMS Collaborative Network.

Medium- and Long-term Outcomes of the AMS Collaborative Project beyond the funding period include: 1) Create an institutionally-approved 21-credit certificate program available to regional and national audiences; 2) Establish an undergraduate program and online master’s program in systems-based agricultural management; and 3) Sustain the AMS Collaborative through continuing partnerships, collaborations, and projects.

Professional Course Series: Regenerative Agriculture Management Systems



California is the nation's leading agricultural producer by total receipts, generating over \$50 billion in 2019, far exceeding the No. 2 leading state of Iowa (\$27.5 billion). By sheer size and productivity, California has significant potential to contribute to working lands conservation efforts.

However, climate change, diminishing soil health, low implementation of conservation efforts, and lack of knowledge and/or access to information, training, and assistance with systems-based agricultural management have left us less resilient and more vulnerable to economic and environmental threats.

CRARS has developed this four-course professional series to support the expansion of systems-based farm, ranch, and forest management practices on California working lands, and foster conversation and innovative, collaborative strategies to address current and future threats and opportunities for California agricultural production. The courses are:

- Systems Theory and Practice
- Soil Health Systems
- Science & Practice of Ecological Forest and Range Management
- Farm/Ranch Planning & Design

Course Structure:

- Fully online for flexibility and convenience
- Lectures and coursework (5-6 hours per week) completed at participant's own time and pace
- Weekly, one-hour live-online discussions with participants and faculty
- Pass/No Pass quizzes to gauge mastery of the content
- Certificate of completion given at the end of each course

Participants can take any number of individual courses, or take all four to complete the series.

Program Faculty:

Cynthia Daley, PhD.; director of the Center for Regenerative Agriculture and Resilient Systems; Rawlins endowed professor for environmental literacy; professor of agriculture

Garrett Liles, PhD; associate professor of agriculture

Don Hankins, PhD; professor of geography and planning

Priya Tuvell, MAgr; CRARS program manager

Mollie Aschenbrener, MAGD; professor of agriculture and lead teacher, educator and graduate coordinator

2021 and 2022 Research Projects

Awarded a Regional Conservation Partnership Program Grant from the USDA



CRARS, in collaboration with 12 other conservation partners, has been awarded a coveted Regional Conservation Partnership Program award totaling nearly \$7 million for 2020-21 through the USDA's Natural Resources Conservation Service.

The Center and its conservation partners were awarded \$6,995,463 to support "Soil Health Management Systems for Northern California," a five-year project designed to help orchard/vineyard, rangeland, dairy and row crop producers in Northern California build food and fiber production resiliency to counter climate change challenges. The grant will fund four California Resource Conservation District Hub positions to support the development of producer-based Soil Health Management Plans, implementation strategies and protocols in three distinct regions in Northern California. The project integrates carbon farm planning activities and will report on economic and social outcomes in addition to conservation outcomes. It also supports Agriculture Communities of Practice to disseminate adaptive management knowledge, training and exchange of ideas. Working together, CRARS will build plans that conserve and regenerate soil while sequestering carbon and building resiliency through water use efficiency.

"The Regional Conservation Partnership Program is public-private partnership working at its best," said Terry Cosby, acting chief for USDA's Natural Resources Conservation Service (NRCS). "These new projects will harness the power of partnership to help

bring about solutions to natural resource concerns across the country while supporting our efforts to combat the climate crisis."

Conservation partners work in collaboration with NRCS to help farmers, ranchers, and forest landowners throughout the nation implement systems that conserve water and soil resources, improve the health of wildlife habitats, and increase climate resilience. These projects offer impactful and measurable outcomes so the NRCS is investing \$330 million in 85 locally driven, public-private partnerships to protect agricultural viability in the face of climate change. The award received by CRARS is one of these projects.

CRARS conservation partners include:

- California Association of Resource Conservation Districts
- The California Department of Food and Agriculture
- Carbon Cycle Institute
- Fibershed
- Glenn County Resource Conservation District
- Humboldt Resource Conservation District
- Lassen Resource Conservation District
- Lassen County Farm Bureau
- Mendocino County Farm Bureau
- Mendocino Resource Conservation District
- Modoc Resource Conservation District
- University of California Cooperative Extension

Legumes and Cover Crop Research



Professor Hossein Zakeri

Cover crops have become increasingly popular in California because of their contributions to improved soil health, and cool season cover crops have sparked interest as a result. Of the cool season pulses used in cover crop mixtures, fava bean (*Vicia fava L.*) and pea (*Pisum sativum L.*) express high nitrogen fixing capacity and have strong potential to reduce grower reliance on nitrogen fertilizers. These legumes are also popular food and protein sources around the world because of their contribution to reducing health issues associated with high cholesterol, diabetes, and cardiovascular disease. This makes them a potential secondary cash crop that could at least defray the cost of adding them as a cover crop.

A team led by agriculture professor Hossein Zakeri and postgraduate researcher Kyle Brasier has launched an extensive research program to study the potential benefits of these crops in northern California. They collaborate with researchers in the Departments of Food Science and Business at Chico State, USDA-ARS in Pullman, UC Davis, Fresno State, and the Crop Development Center at University of Saskatchewan in Canada. They also work closely with local producers including Lundberg Family Farm, Terra Nux LLC., and Chico Flax. The program has provided numerous opportunities for undergraduate students to conduct research on legume species for healthy soils and foods. Following is the list of the team's active and upcoming projects:

1. Screening Fava Bean Germplasm, funded by CDFA (2018-2021): This project aimed to identify fava bean genotypes that are suitable for cover cropping. The project's outcomes resulted in securing a second CDFA grant to test the findings of the first one.

2. Cover Crop Project, funded by CDFA (2020-2023): The project aims to study the performance of small seeded fava bean genotypes in cover crop mixes. Currently, bell bean (a fava bean variety that has large seeds) is grown in cover crop mixes. Replacing bell bean with small-seeded fava will save in seed costs and make it much easier to plant the seed mix with a grain drill. One pound of bell bean yields about 450 plants while small-seeded genotypes can produce over 1000 plants. This project is an extensive collaboration between Chico, Fresno, Pomona, NRCS at Lockeford, Vilmorin Seed at Monterey, and Arizona State. The team just finished planting trials at these locations, and Chico State will lead to complete them all.

3. Pea Nodulation Project, funded by Saskatchewan government (2019-2021). This was a collaborative project with the Crop Development Center at University of Saskatchewan, and involved screening a pea population that has been created to improve nitrogen fixation of field pea. We were specifically interested to see if the population can be used for cover crop.

4. Fava Bean as Food Crop, funded by Western SARE (2019-2023). This project is seeking approaches that can help in promoting fava bean as a food crop. Field trials were concluded last fall and samples are still processing. The outcomes include varieties that can produce fresh pods and also improve soil nitrogen.

5. Alley Cropping in Young Orchards, funded by ARI (2020-2023). This project aims to promote alley cropping as a sustainable farming practice in California. In this project the team works with farmer Dax Kimmelshue in Durham, Calif. Preliminary observations were presented at the American Society of Agronomy conference in Salt Lake City. They showed that alley cropping is less likely to impact water availability of orchard tree and tree water status.



Postgraduate researcher Kyle Brasier

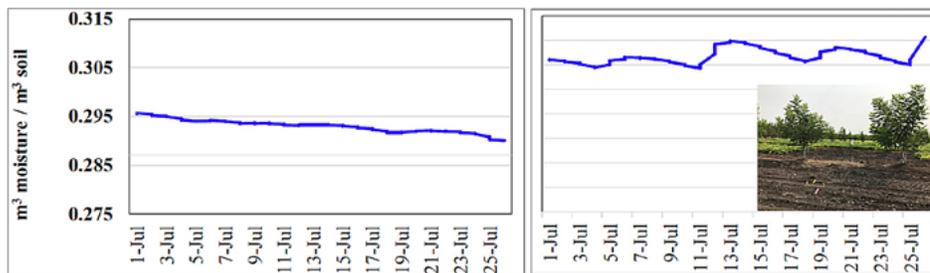


Figure 2- Average daily soil moisture of the alley cropped (right) and bare land (left) during July 2021

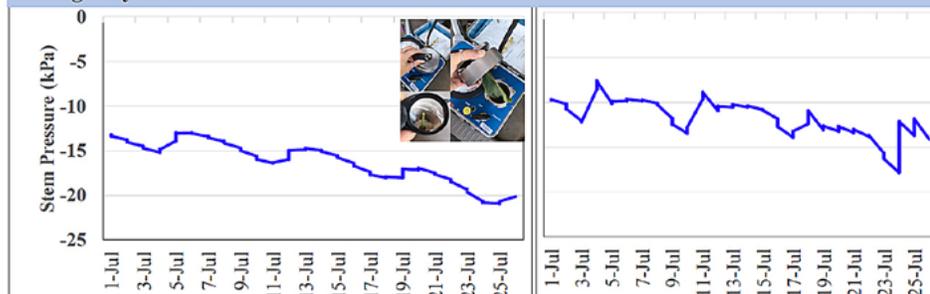


Figure 3- Average leaf water potentials of walnut trees in the alley cropped (right) and bare land (left) during July 2021



Improving Soil Carbon Capture and Water Use Efficiency in the Palo Verde Valley



The Metropolitan Water District transports, stores, and distributes water to a large portion of Southern California, including the counties of Los Angeles, Orange, Riverside, San Diego, San Bernardino, and Ventura. The CRARS is conducting a five-year research program designed to increase Metropolitan’s knowledge of regenerative agriculture and carbon sequestration opportunities. The project contrasts regenerative land management methods to the current conventional practices used by Metropolitan, and contrasts cash crop (alfalfa) productivity between the two systems.

Conventional fallowing practices involve multiple and repeated tractor passes, which comes with climate, fuel, maintenance, depreciation, and labor costs, while also causing damage to soil structures. Collectively, this has led to the need for increased inputs—fertilizer, herbicide, insecticide, and fungicide applications—thereby increasing production costs. While these inputs have increased productivity in conventionally managed production systems, they do so with reduced profits due to the cost of the inputs, and at great cost to the environment. Soil degradation and topsoil erosion is compromising the planet’s ability to produce sufficient food to feed the world’s population, with scientists estimating that we may have as few as 60 years of topsoil left.

In an effort to reduce or eliminate these impacts, the CRARS is studying the effects of summer and winter cover crops, fungal-dominant inoculant, and no till practices. The potential benefits of the project include improved water use efficiency, improved carbon capture, increased net profit, reduced agricultural greenhouse gas emissions, and long-term soil health and fertility benefits that will leave a soil legacy for the next generation.

Project Design

The research is based on a randomized block design with three replications of two contrasting treatments. The first is a conventional fallow system with full tillage and no water application. The second is a regenerative fallow system including winter and summer cover crops seeded with a no-till drill at 60# per acre with minimal irrigation to maintain a living root system all year round. Block 1 will follow a three-year fallow contrast, Block 2 a four-year fallow contrast, and Block 3 a five-year fallow contrast.

The regenerative fallow seeding began in October-November 2020. It was terminated with a roller crimper and a summer cover crop was planted in May-June 2021.

Soil Carbon Accrual Project Using Flux Tower Technology in Multiple Locations



The CRARS team at the location in Blythe, California.

Led by CRARS, the Soil Carbon Accrual Project is a collaboration of more than 10 scientists from two continents coming together to measure the effect of regenerative agriculture on soil carbon in multiple locations over multiple years using flux tower technology. Despite considerable evidence that soil, when well managed, can be a significant carbon sink, conventional methods of measuring soil carbon only capture single measurements at any one time, leading to what seems to be misleading impressions that the soil respire as much CO₂ as it captures.

Flux towers measure the flow of CO₂ continuously (both respiration and accrual). Data from the flux towers and new soil probe technology will be correlated with data from satellite soil carbon estimates and conventional laboratory analysis of soil core samples. The intention is to get a comprehensive technical view and verify which technical measurements are most accurate and efficient. It will also provide an opportunity to evaluate the level of significance soil carbon accretion can play in mitigating GHG levels with much more certainty, thus providing scientists, farmers and policy makers with clear information to use to choose the most effective paths forward to address climate change.

The three- to five year project is designed to holistically compare carbon cycling associated with the standard system (full tillage; herbicide; fertilizers; pesticides and no cover) to a regenerative system (multispecies cover crops; no-till or strip-till/vertical till; and crop rotations) in a robust replicated plot design to quantify the impacts on soil carbon accrual (net carbon flux), soil microbial diversity, water use efficiency, soil health, forage nutrient density, and economic return.

In the past, coordinated deployment of multiple flux towers (also known as eddy covariance (EC) towers) has been cost-prohibitive. The current project will leverage new lower-cost EC technology to replicate EC data collection across a range of agroecosystems representative of the major growing regions of the United States and other places in the world.

This project is not fully funded, but initial preparation for the first year of trials is already underway. In 2022 the first flux towers for the Soil Carbon Accrual Project were put in place in Blythe, California, in the Palo Verde Valley.

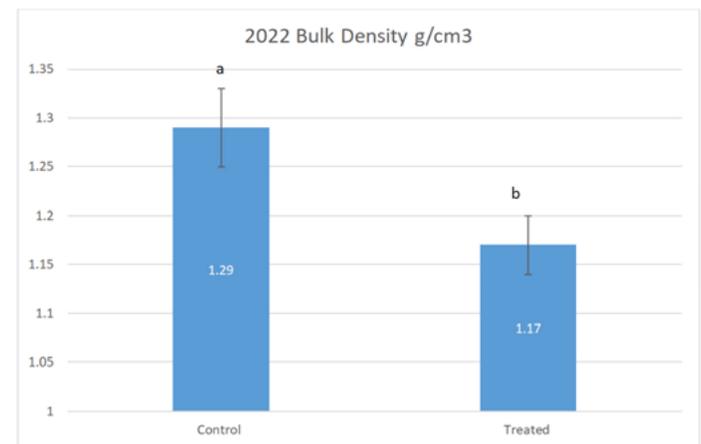
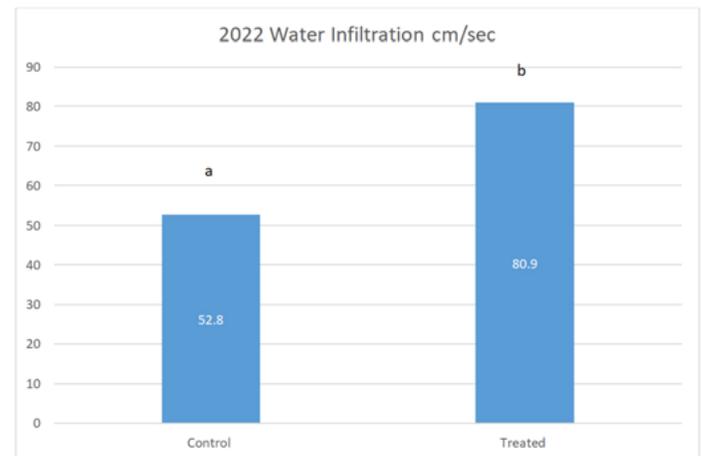
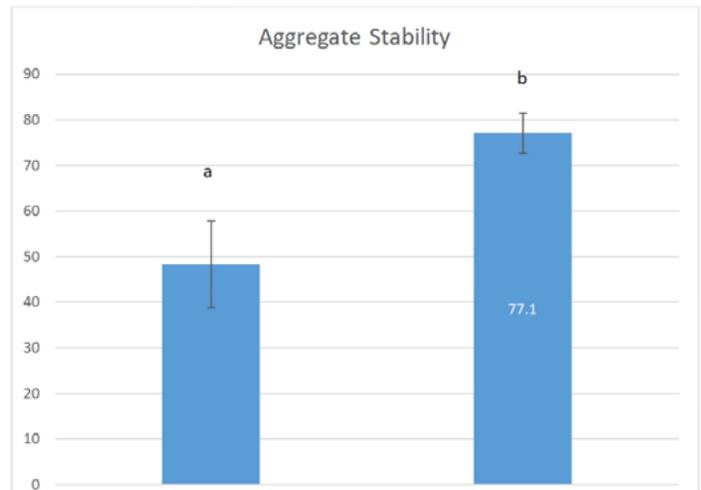


A Review of the Effect of Cover Crops in Olive Orchards on Soil Quality

Clair Akin, the first student in the Interdisciplinary Master's Degree program in Regenerative Agriculture to receive a degree, successfully presented her research on the effect of cover crops in olive orchards at the end of fall semester 2022. Her literature review of previous studies showed varied results from the use of cover crops, depending on initial soil health, management, climate, and varieties. Yield, for example, could be either negatively or unaffected by cover crops, depending on when the cover crop was terminated. The effect on runoff was also varied—showing a positive effect in some studies by acting as a buffer and allowing more water to infiltrate into the soil, and showing no apparent difference in other cases. However, cover crops have been shown to have a large impact on nutrient loss by decreasing total nitrogen loss by up to ninety-nine percent, phosphorus by ninety-two percent, and potassium by seventy-eight percent. That indicates significant environmental and economic benefits. They also decrease erosion, in one study by seven to twelve times.

Akin's project studied the effect of cover crops on water infiltration, aggregate stability and bulk density on an orchard with poor soil quality. The study was done in an olive grove in Artois, California, with an area of 156.1 acres. There were six control rows and ten treatment plots, with varying terrain and soil quality. Cover crops were planted only in treatment plots. Control plots received standard conventional management which, in this case, included no tillage or herbicide use. A mix of twelve varieties of cover crops were planted in the treatment plots with a no-till seed drill during the fall, seeded at a rate of 70 lbs per acre. The species variety included Yellow Mustard, Oriental Mustard, Nemagon White Mustard, Daikon Radish, Triticale, Barley, Cayuse Oats, Magnus Peas, Dundale Peas, Fava Beans, Nitroplex Peas, and Common Vetch. Two composited soil samples were collected per row to account for slope and soil variability, and a set of 32 soil samples were taken in March 2021 and March 2022, after the cover crop had grown from October through May of each year. Crops were terminated each May.

Over the two-year research period that was conducted under serious drought conditions, the cover crop treatment did not have a statistically significant effect on water infiltration. In fact, because of the dry conditions some of the cover crop species did not germinate or grow as expected. However, aggregate stability and bulk density still had positive effects which correlates with other experiments. Akin suggests that, given the drought conditions, using irrigation and more drought resistant cover crops might have shown better effects on water infiltration. Infiltration showed a positive trend in year 2 but it was not enough to show a significant improvement overall. The aggregate stability and bulk density results indicate that, even under these challenging conditions, cover crops could create improvements in soil health.



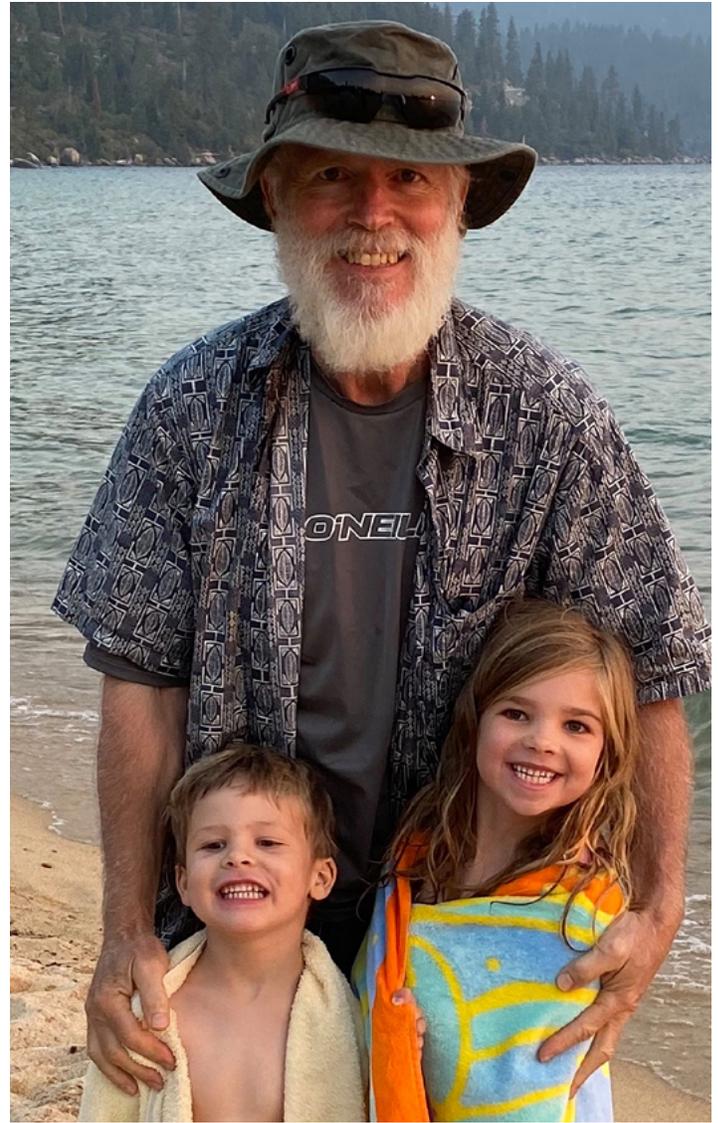
Partners and Collaborators Spotlight

Bruce Burnworth

Bruce Burnworth is a civil engineer who had a dramatic change in fortune after investing in 2019. Inspired by David Johnson's research with BEAM (Biologically Enhanced Agricultural Management) and by Elon Musk's announcement of a Carbon Capture XPRIZE, Burnworth has decided to invest considerable effort to combat climate change through the promotion of healthy soil biomes using the BEAM approach. He intends that widespread adoption will extend the data collection necessary to determine results in various applications. His Healthy Soil Biomes, Charitable LLC is a not-for-profit entity with a mission to accelerate the world's transition to sustainable agriculture using restoration of soil microbiology as a driving factor.

At the moment, Healthy Soil Biomes is working to spread the word about how soil microbiology matters to farm resiliency and increased profitability, food security, and carbon sequestration. Burnworth is pulling together an alliance of organizations devoted to the science of soil and climate change. His organization also provides information for farmers and the general public about how to make a Johnson-Su Beam bioreactor and use it to improve their soil.

One of the tools Burnworth wants to use to make information-sharing more engaging is a tool called Storyfile. By using video technology to prerecord answers to a variety of potential questions in an interview format with a real person, users have what feels like an interactive experience with that person. Burnworth is hoping this approach might help potential adopters get the help they need in a more engaging way than a typical FAQ page. CRARS director Cindy Daley has collaborated with Burnworth and the Storyfile team to create the first Storyfile project focussed on helping farmers and ranchers find answers to some of the questions they might have when first starting out.



Natasha Lilly, DVM, CVA

Natasha Lilly is a mother of three children, and a holistic and regenerative-minded veterinarian and acupuncturist with a special interest in companion animal nutrition and equine medicine. She lives in California, where she co-operates a working ranch, runs a veterinary practice and serves as an adjunct professor at California Polytechnic State University, SLO. She's part of the Royal Animal Health University and Animal Diet Formulator team and recently became a Director of the College of Integrative Veterinary Therapies, CIVT. Lilly says she thrives on exploring solutions for big world challenges that can be appreciated best through the eyes of nature. This led to a partnership and start of the company, Animal Diet Formulator, where she works alongside top leaders and researchers in pet food nutrition globally, in addition to her involvement in regenerative agriculture practices through CRARS. She questions conventional practices when they limit success and enjoys discovering and providing solutions where possible in more natural medicines and modalities through education and exemplary practice that is needed for true health.



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California State University **Chico**
**Center for Regenerative
Agriculture and
Resilient Systems**

Cynthia Daley, PhD, co-founder, director
cdaley@csuchico.edu, 530-898-4335

Timothy LaSalle, PhD, co-founder
tim.lasalle@gmail.com

regenerativeag@csuchico.edu
www.csuchico.edu/regenerative-agriculture

California State University, Chico
400 W. First Street, Chico, CA 95929

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