

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

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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 moved its 2020–2021 seminar series online, dramatically increasing attendance, and enabling simultaneous Spanish interpretation and the recorded presentations to be posted on YouTube. Seminar topics for the 2020–2021 academic year included findings from the COVID-19 farmworker study, heat-related illness, a community-based organization's response to the pandemic, California farm labor statistics, an evaluation of workplace sexual harassment in agriculture, safety culture and frontline leaders, and risk factors for Valley fever.

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 63% from 2020 to 2021.

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. The findings of the WCAHS' evaluation are shared to develop and disseminate best practices for evaluating NIOSH Agricultural Health and Safety Centers. 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, and evaluating the small grant program.

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.

During this reporting period, 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 (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.

COVID-19

WCAHS continued its COVID-19 response in 2020–2021, which included collaboration with agricultural associations and community-based organizations. The COVID-19 SAFE Program has reached over 250,000 people and distributed over 500,000 training and outreach materials. Over 70 short informational videos about COVID-19 safety and vaccines were produced in over 20 languages to reach Indigenous farmworkers.

Sexual Harassment in Agriculture

A UC Davis graduate student has recently completed their doctoral research initiated as a WCAHS emerging issues project to examine sexual harassment in agriculture in California and Mexico as part of a PhD program in epidemiology. Outputs from the project include a journal article, conference presentations, an educational story (or Cuento), and a policy brief.

Cannabis Worker Health and Safety

California has the largest share of cannabis workers in the U.S., but little is known about health and safety in this large and rapidly expanding industry. Through its emerging issues program, WCAHS is identifying key occupational health and safety issues of the cannabis industry. The project enrolled 29 workers from two cannabis cultivation facilities. Participants were mostly white and Latino men under 30, with a median of 26 months of employment in the cannabis industry. Symptoms potentially suggestive of asthma were reported by 38% of participants, and work-related respiratory, nasal, eye, or dermal symptoms were reported by 38% of participants.

Outputs from the project include outreach materials, and a manuscript for publication in a peer-reviewed journal, which is in preparation. The cannabis investigator team was awarded a rapid response grant to convene a virtual meeting with the goal of bringing together cannabis industry occupational health and safety stakeholders to identify the most critically needed research, regulatory, and educational actions to prevent occupational illness and injury among cannabis workers. The meeting “Cannabis Industry: Setting Priorities for Occupational Health” was held on July 22, 2021 and attended by 45 participants. An op-ed summarizing the needs identified during the presentations and focus groups is in preparation.

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 received 20 proposals for the 2020–2021 funding cycle, of which [five were funded](#). An RFA was released in spring 2021 for short-term projects for which 18 proposals were received and [11 were funded](#).

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 screening of PM samples from three agricultural regions of California and several major wildfires has been completed. 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. 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. 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.

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 has guarded against reinfestation by harmful nematodes while promoting increased levels of plant nutrients in treated soils. Data from almond trees grown in biosolarized soils indicated that trees required time to adapt to treated soils before the growth rate improved. As a result, studies were conducted to examine strategies for decreasing the remediation time for soils following biosolarization. The amount and particle size of almond hulls and shells incorporated into the soil ahead of biosolarization were identified as key factors for controlling the remediation time. Furthermore, experiments have captured and profiled volatile compounds released during biosolarization to identify those that may contribute to pest inactivation and to gauge the relative exposure risk for workers near biosolarized fields. Volatile fatty acid and ketone compounds were prominent, with some identified compounds being known biopesticides. All detected volatile compounds with defined exposure limits were measured at levels far below those limits, indicating minimal safety risk for agricultural workers—in contrast to the much greater toxicity of conventional soil fumigants. 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 were explored. Residues from commercial onion processing showed promise for effective pest control in early laboratory studies that simulate biosolarization in soil bioreactors. 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: Investigators have been working on developing the second prototype of the harvest aid to simulate various speeds and field configurations. The system will allow semi-continuous harvest by workers. Progress was made into this system prior to the COVID-19 pandemic and campus shutdown; however, due to campus restrictions, limited in-person activities took place after mid-March of 2020, and most interactions have been virtual/online (via Zoom, phone, internet, etc.). Recently, starting in August 2021, in-person research activities have resumed on campus, and the research team has resumed building the harvest simulation system. During this period, the personal robot harvest aid has been updated, where the robot/personalized picking system can be used with a standard strawberry picking cart. Limited testing of the system occurred within the restrictions of COVID-19 campus and county guidelines. 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 strawberry harvesting workers.

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.

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.

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.

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 66,000 pocket cards.

A manuscript titled “Compensation incentives and heat exposure affect farm worker effort” is in revision for publication in PLoS ONE. 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.

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 2020–2021

Continuous Surveillance of Agricultural Workers Occupational Health and Injuries

Tim Beatty, PhD, UC Davis

The Impact of LCN2 in the Lung Inflammatory Response to Agricultural Dust Exposure

Stephanie Guardado, PhD candidate, UC Riverside

Evaluating the Stability of Agricultural All-Terrain Vehicles

Farzaneh Khorsandi, PhD, UC Davis

Examining the Impact of Nanopesticides and Nanofertilizers on Farmworker Safety

Sanjai J. Parikh, PhD, UC Davis

The Effects of Air Quality on Economics of Farm Worker Productivity

Daniel A. Sumner, PhD, UC Davis

Funded Rapid Response Projects 2020–2021

Student Outreach Clinic – Fall Harvest

Gerald Ackerman, University of Nevada, Reno School of Medicine

Pandemic and Wildfire Smoke Safety Project (PAWSS)

Agriculture and Land-based Training Association (ALBA)

Chemico-Toxicological Assessment of Potential Impacts of Wildfire Emissions on Farmworker Health

Keith J. Bein, PhD, UC Davis

Potential Risks to Wearers of Face Masks: Inhalable Particulates from Facial Mask Debris from New Face Masks

Shiori Echizenya, student, UC Davis School of Veterinary Medicine

Promotion of Naturally Occurring Biopesticides from Date Industry By-products to Reduce Workers Exposure to Chemical Fumigants

Jesus D. Fernández-Bayo, PhD, UC Davis

Agricultural Use of 1,3-Dichloropropene and Emergency Department Visits for Asthma in California from 2013 to 2017

Robert Gunier, PhD, MPH, UC Berkeley

Workplace Burden of Valley Fever

Savannah Hunter, MA, PhD candidate, UC Davis

Understanding COVID-19 Testing and Vaccine Access for Daytime Farmworkers in Imperial County

Adrienne (Annie) Keeney, PhD, San Diego State University

Occupational Exposure to Antibiotic Resistant Bacteria in Poultry Farming

Xunde Li, PhD and Xiang (Crystal) Yang, PhD, UC Davis

Agricultural Worker Exposure to Wildfire Smoke Pollution in California During the 2020 Fire Season

Miriam E. Marlier, PhD, UCLA Fielding School of Public Health

Cannabis Industry Occupational Health and Safety Stakeholder Meeting

Marc Schenker, MD, MPH, UC Davis

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.

Small Grants for Outreach-Specific Activities

WCAHS launched a small grant program specific to outreach activities in 2018 to expand and enhance the topical and regional reach of WCAHS and facilitate stronger collaboration between University of California Cooperative Extension personnel, academic and private educators, and community organizations.

The Outreach Small Grant Program funded [three proposals](#) for the 2020–2021 funding cycle.

Funded Outreach Small Grant Projects 2020–2021

- Hawaii Agricultural Safety Webinar Series; AgSafe, Modesto, CA
- Agricultural Supervisor Training; California Farm Labor Contractor Association, Sacramento, CA
- Developing, Implementing, and Evaluating an Outreach Program Regarding Agricultural All-Terrain Vehicle Safety; Farzaneh Khorsandi, PhD, UC Davis