

**Fostering Deep Learning of Climate–Agriculture Nexus Through Supervised Student Experiences  
in California**

**Samuel Ikendi**

Academic Coordinator for Climate Smart Agriculture  
University of California Agriculture and Natural Resources/Cooperative Extension  
University of California, Merced  
5200 N. Lake Road, Merced, CA 95343  
[sikendi@ucanr.edu](mailto:sikendi@ucanr.edu)

**Karina Díaz Rios**

Associate Professor and Cooperative Extension Specialist for Nutrition  
University of California Agriculture and Natural Resources/Cooperative Extension  
University of California, Merced  
5200 N. Lake Road, Merced, CA 95343  
[kdiazrios@ucmerced.edu](mailto:kdiazrios@ucmerced.edu)

**Prakash Kumar Jha**

Assistant Project Scientist for Climate Adaptation  
University of California Agriculture and Natural Resources/Cooperative Extension  
University of California, Merced  
5200 N. Lake Road, Merced, CA 95343  
[prajha@ucanr.edu](mailto:prajha@ucanr.edu)

**Tapan Pathak**

Associate Professor and Cooperative Extension Specialist for Climate Adaptation  
University of California Agriculture and Natural Resources/Cooperative Extension  
University of California, Merced  
5200 N. Lake Road, Merced, CA 95343  
[tpathak@ucmerced.edu](mailto:tpathak@ucmerced.edu)

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#### **Introduction/Need for Idea or Innovation**

The need to engage college students in climate–agricultural discussions cannot be overstated. Moreso in the California Central Valley, where many of these students witness first-hand the impact of production agriculture on the environment and the environmental impact on production, such as drought and water shortages (Liu et al., 2022; Moyers et al., 2024), pest invasion (Jha et al., 2024), wildfires (Pinzón et al., 2025), floods (Huang & Swain, 2022), and dust storms (Adebiyi et al., 2025). These impacts create the desire within students to be part of problem solvers through research, advocacy, and advising in Cooperative Extension (Ikendi et al., 2025a). Recent research also asks universities to be a bridge for students to engage in climate–agriculture discussions (Dooley & Grady, 2020; Leal Filho et al., 2021; Reimers, 2020; Stein, 2024). Stein (2024) emphasized, “University educators will need to invite deepened engagement with the realities of climate change on and beyond our campuses and create more opportunities for climate education across all areas of the university” (p. 5). To satisfy such educational demands, a transdisciplinary team of academics from the University of California engaged students in a two-month-long supervised summer internship to give them the much-needed experience and exposure to the climate–agriculture interactions.

#### **How the Idea Works/Methodology/Program Phases/Steps**

The climate–agriculture education is a four-part program, comprising a one-week workshop, a formal quarter class, a summer internship, and a year-long Externship. This abstract focused on a two-month summer internship completed in 2024 and 2025. The project begins with a call for applications, designed for students to learn about how climate affects agriculture and explore actionable solutions. Undergraduate students who participated in the spring climate–agriculture workshop (Ikendi et al., 2025a) and a formal quarter class are especially encouraged to participate. Applicants submit a one-page proposal highlighting four areas, including an introduction and rationale for the selected areas of interest, objectives, activities to be accomplished, and approaches and deliverables for their internship. Further, applicants are required to identify their mentor(s) and request a letter of approval for mentorship. An internship should preferably be in student’s summer residence. Online mentorships are acceptable, depending on project’s description.

The project team screens the applications and the top three, per grant funding, are selected for internship. Selected students are oriented on the expectations of the internship and given the learning journal template where they report weekly their learning outcomes and projected activities. Students meet online with the project team every two weeks to share their project deliverables, trials, and tribulations, and get feedback from the team and peers for improvement and motivation. Students’ mentors submit two reflection reports to the program team, mid and end of internship, providing a short assessment of the student’s work and progress with expected activities according to their work plan, time management, level of maturity, responsibility exhibited, e.g., independence, ability to relate, work, and communication. At the end of the internship, students provide a detailed learning journal and reflexive statements of their internship, while responding to specific guiding questions, which increases mastery of concepts (Ingles & Retallick, 2024).

#### **Results to date/Implications**

In 2024 and 2025, six students, including three males and three females, completed their internships. Students came from six programs, including civil engineering, physics, computer science, environmental engineering, environmental systems, and public health. Nine mentors participated, with three students concurrently mentored by two mentors. Mentors included three professors, three extension specialists, two farm managers, and a postdoctoral scholar. Each student worked on a project of interest to experientially expand their learning about climate and agriculture. The projects included alternative pesticides, alternative crops such as agave and guayule for natural rubber, designing a cropping atlas, cover crops and carbon

## Innovative Idea

sequestration, and a review of social media information related to food products sold in grocery stores. Three students completed on-site experiments, while three completed their internship projects online.

Students shared their reflexive learning in the journals. In 2024, a junior in Computer Science worked on developing crop–climate suitability models for the California Central Valley in Google Earth Engine and created a GitHub code for the model. Crop suitability modeling helps to determine which crops are suited to grow based on climate and other factors, helping farmers optimize production, predict how crops respond to climate change and other beneficial ways (Peter et al., 2020). This student looks forward to learning more about agave pollination, drought tolerance, carbon sequestration, and its economic viability as an alternative crop in the Central Valley of California. Additionally, mentored by a farm manager, an Environmental Systems Science major in 2025, worked on environmentally friendly pesticide research. The student prepared an analysis, set up three controlled quadrants, and tested different pesticides in the controlled quadrants. The pesticides used were from H&C, an alternative (chrysanthemum oil insecticide) on orange and lemon trees. She stated, *“I got to experience doing research firsthand, both on-site with citrus trees and off with peer articles. I also learned about the local pests harmful to these plants in the Central Valley.”*

A Civil Engineering student synthesized existing crop data to develop a tool that shows the diversity of crops across California. He stated, *“The major activities that I have undertaken were crop data analysis and working with ArcGIS. These activities have contributed to my technical competence. I want to be able to develop my technical skills to grow myself and be able to explore different career paths within the field.”* The student’s study aligns with the CDFA’s vulnerable communities platform, examining climate decision systems, including creating a cropping climate atlas (Ikendi et al., 2025b, p. 3). Also, a Public Health major completed a project on nutrition education content on social media in the context of grocery shopping. Her research culminated in a research poster abstract submitted to the American Public Health Association conference. She retaliated, *“My activities contributed to my technical competence by understanding how to code for grocery shopping posts, screen efficiently, and analyze data across large datasets. This experience helped strengthen my skills in data management and coding, with identifying trends across complicated data sheets.”* The project findings can broaden our understanding of the quality of information consumers encounter and help identify strategies to promote climate-friendly consumption patterns (Shine et al., 2022).

### Future Plans/Advice to Others

Often, university and community college students get deeper exposure to scientific knowledge of climate science and agricultural science separately, but there are not enough opportunities for them to learn about the climate and agriculture nexus, along with practical learning experiences. By engaging students in project-based learning with field experts, we foster the development of the next generation climate-ready workforce equipped with scientific knowledge and resources to provide science-based solutions to stakeholders. With this opportunity to work with Cooperative Extension and university academics through service-learning and applied projects, we provide an enriched educational learning experience for students. Moreover, by investing in college-age students, we are supporting the USDA priority and making much-needed progress towards developing the next generation of climate-ready and agriculturally literate workforce. These summer internships are to be followed by a year-long Externship with program partners.

### Cost/Resources Needed

Implementing educational programs often requires funding. In this USDA-NIFA grant-funded project, each student received a stipend of \$5,000 for the two months. Also, voluntary labor resources, specifically the mentors, were required. Each student identified a mentor who aligned with their internship interests and provided a letter of confirmation of mentorship. Since project coordinators are not *de facto* mentors, well-designed learning journal templates with reflection prompts are required to ensure students report their progress online and discuss the outcome during scheduled meetings with the project coordinators.

References

- Adebiyi, A. A., Kibria, M. M., Abatzoglou, J. T., Ginoux, P., Pandey, S., Heaney, A., ..., & Akinsanola, A. (2025). Fallowed agricultural lands dominate anthropogenic dust sources in California. *Communications Earth & Environment*, 6(1), 324. <https://doi.org/10.1038/s43247-025-02306-0>
- Dooley, K. E., & Grady, R. T. (2020). Agricultural education and extension curriculum innovation: The nexus of climate change, food security, and community resilience. *The Journal of Agricultural Education and Extension*, 26(1), 1–3. <https://doi.org/10.1080/1389224X.2019.1703507>
- Huang, X., & Swain, D. L. (2022). Climate change is increasing the risk of California mega floods. *Science Advances*, 8(31), eabq0995. <https://doi.org/10.1126/sciadv.abq0995>
- Ikendi, S., Rios, K. D., Jha, P. K., & Pathak, T. (2025a, May 19–22). *Developing the next generation of climate-ready workforce in California* (Poster Proceedings, pp. 101–104). American Association for Agriculture Education National Conference, Lubbock, TX.
- Ikendi, S., Lyons, A., & Pathak, T. B. (2025b). Advancing decision support for climate adaptation in agriculture and natural resources. *Frontiers in Environmental Science*, 13, 1605176. <https://doi.org/10.3389/fenvs.2025.1605176>
- Ingles, D. M., & Retallick, M. S. (2025). Reflective practice in an experiential learning program: an exploratory content analysis of reflective writing in experiential learning portfolios. *Journal of Agricultural Education*, 66(2), Article 1. <https://doi.org/10.5032/jae.v66i2.3029>
- Jha, P. K., Zhang, N., Rijal, J. P., Parker, L. E., Ostojica, S., & Pathak, T. B. (2024). Climate change impacts on insect pests for high value specialty crops in California. *Science of The Total Environment*, 906, 167605. <https://doi.org/10.1016/j.scitotenv.2023.167605>
- Leal Filho, W., Sima, M., Sharifi, A., Luetz, J. M., Salvia, A. L., Mifsud, M., ... & Lokupitiya, E. (2021). Handling climate change education at universities: An overview. *Environnemental Sciences Europe*, 33, 109. <https://doi.org/10.1186/s12302-021-00552-5>
- Liu, P. W., Famiglietti, J. S., Purdy, A. J., Adams, K. H., McEvoy, A. L., Reager, J. T., ... & Rodell, M. (2022). Groundwater depletion in California’s Central Valley accelerates megadrought. *Nature Communications*, 13(1), 7825. <https://doi.org/10.1038/s41467-022-35582-x>
- Moyers, K., Abatzoglou, J. T., Escriva-Bou, A., Medellín-Azuara, J., & Viers, J. H. (2024). An invisible water surcharge: Climate warming increases crop water demand in the San Joaquin Valley’s groundwater-dependent irrigated agriculture. *PLoS Water*, 3(3), e0000184. <https://doi.org/10.1371/journal.pwat.0000184>
- Peter, B. G., Messina, J. P., Lin, Z., & Snapp, S. S. (2020). Crop climate suitability mapping on the cloud: A geovisualization application for sustainable agriculture. *Scientific Reports*, 10(1), 15487. <https://doi.org/10.1038/s41598-020-72384-x>
- Pinzón, N., Galt, R., Roche, L., Schohr, T., Shobe, B., Koundinya, V., ... & Powell, J. (2025). Farming and ranching through wildfire: Producers' critical role in fire risk management and emergency response. *California Agriculture* 79(1), 9–18 <https://doi.org/10.3733/001c.128403>
- Reimers, F. M. (Eds.) (2020). *Education and climate change: The role of universities*. Springer.
- Shine, D., Minehan, M., & Knight-Agarwal, C. (2022). #Healthpromotion: A qualitative exploration of how dietitians can use social media to positively influence women aged 18–35 years. *Nutrition & Dietetics*, 79(4), 489–496. <https://doi.org/10.1111/1747-0080.12765>
- Stein, S. (2024). Making space for critical climate education. *About Campus*, 29(5), 4–13. <https://doi.org/10.1177/10864822241284622>