Application: 2022-0000000006

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2022 CITRIS UCSC Campus Seed Funding - Climate Resilience

Summary

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UCSC CITRIS Seed Funding: Application Form

Completed - Jul 14 2022

Application Form

Project Title

Fostering Climate Resilience via User-friendly IT access and tools for Disadvantaged Latinx farmers in California

Project Summary

Please enter an abstract of 250 words or less

There are 45,000 small farms (less than 50 acres) in California that are at risk from the current and future impacts of climate change as they affect water availability, temperatures in the field, soil quality and the productivity and mix of crops that can be raised under more adverse conditions. Of these small farms 14,600 are operated by Latinx farmers with limited access to state and federal support and resources, limiting their resilience. Deployment of “smart” agricultural technologies and knowledge, tools and practices for using these technologies can provide these farmers with the means of becoming more resilient in the face of climate-related challenges. However, the cost and complexity of smart, IT-linked technologies put them out of the reach of many, capital poor farmers. The goal of this project is to use a UCSC-student developed multi-function sensor, manufactured by SproutLabs to help Latinx farmers in the Monterey Bay Region deploy smart technology and provide them with training, competence and confidence to use related IT programs and applications. The sensor will monitor soil moisture and other ambient conditions, enabling farmers to use their water supplies more efficiently. We are requesting $25,000 to purchase, deploy, program and monitor SproutLab sensors and collect data; conduct training workshops, in Spanish, for Latinx farmers; and employ UCSC engineering students to work with the farmers. Experience gained from this project can then be used to create broader initiatives and reach out to small farm operators across California.

Project Information

Brief narrative: Describe the problem your project aims to address and the methodology or process you propose. (1,500 words or less)	i. Needs statement: The impacts of climate change on American agriculture are expected to be extremely serious, especially in California (Fernandez-Bou, et al, 2021). Climate change will increase obstacles to success, in particular, for small farms (less than 50 acres), which have fewer options to respond and adapt. Climate change will affect temperatures in the field, soil quality, water supplies, and the productivity and mix of crops that can be raised under more adverse conditions. According to a recent report on agriculture in the San Joaquin Valley (Fernandez-Bou, et al., 2021) “Some of the

most economically valuable commodities are threatened by some early climate change effects, including reduced chill hours, water scarcity, and extreme heat.” The same report also sees California agriculture as offering a “unique opportunity for climate change adaptation and mitigation innovation by adopting new tools, using data technology, promoting renewable energy, and making land and water planning more robust” (id., p.15).

According to the report, “Small farmers, including disadvantaged and minority farmers, are among the most impacted by climate extremes in part because of their limited resources to build the needed resilience” (id., p. 7). The number of minority and disadvantaged farmers across the United States and in California is growing, driven especially by those in transition from farmworker to farm operator. In the words of the US Department of Agriculture, these farmers often lack the resources, expertise, financial and logistical knowledge to take advantage of “specialized technical support [from the U.S. agricultural system] that would benefit the launch, growth, resilience and success of their agricultural enterprises” (NIFA, 2022).

During a series of workshops in 2021-22, we conducted interviews with Latinx farmers to assess their needs. We found that these farmers seek, in particular,

1. Knowledge, skills, tools and techniques to increase resilience in response to changes in land availability, access costs, product demand, and disruptive challenges (such as climate change);

2. Practices directed to environmental sustainability, management of critical resources, such as soil, carbon and water, and risks and understanding of new regulations and food safety issues, and

3. Information about costs and benefits of specific

technologies, techniques and practices for improved management of land and production, increased efficiency and yield, and communication and information exchange.

Latinx farmers face a number of obstacles accessing such resources because many are provided primarily through the internet and require IT knowledge and skills. These farmers may not speak or read English and they face informational and logistical challenges in accessing state and federal agricultural programs, especially in terms of paperwork and bureaucratic requirements, all of which require IT literacy.

We believe that better and easier access to smart technologies can bridge the IT gap by providing three significant benefits to Latinx farmers:

1. Acquisition of IT skills and improved access to and use of digital resources through the training and applied experience as well as opportunities to engage in farmer-to-farmer knowledge exchange;

2. Greater resilience in the face of near-term weather and longer term climate-related challenges while increasing productivity and profits and protecting the environment (Loures, et al, 2020); and

3. Reductions in the transaction costs of responding to changes in weather, climate and markets while connecting them with the U.S. agricultural system (e.g., USDA, land grant schools, ag advisors) which offers financial support and technical assistance to small farms for implementing agricultural resilience in the face of climate change (NIFA, op cit.).

The IT technology to be deployed in this project is a smart sensor, manufactured by SproutLabs, that can monitor soil moisture, solar insolation, ambient weather conditions and carbon dioxide levels and control irrigation timing to use water resources more efficiently. Because small farmers' access to water frequently depends on leasing arrangements with larger farms, they may have only limited control over supply volume. In the face of California’s current drought, and looming climate-linked challenges, water resilience is one of the most important challenges facing small farmers.

The goal of this project is to deploy the SproutLabs multi-function sensor, first developed as a UCSC engineering student project, to help a group of Latinx farmers in the Monterey Bay Region deploy smart technology and provide them with training, competence and confidence to use related IT programs and applications. The complete architecture of the sensor and its environment is shown in the illustration at the end of this application, with the sensor deployed for measuring soil moisture and weather data to determine irrigation needs.

ii. Project methodology & process

This project is based on the following hypotheses:

H1: Acquiring IT technology, knowledge and skills can allow Latinx farmers to operate their farms more efficiently, increase crop productivity and access state and federal resources to facilitate greater resilience to climate impacts.

H2: Field deployment of smart sensors with associated software, operating and data collection functions, and training in their use, can help Latinx farmers acquire IT experience and skills that will assist them in conserving water and increasing resilience in the face of uncertain supplies.

Our field testing of these hypotheses relies on the following objectives:

1. Installation and operation of 4 sensors on two rows in the greenhouses of Whiskey Hill Farms in Watsonville California, in order to calibrate the sensors, set up the data collection and storage hardware and software.

2. Test the efficacy of these sensors in managing water use and productivity with one control row without sensors and drip-irrigated by a timer and one experimental row in which sensors operate drip irrigation based on soil moisture measurements.
Deploy a similar set of sensors and controls on three different Latinx-operated small farms and monitor operation, data and results during the 2022 and 2023 growing seasons (depending on crops).

3.Work with farmers on identifying sites for sensors and controls, installing sensors and hardware, teaching them about software, monitoring sensor operation and irrigation, trouble-shooting hardware and reviewing data and results on their smartphones.

4. Conduct pre- and post- experiment surveys of use of and familiarity with and access to IT resources, and compare productivity of control and experimental sites.

The project methodology is structured around experimental deployment and operation of soil moisture sensors at Whiskey Hill Farms (WHF) in Watsonville, California and at three Latinx operated farms near Salinas. The WHF portion is designed as a control, to monitor soil moisture, irrigation and productivity in a greenhouse environment in which regenerative agriculture is practiced. The three Latinx farms will be the experimental subjects, both in terms of sensor deployment and operation, and instruction and training of participants about sensor operation and monitoring, IT applications and comparative water use. SproutLabs will provide the sensor technology, deploy and troubleshoot it, and set up data monitoring and collection for analysis (see attached Figure). Engineering students will be solicited to provide technical assistance to farmers and field test the sensors. Real time data and results will be made available to farmers through their smartphones, which can also be used to reprogram the sensors as needed.

Based on our experience and interviews with farmers, we have found the most effective approach to teaching Latinx operators of small farms is through “hands-on,” experiential demonstrations and applications (Emerick & Manzoor, 2021). Conventional methods of classroom instruction run into translation and interpretation problems, and lectures about and pictures of operations and applications ignore the farmers’ social and knowledge-based contexts, especially where IT skills and applications are involved. Direct hands-on deployment in the field will provide training and experience with IT-based tools and technologies. Learning to operate and interpret past, present and forecast conditions and to use the apps associated with the device will provide them with experiential learning and growing familiarity not only with the specific hardware but also IT more generally.

III. Project timeline & workplan (objectives & tasks)

7/22. Complete experimental setup: Install sensors in two experimental beds at Whiskey Hill Farms (WHF); set up software, communication, data collection, data analysis; Identify 3 farms & farmers

8/22. Introduce farmers to experiment: Operate & monitor WHF sensors, performance, data collection; troubleshoot & fix bugs. Meet with farmers to explain project, methodology, schedule, etc. Conduct IT knowledge pre-test

9/22. Set up experiment on farms: Operate monitor WHF sensors; adjust operation as required. Field surveys of farms to identify sensor & control sites; install technology with farmers & provide training; testing & debugging

10/22. Monitor sensor operation: Operate & monitor WHF & farm sensors; Review data & adjust

	sensor operation as needed 11/22. Measure & compare productivity: Harvest rows & weigh crops; analyze water use & production data. Collect harvest data at control & sensor rows on farms (for later comparisons); 12/22. Report on preliminary results: Complete WHF data analysis & prepare report on results; review operation & data with farmers 1/23-6/23. Continue sensor operation & monitoring: Work with farmers on further training, data analysis, planning for growing season 7/23. Report final results: Harvest selected sites & weigh crops; analyze water use & production data; conduct IT post-test; analyze data; prepare final report
Impact statement: What result do you hope to achieve? What potential impact will the research results have on the field? On society? (500 words or less)	Impacts There are two impact goals in this project: 1. Help Latinx small farm operators to prepare for climate change and increase resilience to its impacts through deployment of field-based smart technologies; and 2. Help Latinx small farm operators acquire greater IT knowledge and skills to improve access to on-line financial, informational and instructional resources that can finance field-based IT technologies for their farms Climate change will impact agricultural productivity through rising temperatures, reduced water supplies, more severe storms and droughts, deterioration of soil quality and adverse working conditions in the field. Farmers can deal with these impacts through deployment of low-cost smart technologies that can provide rapid, real-time

reports on conditions in the field. Networked-linked soil moisture sensors are one such technology, which monitor soil water content at different depths and can regulate irrigation in response. This will increase efficiency of water use and reduce water needs, especially in the face of extended drought and unpredictable rainfall. Such modern cutting-edge technologies require IT knowledge, which is best achieved through on site installation and training (rather than in-class or on-line instruction).

This project is designed to provide both smart technology and IT training to Latinx operators of small farms, and to improve farm operations, productivity and revenues through more careful monitoring and use of scarce and costly resources. These farmers already experience the fringe impacts of climate change, in terms of reliable water supplies, rising temperatures, severe storms and localized flooding, but operate largely without reference to medium- and long-term environmental, resource and weather conditions. Access to real-time data through smart technology will allow them not only to respond to immediate conditions and crop needs but also to track trends and conditions across their acreage. To date, direct access to IT tools and devices has been limited by cost, access and skills. The SproutLabs sensor is low cost (less than $200 per sensor), will be widely available in the future, and will be easy to install, program and understand. If successful, we anticipate that devices, such as the SproutLabs sensor, along with training and deployment, will become available to all small farms in California (and the United States) and increase their resilience in the face of climate change.

The benefit to society as a whole from helping small farms become more productive and resilient is significant. Even though small farms produce only a fraction of the United States' food supply, they are vital to regional supplies of fresh produce and offer a critical alternative to large-scale, energy inefficient monoculture agriculture linked to

	complex supply and distribution chains. As the COVID pandemic and the Russian invasion of Ukraine both demonstrate, these supply chains are fragile and subject to unpredictable and disruptive shocks. Climate change will only increase such risks. Raising the productivity and resilience of small farms, especially through smart technologies, can ameliorate some of the worst impacts.
Budget narrative: Please give a brief summary of the budget categories and amounts needed for the proposed research. (500 words or less)	Budget narrative. Personnel ($5,000): For undergraduate engineering students to monitor, troubleshoot and provide assistance to farmers; data collection, formatting, analysis, presentation (250 hours @ $20) Supplies ($4,000): 20 SproutLab sensors @ $200 for installation & operation at WHF and three farms (5 at each farm) Subcontract to SproutLabs ($10,000): For SproutLabs staff support ($200 hrs. @ $50/hr) for cost of installation, service, onsite workshops & continuing visits in support of hardware & software maintenance and development of new software as required; localizing the frontend for non-English speakers Subcontract to GloballyYou ($2,000): Bi-lingual Spanish-English Interpretation for on farm training sessions and translation of written materials (40 hours @ $50/hr.) Training workshops ($4,000): For compensation to participating farmers' lost work time during deployment and training (5 operators at 3 farms @ 20 hours x $40/hr.). Total request: $25,000
Downstream project applications: What	Downstream applications

opportunities do you anticipate for building on the results of this seed award, if awarded? Describe larger grant proposal opportunities or partnerships here. (500 words or less)	i. Anticipated project outcomes 1. Successful demonstration of sensor deployment, IT learning and experience and productivity results will provide a model for project reproduction across California; 2. Smart technology can increase resilience by preparing farmers to anticipate adverse short-term conditions and better plan for those conditions. The project expands technical assistance to disadvantaged farmers and their ability to tap into knowledge, skills and resources on offer from federal, state and local agencies and funders. 3. The project will offer real time on the field experiential learning for UCSC students (especially engineering students) and feed into improved user design and operation. 4. The project provides support for one of UCSC's successful engineering spinoffs and can provide guidance to engineering students seeking to take their projects into startups. ii. Grants & funders to which we will apply for future support: 1. USDA offers a number of grant opportunities that provide funding for technical assistance to disadvantaged farmers, new and beginning farmers and other opportunities. 2. Western Sustainable Agriculture, Research and Education (WSARE) is a program at Montana State University, funded by USDA, which offers a range of grants for on-farm projects, agricultural education and technical training. 3. NSF sponsors program that supports STEM education outside schools, colleges and universities, which this project does. 4. California Department of Food & Agriculture (CDFA) funds a range of projects and programs in

support of California farmers, especially beginning and disadvantaged ones.

5. The project will appeal to firms developing hardware and software for agriculture, community foundations supporting disadvantaged communities, businesses seeking to expand their customer base and private donors interested in local food supply and security and social support for small farmers.

6. Eventually, it may be possible to generate revenues for services to small farmers.

ii. Partners & collaborators working with us include

1. The Sustainable Systems Research Foundation (SSRF) in Santa Cruz, a nonprofit green think and project incubator founded by two UCSC instructors.

2. Whiskey Hill Farms (WHF) in Watsonville, a pioneer in closed-cycle regenerative agriculture and technology.

3. The Community Alliance with Family Farmers (CAFF) in Davis, which provides various technical and educational resources to small farms in California.

4.Hartnell College in Salinas, which offers programs in Agricultural Business and Business Technology and is a Hispanic Service Institution.

5. Pajaro Valley School District and Watsonville and Renaissance High Schools, which both have agriculture programs

We anticipate additional collaborators on this project.

Citations (Include any citations relevant to the Project Information given above.)

1	Angel Santiago Fernandez-Bou, et al., 2021. “Regional Report for the San Joaquin Valley Region on Impacts of Climate Change.” California Natural Resources Agency. Publication number: SUM-CCCA4-2021-003, at: https://www.energy.ca.gov/sites/default/files/2022-01/CA4_CCA_SJ_Region_Eng_ada.pdf.
2	NIFA (National Institute of Food & Agriculture), 2022. “Request for Applications: American Rescue Plan Technical Assistance Investment Program,” Washington, DC: USDA, USDA-NIFA-OP-009004; Calo, Adam, 2018. “How knowledge deficit interventions fail to resolve beginning farmer challenges,” Agriculture and Human Values 35: 367-81, DOI 10.1007/s10460-017-9832-6.
3	EPA. 2021. Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts. U.S. Environmental Protection Agency, EPA 430-R-21-003, p. 82, at: www.epa.gov/cira/social-vulnerability-report.
4	Emerick, Kyle & Manzoor H. Dar. 2021. “Farmer Field Days and Demonstrator Selection for Increasing Technology Adoption,” The Review of Economics and Statistics 103, #4 (October): 680-93.
5	Loures, Luis, et al. 2020. “Assessing the Effectivenes of Precision Agriculture Management Systems in Mediterranean Small Farms,” Sustainability 12, 3765, at: doi:10.3390/su12093765.

Lead Principal Investigator information

You will have the opportunity to add co-PIs on the following page.

Full Name

First Name	Adina
Last Name	Paytan

Campus Division

Physical and Biological Sciences

If you Selected "Other" for Campus Division

provide a short explanation

(No response)

Email Address

apaytan@ucsc.edu

Home Department

Earth & Planetary Sciences

URL for professional curriculum vitae and/or publication information

https://paytanlab.ucsc.edu/people/adina-paytan/

Does this application include any pre-tenured faculty?

Inclusion of pre-tenured faculty is highly encouraged but not required.

Does not include pre-tenured faculty

Prior CITRIS Core Seed Awards

Have you received CITRIS Multi-campus Core seed funding in the past?

No

Prior CITRIS UCSC Campus Seed Awards

Did you receive CITRIS UCSC Campus Core seed funding in 2019?

No

If yes, please list the previous project title(s), award year(s), and PI names.

(No response)

Co-Principal Investigator information

This section allows you to add all of the co-PI's on your project.

Note: In order to give others (i.e. co-PIs and/or students) the ability to edit this application, from your Application screen click the "Add Collaborators" button.

First co-PI's Full Name

First Name	Ronnie
Last Name	Lipschutz

First co-PI's Email Address

rlipsch@ucsc.edu

First co-PI's Campus Division

Social Sciences

If you selected "Other" for Campus Division

provide a short explanation

(No response)

First co-PI's Home Department

Politics

Webpage link for professional curriculum vitae and/or publication information

https://politics.ucsc.edu/faculty/index.php?uid=rlipsch

Principal Investigator status

I authorize that the co-PI has Principal Investigator status on UCSC campus

Do you have another co-PI to add to this proposal?

No

Budget Section

Finances

Proposal total must not exceed $40,000.

Proposal total	25,000
GSR/Student Salary/benefits sub-total	5,000
Travel sub-total	0
Equipment/supplies/expenses sub-total (non-travel)	4,000

Campus divisions where funds will be spent

To help us track cross-division fund distributions, a dollar amount is required in each field below. Click here to view a table of the funds available per award, then indicate how you plan to distribute them below.

Responses Selected:

Physical and Biological Sciences
Social Sciences

Physical and Biological Sciences

PI Name	Dr. Adina Paytan
Amount	$25,000
Additional PI name (if applicable)	(No response)
Additional Amount (if applicable)	(No response)

Social Sciences

PI Name	Dr. Ronnie Lipschutz
Amount	0
Additional PI name (if applicable)	(No response)
Additional Amount (if applicable)	(No response)