

Improving the Health and Safety of People Working in Agriculture in the West

Annual Report Period: 9/30/21–9/29/22

Grant Number: U54 OH007550



Kent E. Pinkerton, PhD, Professor and Director, University of California, Davis
October 2022

Key Personnel Contact Information

Kent E. Pinkerton, PhD
Director
530-752-8334
kepinkerton@ucdavis.edu

Fadi Fathallah, PhD
Associate Director
530-752-1612
fathallah@ucdavis.edu

Christopher Simmons, PhD
Director of Research & Director of Outreach
530-752-2109
cwsimmons@ucdavis.edu

Heather Riden, MA
Program Director
530-752-5253
heriden@ucdavis.edu

Stuart Henderson, PhD
Director of Evaluation
916-703-9220
sthenderson@ucdavis.edu

WCAHS Online

Website: aghealth.ucdavis.edu

Facebook: [@AgHealthUCD](https://www.facebook.com/AgHealthUCD)

Twitter: [@AgHealthUCD](https://twitter.com/AgHealthUCD)

Instagram: [@aghealthucd](https://www.instagram.com/aghealthucd)

WCAHS YouTube Channel: youtube.com/channel/UCCrF9GcijzIdd2shYwCFGjw

Ag Centers' YouTube Channel: youtube.com/user/USagCenters

SECTION ONE

Center Summary, Administration & Evaluation



Summary

Agriculture in the western United States represents one of the most labor-intensive and productive operations in the world. California's agricultural industry alone is the largest and most diverse in the nation, producing two-thirds of the country's fruits and nuts and one-third of the country's vegetables.

The mission of the Western Center for Agricultural Health and Safety (WCAHS) is to improve the health and safety of those working in western agriculture, with particular consideration of the unique issues in the states of Arizona, California, Hawaii, and Nevada, where more than a third of the nation's farmworkers live. Agriculture ranks among the most hazardous occupations in the United States and WCAHS has a direct public health impact by increasing the understanding of what causes injuries and illnesses in this population and applying the findings to develop interventions.

Research accomplishments include the recognition of inorganic dust as a cause of respiratory disease in agriculture, ergonomic changes to reduce injury during the grape harvest, new assays for pesticide monitoring, outreach to farmworkers on pesticide and heat-related illness prevention, and addressing the health impacts of migrant status on farmworkers. WCAHS works with regional growers, industry, labor, government agencies, and community-based organizations to address agricultural safety and health issues through the translation of research results into effective workplace interventions.

WCAHS is located at the University of California, Davis, which is ranked number one in the United States for its agriculture program.

Center Administration

The WCAHS administrative team, including the Director, Associate Director, Outreach Director, Research Director, and Program Director, meet twice a month to review, prioritize, and advance Center activities. The administrative core provides leadership in convening center faculty and stakeholders in research and advisory meetings.

WCAHS continued to provide the 2021–2022 seminar series online with simultaneous Spanish interpretation. The recorded presentations were posted on the Center's YouTube channel. Seminar topics for the 2021–2022 academic year included resource development for Punjabi-speaking farmworkers, impacts of pesticides and nano-based agrochemicals on farmworker health, wildfire smoke exposure, Valley fever, and zoonotic pathogen exposure, among others. In total, the WCAHS seminar series reached approximately 850 people through live Zoom sessions and YouTube recordings.

Communication

WCAHS continues to disseminate agricultural health and safety information utilizing numerous formats to target our diverse stakeholders. The WCAHS website is a resource hub that provides downloadable, bilingual training resources and information about topical areas of expertise. With the continued provision of timely resources and information related to wildfires, heat illness, and COVID-19, WCAHS website traffic increased by 107% from 2021 to 2022.

The Center sends two monthly email newsletters. One features WCAHS research and outreach activities, funding opportunities, and center events. The other, *Próximamente*, is a bilingual newsletter and targets the agricultural community (e.g., growers, farm supervisors, farmworkers) with safety tips, regulatory reminders, and upcoming training opportunities.

Additionally, WCAHS utilizes the social media channels Twitter, Instagram, Facebook, and YouTube to connect with other researchers and agencies, growers, and UC Davis centers and institutes.

Evaluation

The WCAHS evaluation component assesses the progress and impact of the Center's research and outreach efforts, as well as the Center overall. The evaluation team collects data from program records and study investigators to document outputs and outcomes. Evaluation supports Center-wide activities, including systematically tracking all outreach trainings and events, evaluating participant experience of the annual symposium, synthesizing External Advisory Board feedback, evaluating the small grant program, highlighting center impact, and conducting other targeted evaluations for the center. The findings of the WCAHS' evaluation are shared internally and externally to develop and disseminate best practices for evaluating NIOSH Agricultural Health and Safety Centers.

Cross-Center Collaboration

WCAHS is an active participant in the Agriculture, Forestry, and Fishing (AgFF) Evaluation, Communication and Outreach (ECO) group, a cross-center forum that enables all 11 AgFF centers to share approaches to evaluation and outreach and collaborate on priorities, challenges, and opportunities. The WCAHS outreach and evaluation teams participate in all ECO group calls. WCAHS contributes to cross-center safety campaigns by ensuring content is translated into Spanish and is culturally tailored for target audiences. The U.S. Agricultural Safety and Health Centers' YouTube channel has seen an increase in average view duration, subscribers, likes, and shares as a result of these efforts.

From October 2021 to August 2022, the evaluation team collaborated on a contribution analysis of the AgFF centers' role in addressing heat-related illness (HRI) with the Florida, Washington, and Texas centers. The product of this contribution analysis, a comprehensive logic model that summarized outputs and outcomes pertaining to HRI from all four centers, will serve as the model for other planned contribution analyses by NIOSH.

Leveraging Impact

WCAHS maximizes the impact of its NIOSH Center funding by obtaining extramural funding, nurturing existing partnerships, and building new partnerships with community organizations and others in the industry. We also receive substantial funding from UC Davis to support graduate student research on agricultural health and safety topics, which further allows us to leverage the funding from NIOSH. These activities broaden our impact, enhance outreach and training activities, and nurture the next generation of researchers.

Examples of ongoing contracts and grants affiliated with WCAHS include:

- The COVID-19 Statewide Agriculture and Farmworker Education (SAFE) program, part of a statewide rapid response to COVID-19, funded by the California Labor and Workforce Development Agency and extended by the California Department of Public Health (PI: Heather Riden).
- WCAHS is partnering with California AgrAbility on the Western Regional Agricultural Stress Assistance Program, a USDA Farm and Ranch Stress Assistance Network grant (PI: Fadi Fathallah).
- The Worker Occupational Safety and Health Training and Education Program (PI: Heather Riden), an initiative of the California Department of Industrial Relations to reduce injury and illness in California's workers. WCAHS conducts Injury and Illness Prevention Program trainings, among others. A particular recruitment focus is newly licensed growers and farm labor contractors.
- UC Davis students are funded through the UC Berkeley NIOSH Education and Research Center to study agricultural health and safety (PI: Fadi Fathallah).

SECTION TWO

Emerging Issues Program



Program Goals

The goal of the Emerging Issues Program is to respond quickly to emerging agricultural health and safety topics. This program has the potential to mobilize academic expertise and achieve breakthroughs in novel or understudied areas of agricultural occupational health, and to create relationships between Center members and potential new members, both at UC Davis and at other institutions. Projects may be research-, education-, or outreach-related. New emerging issues topics are discussed during Steering Committee meetings, center events, and External Advisory Board meetings.

WCAHS continued to work closely with a recent UC Berkeley MPH and UCSF MD graduate on a qualitative study assessing the unique preferences of Punjabi-speaking farmworkers in communications and outreach related to occupational health and safety information in agriculture. Findings will be submitted to a peer-reviewed journal in Winter 2022 and will inform new safety signs and outreach resources for Punjabi-speaking farmworkers throughout the California Central Valley.

SECTION THREE

Research: Core Projects, Small Grants, and Graduate Student Funding



Core Center Research

WCAHS has five core research projects that are funded for five years (descriptions below).

Small Grant Program

The WCAHS Small Grant Program (pilot project funding) funds new research projects annually for 12 months. When additional funds become available, WCAHS announces additional funding opportunities resulting in rapid response/short-term funding. The Small Grant Program funded five projects in the 2021-2022 funding cycle.

Graduate Student Research Funding Program

UC Davis provided institutional support to fund graduate students working on research related to agricultural health and safety. Through a competitive application process, WCAHS provided financial support (tuition and stipends) to graduate students each quarter.

PROJECT 1

Differential Characterization of Air Pollutant Emissions and Associated Toxicity from Common Agricultural Practices in the San Joaquin Valley

Kent E. Pinkerton, PhD, School of Medicine and School of Veterinary Medicine, and Keith Bein, PhD, UC Davis



Problem: This project aims to measure the relative toxicity of agriculturally related dust and particulate matter (PM) pollution, alone and in combination with wildfire smoke, as a means to protect and improve farmworker health through training, education, translation of research, and outreach. Air pollution (particulate matter emissions) from agricultural practices differs in physical and chemical composition, which determines its toxicity and resulting health effects. During the last few years, air quality in the agricultural setting has become further complicated by the presence of wildfire smoke transported over large distances throughout California and persisting for long periods of time.

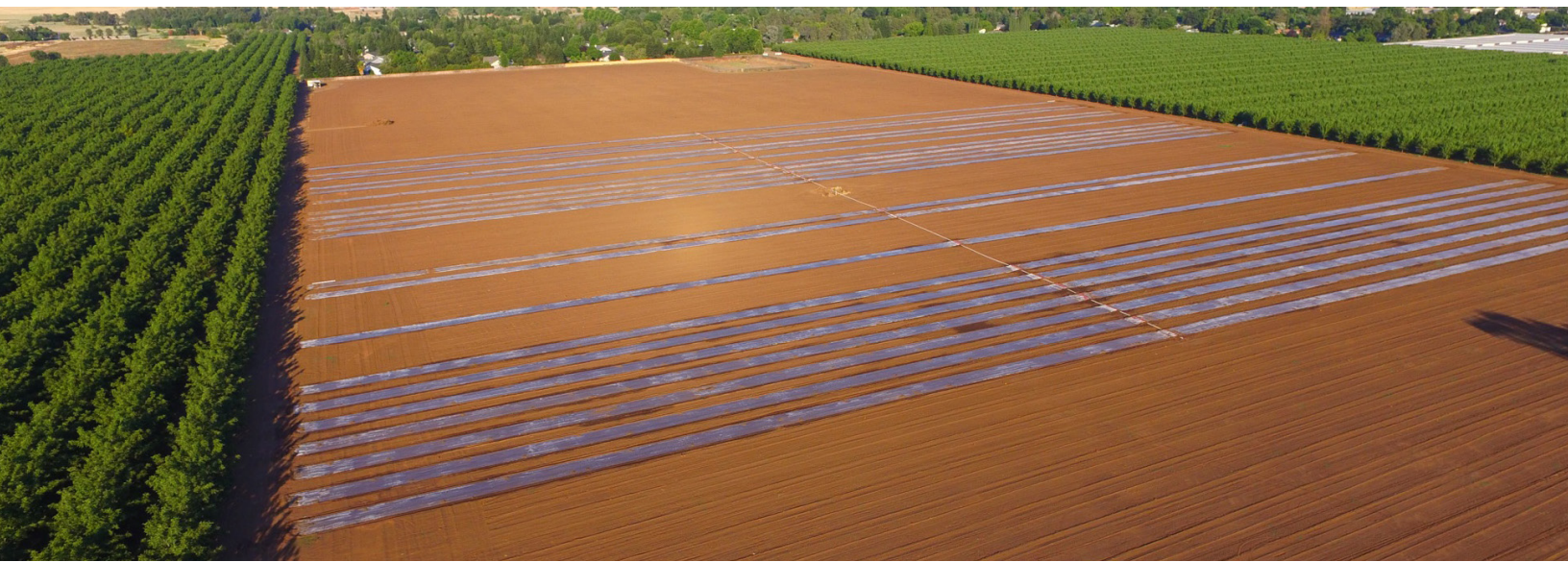
Project overview: Airborne PM from California's Sacramento, San Joaquin, and Imperial Valleys is being collected at various farming sites with different labor-intensive crops and farming practices. Concurrently, a Rapid Response Mobile Research Unit has been deployed during several major wildfire events to collect samples of wildfire smoke. The impact of co-exposure to these PM samples from agricultural and wildfire emissions on cells and respiratory health is under investigation. The importance of PM size on observed biological response is also being investigated. Different PM sizes are associated with unique chemical compositions, thus posing different health hazards.

Progress to date: Biological and chemical screening of PM samples from three agricultural regions of California, the city of Sacramento, and several major wildfires have been completed or continue to be in the process of further analysis. The agricultural sites include Davis, Parlier, and Calipatria, CA, while the wildfires include the 2017 Napa/Sonoma wildfires, 2018 Carr Fire, 2018 Camp Fire, and 2020 wildfire siege. A simple, but sensitive, cell culture assay of immortalized human macrophages has provided a unique tool to screen samples from these regions with excellent success. An additional analysis using immortalized epithelial cells has further expanded our understanding of unique properties possessed by particulate samples. Results from completed studies on the relative toxicity of different PM sources, including agriculture, wildfires, and vehicular emissions, have resulted in peer-reviewed publications, numerous presentations at professional conferences, stakeholder organizations, and symposia, as well as invited talks and several interviews through various media outlets. Several additional publications have been submitted and others are in preparation for submission. The PM samples are now undergoing a comprehensive analysis to characterize their chemical composition and the potential mechanism(s) of biological action. These efforts will result in additional publications and presentations. Studies on the impact of wildfire smoke in the agricultural setting have resulted in the creation of a checklist and guidelines for health and safety training of farmworkers that continue to be disseminated in agriculture nationwide.

PROJECT 2

Reducing Toxin Exposure for Workers in Western Agriculture: Development of Sustainable Alternatives to Soil Fumigation

Chris Simmons, PhD, College of Agricultural and Environmental Science, UC Davis



Problem: Many conventional and widely used soil fumigants have been identified as being toxic and/or carcinogenic. As a result, acute and chronic exposure risks exist for agricultural workers and communities near fumigation sites.

Project overview: Biosolarization is a potential alternative to toxic soil fumigation and is less damaging to health and the environment. Instead of toxic conventional pesticides, biosolarization uses solar heating and microbial activity to create soil conditions that are lethal to many pests but relatively safe for humans. This project tests whether biosolarization is an effective fumigation substitute in the context of western agriculture, which entails controlling major western agricultural soil pests in western specialty crops.

Progress to date: Experiments were conducted to examine biosolarization in California agriculture and address barriers to adoption for biosolarization. This entailed using major sources of residual biomass in the state, such as hulls and shells from almond processing, as soil amendments to trigger production of natural biopesticides and other pest-inactivating conditions during biosolarization. Following field trials in 2017 that demonstrated control of soil pests immediately following biosolarization, ongoing monitoring of field sites has shown long-term benefits to soil health associated with biosolarization including persistent pest suppression and elevated plant nutrient content. Specifically, biosolarization guarded against reinfestation by harmful nematodes for approximately two years while promoting increased levels of plant nutrients in treated soils; by four+ years post-treatment, soil pest and nutrient properties in biosolarized and untreated soils became more similar. However, ongoing monitoring of soil and almond tree properties at the trial site have shown that certain varieties of almond trees in biosolarized soils exhibit greater trunk diameters and greener canopies than those grown in untreated soils. These are indicators of increased vigor that may lead to improved yield. Industry engagement continues to be an integral element of this project. To further expand the applicability of biosolarization in western agriculture, new regional sources of compatible organic matter soil amendments continue to be explored. Residues from commercial onion processing have proven to be effective in laboratory pest control studies by yielding high levels of biopesticides and phytoparasite control during biosolarization. Across all aspects the project, direct collaboration with commercial growers and food processors, presentations at industry events, and publication of articles in agricultural trade journals were used to increase grower awareness and promote adoption of biosolarization.

PROJECT 3

Ergonomic and Biomechanical Evaluation of Mechanical and Robotic Strawberry Harvest-Aids

Fadi Fathallah, PhD, College of Engineering and College of Agricultural and Environmental Science, UC Davis



Problem: Workers who harvest strawberries can suffer from musculoskeletal disorders, especially low-back disorders. Interventions to reduce low-back disorders, while maintaining acceptable productivity levels are needed.

Project overview: This project evaluates the ergonomics, biomechanics, and productivity of using mechanical and robotic strawberry harvest-aids to protect workers from low-back disorders while maintaining yields. This project strives to use a series of optimized and controlled interventions to gain a better understanding of the balance between productivity and ergonomics of multi-person and personal labor-aid machines for strawberry harvesting. Machine-specific interventions will be evaluated for safe deployment.

Progress to date: During this period, building upon our previous harvest-aid prototype mockups, we have developed a mock environment that simulates a real-world strawberry harvest; wherein a subject is placed in identical postures to the real-world counterpart. All the mockup dimensions, which are critical for biomechanical assessment, were in-line with the real-world benchmark. For instance: (i) bed height, (ii) bed furrow spacing, (iii) berry density, and (iv) platform height all reflected the field benchmarks accurately. A 2-D motion capture system was utilized to capture trunk posture and paired with a newly developed custom analysis program. The capture system allowed investigation into the relationship between lumbar flexion angle and lumbar biomechanics. The custom program added the capacity to automate calculations, data visualization, and statistics. A total of six volunteers participated in simulated harvest trials. The data analysis of these trials is currently underway. During this period, the personal robot harvest-aid has been further updated, where the robot/personalized picking system can be used with a standard strawberry picking cart. Additional field testing of the system occurred with the updated co-robot. Optimization algorithms for co-robot deployment are frequently updated based on information gathered from the field. The study team is continually assessing the best means to deploy the results of this project into useful and practical guidelines that minimize the risk of musculoskeletal disorders among workers who harvest strawberries.

PROJECT 4

Heat Illness Prevention in Farmworkers: Translation of Economic, Socio-Cultural, and Physiological Factors into Effective Interventions

Marc Schenker, MD, MPH, School of Medicine, UC Davis



Problem: Despite major campaigns to reduce heat-related illness in agricultural workers, deaths and illnesses still occur at higher rates than in other industries where workers are exposed to hot environments.

Project overview: This project engages farm organizations and workers in a collaborative effort to better understand and address the complexities of heat-related illness. Our goal is to translate the physiological and behavioral data collected from our earlier research into effective risk reduction strategies.

Progress to date: A video was produced featuring testimonials from a farm owner, agricultural economist, and farmworker, which stressed the importance of proactively protecting workers and demonstrates that worker protections benefit everyone in the long run. The video has been viewed 879 times in English and Spanish on YouTube. Participatory heat-related illness prevention training materials were developed, including discussion guides, visual aids, and a pocket-sized information card for farmworkers. In addition, a ‘Tips for Trainers’ guide was created as supervisors consistently noted the usefulness of concrete suggestions for training their workers. These materials cover Cal/OSHA training requirements and emphasize key points found in the research, such as work rate as a major risk factor for heat-related illness. The video and training materials were used in nine trainings in English and Spanish for supervisors and workers and were featured in NIOSH’s monthly eNews as well as the WCAHS newsletter. Feedback has been overwhelmingly positive. To date, almost 2,000 English and over 4,000 Spanish training packets have been distributed, along with over 70,000 pocket cards. The High Plains Intermountain Center for Agricultural Health and Safety in Colorado adapted the training materials as a resource for Colorado employers to comply with heat illness standard training requirements in that state.

After detailed testing of a beta version of a mobile application to assist supervisors in managing the safety of their work crews, investigators found that the app was very similar to the latest update of OSHA-NIOSH’s Heat Safety Tool. Due to this similarity and limited capacity for long-term maintenance of an app, investigators chose to reallocate remaining resources to printing and promotion of the new toolkit.

Two manuscripts have been published: one titled “Compensation incentives and heat exposure affect farm worker effort” in PLoS ONE and “Anemia, Weight Status, and Fatigue Among Farmworkers in California: A Cross-Sectional Study” in Journal of Occupational and Environmental Medicine. A manuscript titled “How does temperature affect farmworkers’ work rates?” is in preparation.

In addition to academic outreach resulting from academic publications of the study, investigators were engaged in several media contacts on heat stress illness resulting from attention derived from the very hot summer temperatures. Most of these contacts were with Marc Schenker, the PI on this project, and included news articles in the Woodland Daily Democrat, The Fresno Bee, Agri-Pulse, Hortidaily.com, Aljazeera.com, The National Observer, Civil Eats, and live interviews on NPR All Things Considered.

PROJECT 5

Reducing Occupational Exposure to Zoonotic Pathogens in California Dairy Workers

Edward R. Atwill, DVM, MPVM, PhD, School of Veterinary Medicine, UC Davis



Problem: Zoonotic pathogens can cause illness in both humans and animals. Numerous zoonotic pathogens are common in dairy cattle populations and throughout the dairy environment. Working within a dairy system increases the risk of exposure to dairy feces that may harbor zoonotic pathogens. However, the amount of exposure required before a worker inadvertently ingests enough zoonotic pathogens to become ill is poorly understood.

Project overview: The project will identify high-risk occupational tasks based on exposure to different concentrations of zoonotic pathogens and then develop recommendations that will reduce the risk of exposure for dairy workers. Fecal samples will be collected and analyzed to quantify five zoonotic pathogens shed by infected dairy cattle. Enrolled dairy workers will be observed performing usual job tasks to help identify occupational tasks and specific personal behaviors that increase a worker's exposure to zoonotic pathogens. Based on project findings, outreach training and materials will be developed and disseminated through training programs.

Progress to date: The project team has enrolled 44 dairy workers into the study. Enrollment will remain open throughout the duration of the project. Each enrolled participant has completed the occupational exposure survey which covers standard demographic items, dairy worker job satisfaction and job stress, and microbial risk exposures. Pilot data was collected to optimize the behavioral data collection techniques. Data was collected during five sampling events totaling 20 hours of observational data collection. Study data collection began in July 2019, resulting in nearly 50 hours of behavioral data collection. A total of 528 fecal samples have been collected from the three participating dairies. Each fecal sample has been processed to determine the presence and concentration of five zoonotic pathogens, *Escherichia coli* O157:H7, *Salmonella* spp., *Listeria monocytogenes*, *Campylobacter jejuni*, and *Cryptosporidium parvum*. To date, we have not collected fecal material from the same dairy cow. Due to restrictions related to COVID-19, ongoing sampling efforts have been postponed until the current restrictions/state closures are lifted. All collected data have been analyzed and presented during the WCAHS Monthly Seminar Series, with digital recordings available on YouTube. A manuscript titled "Occupational patterns of acute exposure to zoonotic pathogens occurring among California dairy farm workers" is in preparation for publication in Journal of Agromedicine.

SMALL GRANTS

The WCAHS Small Grant Program (pilot project funding) funds new research projects annually for 12 months. When additional funds become available, WCAHS announces additional funding opportunities resulting in rapid response/short-term funding.

Funded Small Grant Projects 2021–2022

Potential of Health Risks of Lights on Workers in Controlled Environmental Agricultural Systems

Md Shamim Ahamed, PhD, UC Davis

Wearable Lumbar Spine Posture-Monitoring Device for Back Pain and Injury Prevention in High-risk Agricultural Workers

Britta Berg-Johansen, PhD, Cal Poly

Effects of Prolonged Exposure to Agricultural Dust on Intestinal Function and Gut Microbiome

Meli'sa Crawford, PhD, UC Riverside

Understanding the Persistence of Poor Air Quality and Environmental Injustice in Imperial Valley, California

Ian Faloona, PhD, UC Davis

Health Practices Among Farmworker Communities in California

Rosa Manzo, PhD, UC Merced

SECTION FOUR

Training and Outreach



The WCAHS outreach core builds and maintains relationships with agricultural stakeholders throughout California and the region through free safety trainings, resources, and events. Years of collaboration and support at the individual and organizational levels have resulted in an increasing number of new opportunities to expand the reach of the program.

Trainings

The WCAHS outreach core develops bilingual agricultural safety resources and delivers trainings on a variety of topics. Areas of particular expertise include heat illness prevention, sexual harassment prevention, hazard assessment, wildfire smoke exposure, and pesticide safety. Trainings range in length from short tailgate trainings held in the field to three-hour train-the-trainer courses for farm supervisors. The train-the-trainer format maximizes the reach of important safety information through the subsequent dissemination by the supervisors to their workers, resulting in the education of more individuals than could be reached by a single trainer from the Center. While most trainings are offered in English and Spanish, translators have been employed to assist in the training of Punjabi or Hmong workers. The outreach core presents to growers, farm labor contractors, and policy makers; it is also engaged in local *promotores* (community health workers) networks.

The outreach core continues to develop, deploy, and evaluate training techniques, particularly those related to emerging safety issues. The publication in *Journal of Agromedicine* is an example of how core researchers assess stakeholder perceptions and understanding in response to specific training topics and formats. Additionally, such work promotes adoption of effective safety training techniques by others.

The core has expanded its internal training via work with College Corps student fellows and student interns under the new center internship program. These activities are positioning students to be leaders and advocates for agricultural health and safety in their communities in addition to motivating careers in this field.