A. COVER PAGE

Project Title: Upper Midwest Agricultural Safety and Health (UMASH) Center	
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Human Subjects: Yes HS Exempt	**Vertebrate Animals:** N/A
hESC: N/A	**Inventions/Patents:** N/A

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The Upper Midwest Agricultural Safety and Health Center (UMASH) is a multidisciplinary Center of Excellence in Agricultural Disease and Injury Research, Education, and Prevention. UMASH is a collaboration of the University of Minnesota School of Public Health, University of Minnesota College of Veterinary Medicine, University of Minnesota School of Medicine, National Farm Medicine Center of the Marshfield Clinic, Migrant Clinicians Network, and the Minnesota Department of Health. UMASH has used its unique multidisciplinary expertise to primarily focus on worker health and safety issues related to animal agriculture production. The central theme of UMASH is to promote a One Health philosophy that emphasizes the connections between human health, animal, and plant health and the health of the environment for addressing the changing health and safety conditions for the people who are feeding the nation and the world. The long-term objective of the UMASH center is to improve the health and safety of agricultural workers and their families. The objectives of the proposed center activities are to apply multidisciplinary solutions to create and translate new knowledge for addressing agricultural health and safety concerns relevant to the Upper Midwest, the country, and the world. The specific aims of UMASH are to:

Aim 1. Continue to leverage the multidisciplinary expertise of the UMASH partnerships to build regional capacity agricultural health and safety.

Aim 2. Conduct research that applies innovative approaches to the complex agricultural health and safety concerns in the Upper Midwest.

Aim 3. Engage a multidisciplinary network of stakeholders to understand agricultural health and safety from the context of those affected most.

Aim 4. Identify and respond to emerging issues identified through the stakeholder networks.

Aim 5. Conduct outreach and engagement to actively translate the knowledge generated from UMASH and other sources to stakeholders.

Aim 6. Collaborate with other NIOSH funded centers to improve the impact of the NIOSH AFF program.

B.2. What did you accomplish under these goals?

Over the last funding cycle, our evaluation and planning, emerging issues, outreach, and research efforts have been successful in improving agricultural health and safety for those in the Upper Midwest. UMASH has worked to address topics like needlestick injuries, zoonotic disease in agritourism, mental health and stress, and aging on the farm. We've collaborated with community health workers to support immigrant farmworkers. We've cultivated partnerships between rural firefighters and farmers to promote farm safety. Our research has resulted in novel approaches for assessing and preventing occupational injuries and illness in our region and beyond. The following describes an overview of our activities to coordinate and administer the Center, conduct outreach, respond to emerging issues, and engage in innovative research.

Center Coordination and Administration

External Advisory Board. Our seventeen member UMASH external advisory board (EAB), with representatives of agriculture producers, agriculture workers, state departments of agriculture and labor and industry, agricultural extension, health departments, medical care providers, veterinarians, not-for-profit organizations, Mexican Consulate, and a currently funded NIOSH Agriculture Center, provided valuable insight and recommendations to Center researchers and outreach staff. With the support of the Advisory Board, UMASH organized several topic-focused discussions (via conference/web) with sub-groups of the Advisory Board during which updates were presented on the Center activities and research projects related to specific industry topics (e.g., dairy, swine), feedback and questions were sought, and input was solicited about

emerging issues. This topic-focused approach was effective in engaging the advisory board members in the discussions that were most relevant to their background and expertise and provided a cost-effective platform for presentations and discussions given the geographic distribution of the board. Many Advisory Board members also participated in evaluation processes to provide input on coverage and gaps in engaging stakeholders.

Annual Meetings and Networking. UMASH convenes Center meetings quarterly where all investigators and staff are invited to network with one another, provide support and updates, and engage in evaluation and planning. Additionally, each year, UMASH plans an Annual Event where Center investigators, staff, EAB members, and persons outside UMASH have an opportunity to hear of the UMASH activities and listen to the results of UMASH projects or works in progress. For example, UMASH co-hosted the National Occupational Research Agenda (NORA) Symposium with the Midwest Center for Occupational Health and Safety in 2021. Dr. Michael Osterholm and a panel of occupational health experts discussed the impact of COVID-19 on the workplace with over 500 registrants. Additionally, UMASH previously hosted several Annual Forums around selected emerging issues to identify key stakeholders, share what we know about the issue, and strategize about possible interventions. Previous Forums have focused on stress and mental health, antimicrobial resistance, aging on the farm, and occupational medicine.

Evaluation and Planning. The Evaluation and Planning team has successfully 1) engaged in Center-wide and strategic planning, coordination, implementation, and evaluation to ensure appropriate management of Center resources, activities, budgets, records, and reports, 2) collaborated with and contributed to other Agricultural Centers and NIOSH to enhance and demonstrate the impact of the NIOSH Agricultural Center program, and 3) facilitated bidirectional communication and collaboration between internal UMASH partners and external stakeholder to enhance the overall effectiveness of the Center. A strategic planning process and Center-wide needs assessment was conducted to highlight Center strengths, identify areas of opportunity, and create an updated UMASH Strategic Plan. This team has provided support for Outreach, Research, and Emerging Issues cores to enhance coordination and support evaluation capacity. Finally, there are many examples of this team's collaboration and coordination with other US Ag Centers and leadership on Evaluation, Collaboration, and Outreach (ECO) meetings, such as coordinating and evaluating the National Farm Safety and Health Week (NFSHW) campaign, participating in the NIOSH contribution analysis process, and co-authoring a manuscript describing and analyzing data from the Ag Centers' collaborative YouTube channel (Beseler, et al. 2021).

Outreach:

The UMASH outreach team engaged in over 240 events over the course of the funding cycle, across 6 states in more than 30 cities. These events were attended by tens of thousands of people, and UMASH documented direct engagement with more than 1,500 attendees. Team members and project staff have attended, presented, and/or exhibited at 170 meetings and conferences, participated in, or conducted more than 226 outreach events such as oral, poster, panel, keynote presentations and meetings, created over 30 publications, hosted 12 training and education events, created hundreds of products, such as fact sheets, posters, hand-outs, flyers, videos, training curricula, and sent almost 350 email communications. UMASH leverages new technology and digital platforms such as the UMASH website, YouTube channels, and social media (Facebook, Twitter, Instagram, and LinkedIn) to grow our reach and engagement with agricultural health workers and those that serve them, with notable growth across all platforms.

The Telling the Story Project (a collaboration between UMASH, the Great Plains Center for Agricultural Health (GPCAH), and the Central States Center for Agricultural Safety and Health (CS-CASH), has received extensive print, online and broadcast media attention including US News & World Report, Nebraska, and Iowa public television and an editorial in the Omaha World Herald. The project website provides easy access to the stories 24/7/365. Discussion guides created for the stories are being promoted to agricultural educators for classroom use.

Emerging Issues:

The challenges faced by the agricultural workforce are dynamic. The goal of the UMASH Emerging Issues Program enables UMASH to be nimble enough to identify and respond to emerging or re-emerging issues that may impact the health and well-being of the agricultural workforce and their families. To support these activities, the UMASH advisory board is key in identifying emerging issues across the region and providing suggestions to address the topic(s).

Stress, Resilience, and Mental Health. One of the most prominent and underappreciated occupational hazards of being a farmer or farmworker is the accompanying stress due to forces of economics, climate, and the changing agriculture landscape. UMASH has seized the opportunity of a developing system-wide interest in mental health in agriculture to connect partners with interest in the issue. In June 2018, in collaboration with the Minnesota Department of Agriculture, we held the Building Resilient Agricultural Communities Forum (http://umash.umn.edu/agresilience/) to bring people from multiple sectors together to explore issues, identify challenges, brainstorm innovative solutions, and stimulate partnerships. The forum was highly successful, and UMASH established three Partnership Projects (http://umash.umn.edu/stress/) as a result of the forum: 1) Expanded the Gear Up for Ag Program, a health and safety program for college agriculture students to include tools for teaching about stress, mental health, and resiliency, 2) Initiated Cultivating Resiliency for Women in Agriculture, which focuses on collecting early stress detection data from farmers, in particular female farmers, and a 6-part interactive webinar series and 3) Using Stories and Education to Build Resilient Agricultural Communities, which is an extension of a successful National Alliance on Mental Illness program to specifically target the farming community. The reception of these partnership projects was overwhelmingly positive. A number of additional informational products have been generated as spin-off activities of our efforts on this important emerging issue. An added benefit to addressing mental health and stress is that as a pressing concern of many in the agriculture community, it has opened a number of doors for collaboration on the overall health and well-being of farmers and farmworkers. We anticipate continuing to contribute to the complex problem of stress and mental health as our limited resources allow, which, we believe, will also enhance the impact of the other work of UMASH and its partners.

Manure Management. Other emerging issues projects include manure management. A 2019 survey of manure applicators conducted in collaboration with the University of Minnesota Extension resulted in research findings indicating the hazards associated with the application of manure, which was published in the Journal of Agromedicine in 2022 and shared in a webinar for the Livestock and Poultry Environmental Learning Community. Further, UMASH has developed a Manure Safety Toolkit (http://umash.umn.edu/spotlight-manure-safety-toolkit/), aggregating resources and best practices for farmers, custom applicators, and others involved in this work. Additional safety and health resources are being developed to support the needs of manure applicators.

Antimicrobial Resistance. In 2020, two groups completed their partner projects on antimicrobial resistance (AMR), following funding and support from UMASH and the 2019 Annual Forum. This included colleagues from North Dakota State University to understand if large-animal veterinarians are at an increased risk of antimicrobial-resistant bacterial carriage. This study identified a high prevalence of both MRSA and MRSP carriage among veterinary professionals, with a manuscript being prepared for publication. The Ag Health and Safety Alliance received funding to review existing college-level AMR resources, develop new content for agriculture and veterinary courses, evaluate the effectiveness of the AMR curriculum, and analyze survey data to understand the safety behaviors and the risk of AMR infections and prevention methods. Two hundred ninety-nine students were pilot tested, and self-reported agricultural tasks with potential exposures were identified. Many students found value in receiving PPE and highlighted the need for educational outreach around AMR and zoonotic exposures among young adults working with livestock. Ag Health and Safety Alliance is seeking additional funding to support the training of veterinary technicians.

Aging on the Farm. As the average age of the farmer in the United States approaches 60, and as many continue to live and work on the farm, support and resources are needed. In 2020, UMASH hosted two Aging on the Farm community forums and funded four partner projects, including:

- University of Minnesota Occupational Therapy (OT) created six individualized telehealth OT sessions to provide OT services to rural farmers and delivered two webinars about successful aging-in-place on the farm that are now available on demand.
- Rural Minnesota Memory Loss Connection - Big Stone created 25 memory loss kits, available at a local library to be checked out by community members, to bring back memories of life on the farm for rural farmers with dementia.
- Active @ Home, a collaboration between the American Parkinson Disease Association and University of Wisconsin Occupational Therapy, created and mailed out 30 toolkits containing items like stretchy bands, putty, stretch straps, and support blocks to assist participants in developing an exercise and stretching routine and offered telehealth OT programming to rural Wisconsin farmers living with Parkinson's disease to improve their physical and mental wellbeing.
- Healthy Aging on the Farm, a collaboration between United Church of Christ- Zumbrota and The Normandale Center for Healing and Wholeness, learned from farmers about their current support systems, thoughts, and concerns about aging on the farm and tangible ways that other community members can help them with activities of daily living and farm activities that become harder with age.

These partner projects leveraged their professional, academic, and community networks to form transdisciplinary collaborations and create innovative solutions for aging in place on the farm. Each project has plans to build upon its success, and UMASH plans to continue and expand upon this work.

Stress And Infectious Agent Shedding In Livestock. Agricultural fairs serve as important cultural events for local communities and farm economies, while developing youth skills. They also present an increase in animal-to-animal contact and human-to-animal contact and an increased opportunity for zoonotic disease transmission. Cattle are natural reservoirs for Shinga toxin-producing E. coli (STEC), and higher levels of shedding (the release of bacteria or viruses from a body) occur in the summer. It has also been hypothesized that stress increases shedding, but that relationship has not yet been quantified because measurements of cortisol, a stress hormone, have not been collected. This continuing study explores transportation to fairs, the activities associated with showing cattle at fairs, and whether these activities are associated with increased cattle stress.

Research Projects:

Monitoring Zoonotic Diseases in Minnesota Agricultural Workers, Their Families and Those Who Engage in Agritourism. Over the course of the last five years, this project has compiled and published the most systematic and comprehensive dataset and analysis of the burden of enteric zoonotic disease from food animal agricultural exposures anywhere (Klumb et al. 2020). Illnesses caused by *Cryptosporidium*, *E. coli* O157:H7 and other Shiga toxin-producing *E. coli* (STEC), *Campylobacter*, and *Salmonella* infections are reportable to the Minnesota Department of Health (MDH). All ill people are interviewed with a questionnaire that includes questions about agricultural exposures (i.e., living on, working on, or visiting a farm, petting zoo, fair, or another venue with animals). Since 2012, patients who report a food animal agriculture exposure have been re-interviewed with a more detailed questionnaire about their interactions with the animals. From 2012-2019, there were 12,999 laboratory-confirmed illnesses among Minnesotans that were eligible for the study. Of these, 3,019 (23%) reported an animal agriculture exposure in Minnesota proximately preceding illness. Sixty-two percent of ill people with an animal agriculture exposure reported living and/or working on a farm, 28% reported visiting a private farm, and 10% reported visiting a public animal agriculture venue. From October 2020-September 2021, there were 1,662 laboratory-confirmed illnesses among Minnesotans that were eligible for our study. Of these, 304 (18%) reported an animal agriculture exposure in Minnesota before their illness, and 62% reported living and/or working on a farm. MDH also investigates animal-contact-related outbreaks. MDH epidemiologists provided education to the farm owners and families of ill children on private farms. Providing these tailored, one-on-one consultations has become a larger part of the work we do to help prevent these outbreaks from occurring. Additional outreach activities have been conducted as a result of the research findings. Educational

videos have been produced and disseminated, such as a handwashing instructional video and agritourism awareness video. This project also facilitated in-person Agritourism Workshops co-hosted by the Minnesota Department of Agriculture, which included information about human-animal interactions and food and beverage licensing, as well as online Safer Farm Animal Contact Exhibits (Safer FACEs) modules, which included information about human-animal interactions, handwashing, and visitor education and signage. These activities have been well-received by participants. For example, after participating in the Agritourism Workshop, North Star Farm Tour, an agritourism collective in the Upper Midwest, added health and safety as a priority and amended their bylaws so that all members are trained.

Longitudinal Study of Infectious Disease Risks at the Human-Swine Interface. The importance of the human-animal interface, or the ways animals and humans can interact, as a source of emerging infectious diseases is universally recognized. People having regular animal contact are at the front line for exposure to known and emerging pathogens, and veterinarians provide a unique window into occupational risks for emerging zoonotic diseases. A 5-year longitudinal cohort study of U.S. swine veterinarians has been conducted to understand the exposure and health risks attributable to pig exposure for three important emerging zoonotic pathogens that are endemic in the U.S. swine industry: 1) Livestock-associated *Staphylococcus aureus* (including Methicillin-resistant *S. aureus* (MRSA) and multidrug-resistant *S. aureus*); 2) Influenza A viruses; 3) Hepatitis E virus. A control group of companion animal veterinarians without contact with swine was included to compare exposure and health risks and to calculate risks attributable to swine exposure. There was a higher prevalence of *S. aureus* (approximately two-fold) and MRSA (approximately four-fold) in swine vets (SV) compared to companion animal vets (CAV). Isolates from swine vets were dominated by livestock-associated variants, which were uncommon in CAV. Only three individuals – two swine vets and one companion animal vet – reported clinical *S. aureus* infections that were medically confirmed. None were MRSA, and all were minor localized infections. Similarly, there was no indication of an elevated risk of influenza-like illnesses or hepatic disease. While swine veterinarians have a greater potential for exposure to *S. aureus* of animal origin, there is no evidence that they are at higher risk of infection. The risk of injury was similar between companion animal and swine veterinarians.

Optimizing Assessment of Virus-Containing Particles in Animal Agriculture. This study indicates that a two-sampler strategy may be optimal during zoonotic influenza outbreak investigations in animal agriculture facilities. Using a high-flow, non-sizing sampler initially is the best option for detecting airborne viruses at low concentrations. Then, if viruses are detected, sampling with a lower-flow, size-separating sampler will provide the most accurate measurements of airborne virus concentrations and sizes. To meet this second need, the project team designed and fabricated an intermediate-flow, size-separating Bioaerosol Cascade Virtual Impactor (BCVI) to improve assessment of airborne viral particle concentrations and sizes. Its flow rate is ten times higher than existing size-separating samplers for viral aerosols, meaning that the sampler will be able to collect enough genetic material and viable viruses for analyses much more quickly than existing samplers. The research is helping to determine the best ways to sample airborne viruses, not only influenza viruses in animal agriculture operations but also other types of viruses in other settings. In particular, the methods being developed in this study will be applicable in non-agricultural spaces and with other viruses such as SARS-CoV-2. A key use of the sampler and sampling protocols developed in this study will be to more rapidly determine if a potential pandemic agent may be transmissible through aerosols. This will benefit not only workers in animal agriculture, but workers and the public everywhere. Additionally, knowing more about the concentrations and sizes of influenza viruses and other pathogens in animal agriculture operations and elsewhere will help researchers and practitioners determine the most appropriate control technologies to reduce exposure to viral aerosols.

Rural Firefighters Delivering Agricultural Safety and Health (RF- DASH). Firefighters are trusted leaders in rural and agricultural communities, and strong partnerships between firefighters and farmers can help make farms safer. RFDASH equips firefighters and Emergency Medical Services (EMS) personnel to share agricultural health and safety knowledge in their communities. RFDASH quickly surpassed its recruiting goals and has now

trained over 70 hazard analyst trainers in over ten states, expanding well-beyond its Upper Midwest borders. These trainees have gone on to educate many additional personnel, mentioning at least 478 unique contacts as captured through the team's Social Network Analysis (SNA) methods. The media has picked up on the success of this program, with articles in key agricultural outlets and the fire/EMS industry. Trained trainers have effectively implemented RFDASH prevention tools and methods in the field as evident by the rise in usage of the online tools www.saferfarm.org and www.farmmapper.org. To meet the requests of the trainers and EMS communities, the project team has developed a website (rfdash.org), textbook, and other training materials to enhance the sustainability and impact of the program. Existing RFDASH trainers and their local communities are building upon the program to better make both farmers and emergency responders safer.

Promoting Safety and Worker Health for Immigrant Dairy Workers. This project uses the award-winning *Seguridad en las Lecherias* educational model that includes worker training and *promotores de salud* (or Community Health Workers) to reduce worksite hazards and to improve worker knowledge and practices. The project team partnered with Community Health Services Inc. to provide health screenings, health services, safety and health information to dairy workers, farmers, and their families in conjunction with their mobile clinics on farms in southeastern Minnesota. Nineteen farms are enrolled in the project, with 360 workers receiving health and safety training. Through collaboration with the School of Public Health Industrial Hygiene faculty and graduate students and Veterinary Public Health and Preventive Medicine Residents, veterinarians have been engaged to develop a tool for veterinarians to assess safe animal handling practices and infectious disease exposures on dairies, ultimately providing tangible farm assessments to producers in a simple, understandable format. Community and industry leaders (e.g., dairy inspectors, dairy supply sales, nutritionists) have also been engaged to raise awareness and support farm recruitment. When COVID-19 restricted on-farm access to dairy farms in Minnesota, regular communication and engagement with dairies continued. The project team focused efforts to support dairy producers, workers, and farm families with information and access to COVID-19 testing and vaccinations through our University and State partners, with specific outreach to immigrant dairy workers. The team also collaborated with UMN Medical School researchers to conduct a survey of dairy farmers regarding their response, prevention, and biosecurity practices during the pandemic (Yung et al., 2021). The project continued regular communication and engagement on related health issues (i.e. mental health resources) by providing Spanish interpretation. With approval, we were able to resume health and safety trainings in Spanish for immigrant dairy workers in Minnesota and we have expanded this research project to dairies in Wisconsin and South Dakota. The *Seguridad* curriculum was updated, printed, and assembled for the implementation of the Community Health Workers Program on dairy farms. Additional training and outreach materials in English and Spanish have also been developed to meet the expressed needs of workers and producers engaged throughout the project.

Assessing and Preventing Work Related Injuries in Animal Agriculture. This project has engaged key industry partners and experts in animal agriculture (i.e., swine production, dairy operations) to characterize the burden of injury, identify opportunities for prevention, and evaluate progress in controlling injury. With data from larger pork production companies and worker compensation insurance carriers, this project team characterized major injury types and potential opportunities for intervention. The identified areas of focus in swine operations include injuries due to interactions with animals, needlestick injuries, lower extremity injuries, and injuries related to power-washing. The project team also evaluated worker compensation claims data reported to the Minnesota Department of Labor and Industry to explore a broader cross-section of injuries to swine and dairy workers. The results of these analyses from different sources are being compiled to communicate to and review with industry partners to identify opportunities for prevention and future directions. This project highlights two potential avenues for reducing animal interaction injury frequency and burden 1) improving animal handling techniques and 2) reviewing practices and available resources for returning injured workers to work. The findings of this project have prompted UMASH to develop new resources such as swine handling training and needlestick prevention materials.

Overall, over the course of the last funding cycle, UMASH has engaged in effective administration, outreach, and research to address the health and safety of agricultural workers, families, and communities in the Upper Midwest.

B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

The following list includes a subset of professional development opportunities provided throughout the grant:

- International Society for Agricultural Safety and Health Conference
- Midwest Rural and Agricultural Safety and Health Conference
- Continuing Education (AgriSafe webinars, IRB Lunch and Learn, NIOSH Extramural presentations, University of Minnesota Communicators Forum)
- Evaluator, Coordinator, Outreach (ECO) Group
- Hiring and mentoring/developing student employees
- Regional meetings and trainings such as: Women in Ag Network, Minnesota Department of Health Emerging Issues Meetings

B.5. How did you disseminate the results to communities of interest?

UMASH leverages a number of strategies to disseminate resources and information to our stakeholders and target audiences which include in-person outreach events, a robust digital presence, incorporating suggestions from our advisory board (e.g. webinars with Professional Dairy Producers Workers of Wisconsin, stress and mental health concerns with COVID-19 and animal depopulation), and developing strong connections with key organizations across our region who inform and amplify the work of our center. We leverage digital technology to provide timely, relevant, and usable information to stakeholders and target audiences across our region (and beyond). Our website provides 24/7/365 access to resources and is frequently updated with news, events, In the Field updates (highlighting many of UMASH's outreach efforts), Spotlight Stories, which feature an in-depth look at a project, person, or resource in agricultural health and safety. Weekly email blasts highlight these and other timely information and resources such as the Farm Safety Check topics, Signs and Symptoms of Stress resource, education and training videos, safety posters, fact sheets, etc. We have an active presence on social media (Facebook, Twitter, LinkedIn, YouTube, Instagram) where these and other relevant news and safety resources are shared.

Our outreach team continues to build and strengthen relationships with key stakeholders and communications staff through in-person, email, and social media communication channels which have led to more organizations (commodity groups, extension, professional farm organizations, agricultural media, agriculture educators, women in agriculture groups, etc.) mentioning UMASH and sharing our content and inviting UMASH to participate in future events. We use monthly targeted ads on social media and occasional ads in print or online publications to increase the visibility and reach of our center and resources. We actively seek out educational workshops and other events to offer UMASH resources to event organizers for sharing with attendees. Further, we engage with academic and research institutions to enhance our reach, understanding, and collaboration by presenting at conferences and publishing peer-reviewed manuscripts in academic journals.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

N/A

C. PRODUCTS

C.1. Publications, conference papers, and presentations

Publications:

UMASH Center & Outreach Core

- Charlier, Devon, et al., (06/2022)."Assessing Self-reported Occupational Hazards of Manure Applicators in the Upper Midwest", Journal of Agromedicine, https://doi-org.ezp2.lib.umn.edu/10.1080/1059924X.2022.2089423
- Schossow, Megan, et al., (04/2022)."Building Resilient Agricultural Communities: A Process for Addressing Mental Health Challenges in Agricultural Communities", Journal of Agromedicine, https://www.tandfonline.com/eprint/QZMUEYTEGGP4XA8UGDHQ/full?target=10.1080/1059924X.2022.2058138
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- Swenson, Rebecca, (07/2018), "Safely through the Gate: Exploring Media Coverage and Journalists Decisions on the Flow of Farm Safety Stories", Journal of Applied Communications, https://doi.org/10.4148/1051-0834.1840

Evaluation Core:

- Charlier, Devon; Hall, Suness; Kinzer, Hannah; LaVelle, John. (in preparation). Integrating Evaluation into a University-Based Research Center: Triangulating on Graduate Students' Experiences.
- Schossow, Megan; Charlier, Devon; Hall, Suness; Bender, Jeff. (2022). "It Takes a Village: A Novel Process for Responding to Emerging Issues in Agricultural Health and Safety", Journal of Agromedicine, DOI: 10.1080/1059924X.2022.2147114
- Beseler, Cheryl L.; Crawford, Kathryn J.; Charlier, Devon E.; & Ramos, Athena K. (2021). "The NIOSH Agricultural Centers' YouTube Channel: Time Series Modeling of Viewership of Agricultural Health and Safety Videos", Journal of Agromedicine, https://doi.org/10.1080/1059924X.2021.2000907

Surveillance for Zoonotic Diseases in Agricultural Workers in Minnesota II:

- Lehnertz NB, Wang S, Garfin J, et al. (2021). Transmission Dynamics of Severe Acute Respiratory Syndrome Coronavirus 2 in High-Density Settings, Minnesota, USA, March–June 2020. *Emerging Infectious Diseases*. 27(8):2052-63. doi:10.3201/eid2708.204838.
- Waltenburg, MA.; Rose, CE.; Victoroff, T et al. (2021). Coronavirus disease among workers in U.S. food processing, food manufacturing and agriculture workplaces. *Emerging Infectious Diseases*, https://doi.org/10.3201/eid2701.203821.
- Klumb, C., Scheftel, J.M., & Smith, K. (2020). "Animal agriculture exposures among Minnesota residents with zoonotic enteric infections 2012–2016", *Epidemiology and Infection*. 148:e55. https://dx.doi.org/10.1017%2FS0950268819002309.
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Presentations

UMASH Center & Outreach Core

- Bender, Jeff. CS-CASH Grand Rounds. Oral/podium presentation. CS-CASH. Omaha, NE. 09/2022.
- Ploekelman, Melissa; Heiberger, Scott; Charlier, Devon; Leonard, Stephanie; Duysen, Ellen; Palm, Kelsey; Rautiainen, Risto; Yoder, Aaron; Schossow, Megan. Telling a Story to Save a Life - Creating an Impactful First Person Narrative. Oral/podium presentation. International Society for Agricultural Safety and Health. Fort Collins, CO. 06/2022.
- Ploeckelman, Melissa; Charlier, Devon; Edlund, Cassandra; Irvine, Kelsey; Heiberger, Scott; Wickman, Amanda; Schossow, Megan. Get your science shared by building a Media Toolkit. Oral/podium presentation. International Society for Agricultural Safety and Health. Fort Collins, CO. 06/2022.
- Galvan, Alma; Liebman, Amy. Diversity, Equity, Inclusion, and Justice Workshop. Oral/podium presentation. International Society for Agricultural Safety and Health Conference 2022. Fort Collins, CO. 06/2022.
- Bender, Jeff.Highly Pathogenic Avian Influenza (HPAI) Outbreaks: A One Health Perspective. Oral/podium presentation. NORA AgFF Spring 2022 Meeting. 05/2022.
- Maddock, Kelli. Carriage of Antimicrobial Resistant Flora and Enteric Pathogens Among Veterinary Professionals. Oral/podium presentation. National Occupational Research Agenda Symposium. Virtual. 05/2022.
- Edlund, Cassandra. A Strategic Approach to Assessing and Leveraging Resources. Oral/podium presentation. National Occupational Research Agenda Symposium. Virtual. 05/2022.
- Bender, Jeff. The Changing Nature of Work: Impacts of COVID-19 on our Health Care Workforce. National Occupational Research Agenda Symposium. Virtual. 05/2022.
- Schossow, Megan. Women in Agricultural Leadership. Oral/podium presentation. Women in Agricultural Leadership Conference. Chaska, MN. 04/2022.
- Schossow, Megan. Managing Assets: Keeping People on the Farm Healthy. Oral/podium presentation. Wisconsin AgrAbility Summit 2022. Cashton, WI. 04/2022.
- Yoder, Aaron; Duysen, Ellen; Charlier, Devon; Heiberger, Scott; Ploeckelman, Melissa; Leonard, Stephanie. Telling the Story: How one farmer's story provided impactful worker training and outreach. Poster presentation. North American Agricultural Safety Summit. Las Vegas, Nevada. 03/2022.
- Schossow, Megan. Risk on the Farm. Oral/podium presentation. Han San Lake Insurance Annual Meeting 2022. Maple Lake, MN 03/2022.
- Bender, Jeff. Safety Talk with Minnesota Soil. Panel discussion. Minnesota Soil Meeting. Elk River, MN 03/2022.
- Bender, Jeff. Food Safety with Manure. Oral/podium presentation. UMN Extension Food Safety Meeting. 03/2022.
- Schossow, Megan and Peterson, Carol. Breaking: Safety is Sustainable. Webinar. Minnesota FFA Ag Communications Career Development Events and Leadership Conference. Virtual. 12/2021.
- Schossow, Megan; Ploeckelman, Melissa; Davidson, Jana. You've Got Mail: emailing your audience and measuring success. Panel discussion. 2021 Midwest Rural and Agricultural Safety and Health Conference. Virtual. 11/2021.
- Schossow, Megan. Drought and Agricultural Health. Oral/podium presentation. Washington County Water Consortium - September Meeting. 09/2021.

- Schossow, Megan. Collaborative Centers: Co-branding at US Ag Health and Safety Centers. Oral/podium presentation. NIOSH Extramural Communications meeting. Virtual. 08/2021.
- Bender, Jeff. Zoonotic Disease and Food Safety on the Farm. Oral/podium presentation. Healthy Harvest Fall Field Day. Aitkin, Minnesota 08/2021.
- Schossow, Megan. Minnesota Agricultural Cooperative Safety Directors. Oral/podium presentation. Minnesota Agricultural Cooperative Safety Directors Quarterly July Meeting. Spicer, Minnesota. 07/2021.
- Charlier, Devon; Ploeckelman, Melissa; Schossow, Megan. Collaborative Campaigns: Understanding Impact. Oral/podium presentation. 2021 International Society for Agricultural Safety and Health Conference. Virtual. 06/2021.
- Gibbs, Jenna; Sheridan, Carolyn; Brihn, Gus; Sullivan, David; Walls, Kayla. Protecting Livestock Workers, Their Families, and Animals from Zoonotic Disease: Evaluation of New AMR Curriculum in the Gear Up for Ag Program. Oral/podium presentation. 2021 International Society for Agricultural Safety and Health Conference. Virtual. 06/2021.
- Charlier, Devon; Schossow, Megan. Partnering in Mental Health Support. Oral/podium presentation. 2021 International Society for Agricultural Safety and Health Conference. Virtual. 06/2021.
- Schossow, Megan; Olson, Averi; Bender, Jeff. Aging on the Farm. Oral/podium presentation. 2021 International Society for Agricultural Safety and Health Conference. Virtual. 06/2021.
- Charlier, Devon; Wilson, Melissa; Modderman, Chryseis; Cortus, Erin; Janni, Kevin; Peterson, Carol; Schossow, Megan; Bender, Jeff. Assessing Occupational Risks of Manure Applicators in the Upper Midwest. Oral/podium presentation. 2021 International Society for Agricultural Safety and Health. Virtual. 06/2021.
- Charlier, Devon; Wilson, Melissa; Modderman, Chryseis; Cortus, Erin; Janni, Kevin; Peterson, Carol; Schossow, Megan; Bender, Jeff. Assessing occupational risks of manure applicators in the Upper Midwest. Poster presentation. National Occupational Research Agenda (NORA) Symposium. Virtual. 05/2021.
- Sellman, Jonathan. COVID-19 in the Workplace: Creating Safe Workspaces. Panel discussion. National Occupational Research Agenda (NORA) Symposium. Virtual. 04/2021.
- Sheridan, Carolyn; Gibbs, Jenna; Brihn, Gus; Walls, Kalya; Sullivan, David. Protecting Livestock Workers, Their Families, and Animals from Zoonotic Disease: Evaluation of New AMR Curriculum in the Gear Up for Ag Program. Poster presentation. National Occupational Research Agenda (NORA) Symposium. Virtual. 04/2021.
- Olson, Averi; Schossow, Megan; Gaugler, Joseph; Bender, Jeff. Aging on the Farm: Supporting Healthy Aging Across the Lifespan. Poster presentation. National Occupational Research Agenda (NORA) Symposium. Virtual. 04/2021.
- Olson, Averi; Haskins, Tara; Pickett, Kristen; Mullins, Amy. Parkinson's Disease and Aging in Agriculture. Webinar. AgriSafe & UMASH Continuing Education Webinar. Virtual. 04/2021.
- Schossow, Megan. Aging on the Farm. Oral/podium presentation. North American Agricultural Safety Summit. Virtual. 03/2021.
- Schossow, Megan. Tools of the Trade: Dairy Producer Training Guides. Oral/podium presentation. North American Agricultural Safety Summit. Virtual. 03/2021.
- Charlier, Devon; Wilson, Melissa; Modderman, Chryseis; Cortus, Erin; Janni, Kevin; Peterson, Carol; Schossow, Megan; Bender, Jeff. Assessing occupational risks of manure applicators in the Upper Midwest. Poster presentation. North American Agricultural Safety Summit. Virtual. 03/2021.
- Schossow, Megan. Talking Stress, Talking Solutions. Oral/podium presentation. 2021 Women in Ag Network Conference. Virtual. 02/2021.
- Schossow, Megan; Younggren, Dan; Olson, Averi. Aging on the Farm. Oral/podium presentation. Aging on the Farm at Midwest Regional Ag Safety and Health Conference. Virtual. 11/2020.
- Schossow, Megan; Duysen, Ellen; Cheney, Marsha. Striving to Conduct Effective Agricultural Safety and Health Outreach During a Pandemic: From John Deere Masks to Plexiglass. Oral/podium presentation. Midwest Regional Agricultural Safety and Health Conference. Virtual. 11/2020.
- Charlier, Devon; Schossow, Megan; Abderholden, Sue; Sampson-Bernstrom, Wil; McHale, Hayley; Bender, Jeff. Partnering in Mental Health Support: A Partnership Between the Upper Midwest Agricultural Safety and Health Center and NAMI Minnesota. Poster presentation. Midwest Regional Agricultural Safety and Health Conference. Virtual. 11/2020.

- Bertrand, Maria; Charlier, Devon; VanBrocklin, Molly. Oral/podium presentation. Leveraging Social Media to Promote Agricultural Health and Safety. Midwest Regional Agricultural Safety and Health Conference. Virtual. 11/2020.
- Charlier, Devon; VanBrocklin, Molly; Bertrand, Maria. Building Effective Data Visuals. Webinar. 4th Quarterly NIOSH Extramural Communication Community of Practice. Virtual. 11/2020.
- Schossow, Megan; Ploeckelman, Melissa; Pennington, Whitney; Pate, Michael; Yoder, Aaron; Fetzer, Linda. Safety For All. Panel discussion. Fall FANRE Professional Development Conference. Virtual. 09/2020.
- Schossow, Megan. ISASH Lunch & Learn: National Farm Safety and Health Week. Webinar. ISASH Lunch and Learn. Virtual. 09/2020.
- Schossow, Megan. Something for Everyone: US Ag Centers. Oral/podium presentation. UMASH Online Expo. Virtual. 08/2020.
- Ploeckelman, Melissa. Telling the Story. Oral/podium presentation. UMASH Online Expo. Virtual. 08/2020.
- Bender, Jeff. CDC Guidelines & Ag Employer Checklist: COVID-19. Webinar. COVID-19 Guidance with NFCF and LOL. Virtual. 07/2020.
- Bender, Jeff. SAR-CoV-2 and its Impact on Animals. Panel discussion. AgriSafe. Virtual. 05/2020.
- Bender, Jeff. No Longer Invisible – Public Health during the COVID-19 Pandemic. Panel discussion. University of Minnesota School of Public Health. Virtual. 04/2020.
- Bender, Jeff. Keeping Producers/Ag Workers and their Families Safe during the COVID-19 Pandemic. Webinar. AgriSafe. Virtual. 03/2020.
- Schossow, Megan. Public Engagement Case Study: Farmfest Partnering with Minnesota: Connecting the University with Urban, Suburban, and Rural Communities through Public Engagement. Oral/podium presentation. Minneapolis, MN. Virtual. 03/2020.
- Schossow, Megan. Social Media Campaigns. Oral/podium presentation. UMN Communicator Forum. Minneapolis, MN. 02/2020.
- Schossow, Megan. Annie's Project. Oral/podium presentation. Saint Cloud, MN. 02/2020.
- Schossow, Megan. Legislative Update and Testimony for Minnesota House. Oral/podium presentation. Minnesota House of Representatives Agriculture and Food Finance and Policy Division. Saint Paul, MN. 02/2020.
- Bender, Jeff. Legislative Update and Testimony for Minnesota House. Oral/podium presentation. Minnesota House of Representatives Agriculture and Food Finance and Policy Division. Saint Paul, MN. 02/2020."
- Schossow, Megan M.; Kampa, Diane M.; Peterson, Carol M.; Alexander, Bruce H.; Bender, Jeffrey B. Building Resilient Agricultural Communities. Poster presentation. Midwest Regional Agricultural Safety and Health Conference 2019. Marshalltown, IA 11/2019.
- Schossow, Megan. Building Resilient Agricultural Communities. Oral presentation. Women in Sustainable Ag. St. Paul, MN. 10/2019.
- Christensen, Cynthie. Rural Resilience: Building Hope for Tomorrow. Oral presentation. Minnesota Crop Insurance Conference. Mankato, MN. 09/2019.
- Schossow, Megan. Animal Safety with Cottonwood County 4 H. Oral presentation. Fall Field Days with Cottonwood County 4 H. Lamberton, MN 09/2019.
- Kampa, Diane; Schossow, Megan; Alexander, Bruce. Panel discussion. Minnesota Farm Working Group- July 2019. Saint Paul, MN 07/2019.
- Schossow, Megan. Building Resilience Through Partnerships. Oral presentation. International Society on Agricultural Safety and Health Conference. Des Moines, IA. 06/2019.
- Schossow, Megan M.; Kampa, Diane M.; Peterson, Carol Alexander; Bruce H.; Bender, Jeffery B. Tackling Stress in Agriculture through Partnerships. Poster presentation. International Society for Agricultural Safety and Health. Des Moines, IA. 06/2019.
- Schossow M; Ploeckelman M; Koerte T.; Kampa D. Social Safety: Spring Agritourism Campaign. Poster presentation. International Society for Agricultural Safety and Health. Des Moines, IA. 06/2019.
- Bender, Jeff. Biosecurity and Biocontainment for Food Animals. Oral presentation. Biosecurity and Biocontainment for Food Animals; University of Minnesota, College of Veterinary Medicine. St. Paul, MN 05/2019.

- Schossow, M; Ploeckelman, Ml; Koerte, T; Kampa D. Social Safety: Spring Agritourism. Poster presentation. 2019 NORA Symposium. Minneapolis, MN 05/2019.
- McGovern P.M; Saunders J.B.; Mcalpine, D. Stress And Resilience: The Impact Of The 2015 Outbreak Of Highly Pathogenic Avian Influenza On Minnesota Poultry Growers, Farm Workers And Industry Stakeholders. Poster presentation. 2019 NORA Symposium. Minneapolis, MN. 05/2019.
- Schossow, M.; Macy, K.; Moynihan, M.; Friedman, J.; Valeri, L.; Vazquez, C.; Kampa, D.; Harwood, E.; Bender, J.; Alexander, B. Building Resilient Agricultural Communities. Poster presentation. 2019 NORA Symposium. Minneapolis, MN. 05/2019.
- Alexander B.H.; Bender J.; Keifer M.C. Building Partnerships In Agricultural Health And Safety, Upper Midwest Agricultural Safety And Health Center (Umash). Poster presentation. 2019 NORA Symposium. Minneapolis, MN. 05/2019.
- Heiberger, S.; Ploeckelman, M.; Yoder, A.; Duysen, E.; Leonard, S. Telling The Story - Development Of A Collaborative Outreach Project. Poster presentation. 2019 NORA Symposium. Minneapolis, MN. 05/2019.
- Mold, D. & Roberts, M.L. Cultivating Resiliency For Women In Agriculture: An Interactive Webinar Series And Online Questionnaire. Poster presentation. 2019 NORA Symposium. Minneapolis, MN. 05/2019.
- Mold, D. Stressed Out from Work: An Occupational Hazard. Panel Discussion. 2019 NORA Symposium. Minneapolis, MN. 05/2019.
- Sheridan C. & Kampa, D. Stress And Mental Health Conversations With Gear Up For Ag Health And Safety. Poster presentation. 2019 NORA Symposium. Minneapolis, MN. 05/2019.
- Ploeckelman, M. MN State FFA Convention Zoonotic Diseases workshop. Oral presentation. MN State FFA Convention. St. Paul, MN. 04/2019.
- Bender, Jeff. Minnesota Dairy Health Conference 2019. Oral presentation. Minnesota Dairy Health Conference 2019. St. Paul, MN. 04/2019.
- Bender, Jeff. Be Calm - The importance of thoughtful working with cattle. Oral presentation. Upper Midwest Dairy Industry Association - Spring meeting. Rochester, MN. 04/2019.
- Bender, Jeff. Be Calm - The importance of thoughtful working with cattle. Oral presentation. Upper Midwest Dairy Industry Association - Spring meeting. St. Cloud, MN. 04/2019.
- Peterson, Carol & Schossow, Megan. Oral presentation Women's Agricultural Leadership Conference (WALC). Chaska, MN. 04/2019.
- Peterson, Carol; Schossow, Megan. How Safe is Your Farm? Midwest Organic and Sustainable Education Service (MOSES) 2019. February 21-23, 2019. LaCrosse, WI 02/2019.
- Alexander BH. Working and Living: The Environment and One Health. 4th International Conference on One Medicine One Science Chiang Mai, Thailand 02/2019.
- Bender, Jeffrey. Global Antimicrobial Stewardship Efforts, 4th International Conference on One Medicine One Science Chiang Mai, Thailand, February 13, 2019 02/2019.
- Bender, Jeff. Successes and Challenges in Food Safety, Lincoln Memorial University, Harrogate, TN, January 15, 2019 01/2019.
- Schossow, M.; Macy, K.; Moynihan, M.; Friedman, J.; Valeri, L.; Vazquez, C.; Kampa, D.; Harwood, E.; Bender, J.; Alexander, B. Building Resilient Agricultural Communities at MRASH. Midwest Rural and Agricultural Safety and Health Conference. November 28, 2018. Council Bluffs, Iowa. 11/2018.
- Alexander BH. One Health and Occupational Health. 1st Annual Forum on Environmental and Occupational Health, University of Philippines, Manila 11/2018.
- Kampa, Diane M.; Peterson, Carol M.; Moreno, Ada; Bender, Jeff; Alexander, Bruce H. MRASH 2018. November 27-29, 2018. Council Bluffs, Iowa. 11/2018.
- Kampa, Diane M.; Peterson, Carol M.; Moreno, Ada; Bender, Jeff.; Alexander, Bruce H. The Farm Safety Champion: a farmer's perspective. MRASH 2018. Council Bluffs Iowa. November 27-29, 2018. 11/2018.
- Kampa, Diane M.; Peterson, Carol M.; Schossow, Megan; Feng Yun-Han,; Harwood, Eileen; Bender, Jeffrey B; Alexander, Bruce H. Implementing a Monthly Farm Safety Check Tool. Midwest Rural Agricultural Safety & Health (MRASH). January 27-29, 2018. Council Bluffs, IA. 11/2018.

- Schossow, M; Macy, K; Moynihan, M; Friedman, J; Valeri, L; Vazquez, C; Kampa, D; Harwood, E; Bender, J; Alexander, B. Building Resilient Agricultural Communities. Midwest Rural Agricultural Safety and Health (MRASH). January 27-29, 2018. Council Bluffs, IA. 11/2018.
- Anna Schotthoefer. Tick Talk. Men's Night Out. American Legion, Mauston, WI. October 4, 2018. 10/2018.
- Cramer, Gerard. Impact of Daily Exposure to Tetracycline by Hoof trimmers on MRSA and resistance profiles. UMASH Advisory Board and Center Meeting. Minneapolis, MN. September 18, 2018. 09/2018.
- McGovern, Patricia. The Impact of Highly Pathogenic Avian Influenza on Health, Coping & Resilience Among Minnesota Poultry Growers & Farm Workers. UMASH Advisory Board and Center Meeting. Minneapolis, MN. September 18, 2018. 09/2018.
- Peterson, Carol. UMASH Center Overview. Extension Livestock Gathering. St. Paul, MN. August 17, 2018. 08/2018.
- Bender, Jeffrey, Preventing Injuries and Illnesses in Production Animal Practice: Protecting You and Your Clients, American Veterinary Medical Association, Denver, CO, July 13, 2018. 07/2018.
- Kampa, Diane; Peterson, Carol; Moreno, Ada; Bender, Jeffrey; Alexander, Bruce. Implementing a Monthly Farm Safety Check tool to Promote Prevention Strategies and Resources in the Upper Midwest Region. International Society for Agricultural Safety and Health (ISASH). Halifax, Nova Scotia. June 24-27, 2018. 06/2018.
- Kampa, Diane; Peterson, Carol; Moreno, Ada; Bender, Jeffrey; Alexander, Bruce. The Farm Safety Champion: A Farmer's Perspective. International Society for Agricultural Safety and Health (ISASH). Halifax, Nova Scotia. June 24-27, 2018. 06/2018.
- Bender, Jeff. Occupational Risks to You and Your Clients. Veterinary Medicine Bio-security Class May 24, 2018. St. Paul, MN. 05/2018.
- Alexander BH, Bender J, Keifer MC. Building Partnerships in Agricultural Safety and Health, Upper Midwest Agricultural Safety and Health. 2018 NORA Symposium, May 3, 2018, Minneapolis, MN. 05/2018.
- Kampa, Diane; Peterson, Carol; Moreno, Ada; Bender, JB; Alexander, BH. Implementing a Monthly Farm Safety Check Tool. 2018 NORA Symposium, May 3, 2018, Minneapolis, MN. 05/2018.
- Kampa, Diane; Peterson, Carol; Moreno, Ada; Bender, JB; Alexander, Bruce. The Farm Safety Champion - a farmer's perspective. 2018 NORA Symposium. Minneapolis, MN. May 3, 2018. 05/2018.
- McGovern PM, Saunders JB, Mcalpine D. Stress and Resilience: The Impact of the 2015 Outbreak of Highly Pathogenic Avian Influenza on Minnesota Poultry Growers, Farm Workers, and Industry Stakeholders. 2018 NORA Symposium, May 3, 2018, Minneapolis, MN. 05/2018.
- Moe D, Liebenstein M, Sreevatsan S, Cramer G. Describing the Impact of Daily Exposure to Tetracycline by Dairy Cattle Hoof Trimmers of the Upper Midwest on the Prevalence of Multidrug Resistant Staphylococcus Aureus, 2018 NORA Symposium. May 3, 2018, Minneapolis, MN. 05/2018."
- Salzwedel, Marsha; Kampa, Diane. Risk Assessment and Mitigation on Farms. Minnesota Farm Bureau Safety Conference. Eagen, MN. April 26, 2018. 04/2018.
- Kampa, Diane; Peterson, Carol; Gomez, Ada; Bender, Jeffrey; Alexander, Bruce. The Farm Safety Champion: A Farmer's Perspective. Extension Risk Management Education Conference. Milwaukee, WI. April 11-12, 2018. 04/2018.
- Kampa, Diane. Keeping a ""Safe"" Eye on What We Write, Say, and Show in Agriculture. 2018 Women's Agricultural Leadership Conference - A Passion for Progress. Chaska, MN. April 11, 2018. 04/2018.
- Are Accidents Waiting to Happen?. 2017 Dairy Plant and Field Reps Conference. Eau Claire WI. 08/2017.
- Bender, Jeff, Needlestick Prevention in Agriculture. Seminar presentation to medical students. Minneapolis, MN. 08/2017.
- Keifer, Matt; Glamm, David; Ramirez, Marizen; Metz, Gary; Aasen, Paul, Farm Safety: Protecting you, your family, your visitors, and your bottom line. Minnesota Farmfest. 08/2017."
- Wilmes, E., Swenson R., Engaging dairy producers with stockmanship and messages; research findings and implications for communication strategies. International Society for Agricultural Safety and Health. 06/2017.
- McGovern, P., Saunders, J., & McAlpine, D. The Environmental Impact of Highly Pathogenic Avian Influenza on Health, Coping, and Resilience in Farmers. Work, Stress, and Health: The 12th International Conference on Occupational Stress and Health Minneapolis, MN. 06/2017.

- Walker R, Munoz-Zanzi C, Schotthoefer A. Characterizing the Epidemiology of Positive Lyme Confirmatory Tests in North-Central Wisconsin: 2000-2015. Poster Presentation. 2017 NORA Symposium. 05/2017.
- Stinebaugh K, Schotthoefer A, Walker R, Munoz-Zanzi C, Tick-borne disease knowledge, attitudes, and practices among U.S. Forest Services Workers. Poster Presentation. 2017 NORA Symposium. Minneapolis, MN. 05/2017.
- Swenson R and Wilmes E., Engaging dairy producers with stockmanship and messages; research findings and implications for communication strategies. Poster Presentation. 2017 NORA Symposium. Minneapolis, MN. 05/2017.
- Walker R, Munoz-Zanzi C, Schotthoefer A., Characterizing the demographic, spatial, and environmental epidemiology of lyme disease cases in north-central Wisconsin: 2000-2015. Poster Presentation. 2017 NORA Symposium. Minneapolis, MN. 05/2017.
- Swenson R, Wilmes E, Thofson P., Engaging dairy workers with stockmanship and safety messages: research findings and implications for communication strategies. Poster Presentation. 2017 NORA Symposium. Minneapolis, MN. 05/2017.
- McGovern P, Saunders, JB, McAlpine D. Stress and Resilience: The impact of the 2015 outbreak of highly pathogenic avian influenza on Minnesota poultry growers, farm workers and industry stakeholders. Poster Presentation. 2017 NORA Symposium. Minneapolis, MN. 05/2017.

Evaluation Core:

- Ploeckelman, Melissa; Charlier, Devon; Edlund, Cassandra; Irvine, Kelsey; Heiberger, Scott; Wickman, Amanda; Schossow, Megan. Get your science shared by building a Media Toolkit. Oral/podium presentation. International Society for Agricultural Safety and Health. Fort Collins, CO. June 2022.
- Ploekelman, Melissa; Heiberger, Scott; Charlier, Devon; Leonard, Stephanie; Duysen, Ellen; Palm, Kelsey; Rautiainen, Risto; Yoder, Aaron; Schossow, Megan. Telling a Story to Save a Life - Creating an Impactful First Person Narrative. Oral/podium presentation. International Society for Agricultural Safety and Health. Fort Collins, CO. June 2022.
- Hall, Suness. From the Experts: Contextual Factors in Agricultural Health and Safety. Oral/podium presentation. National Occupational Research Agenda Symposium. Virtual. May 2022.
- Yoder, Aaron; Duysen, Ellen; Charlier, Devon; Heiberger, Scott; Ploeckelman, Melissa; Leonard, Stephanie. Telling the Story: How one farmer's story provided impactful worker training and outreach. Poster presentation. North American Agricultural Safety Summit. Las Vegas, Nevada. March 2022.
- Charlier, Devon; Kampa, Diane; Bertrand, Maria; Schossow, Megan. Strategies for Social Media Evaluation. Oral/podium presentation. 2021 International Society for Agricultural Safety and Health Conference. Virtual. June 2021.
- Charlier, Devon; Schossow, Megan; Abderholden, Sue; Sampson-Bernstrom, Wil; McHale, Hayley; Bender, Jeff. Partnering in Mental Health Support: A Partnership Between the Upper Midwest Agricultural Safety and Health Center and NAMI Minnesota. Poster presentation. Midwest Regional Agricultural Safety and Health Conference. Virtual. November 2020.
- Charlier, Devon; VanBrocklin, Molly; Bertrand, Maria. Building Effective Data Visuals. Webinar. 4th Quarterly NIOSH Extramural Communication Community of Practice. Virtual. November 2020.
- Schossow, M.; Macy, K.; Moynihan, M.; Friedman, J.; Valeri, L.; Vazquez, C.; Kampa, D.; Harwood, E.; Bender, J.; Alexander, B. Building Resilient Agricultural Communities. Poster presentation. 2019 NORA Symposium. Minneapolis, MN. May 2019.
- Kampa, Diane M.; Peterson, Carol M.; Schossow, Megan; Feng Yun-Han,; Harwood, Eileen; Bender, Jeffrey B; Alexander, Bruce H. Implementing a Monthly Farm Safety Check Tool. Midwest Rural Agricultural Safety & Health (MRASH). January 27-29, 2018. Council Bluffs, IA. January 2018.
- Schossow, M; Macy, K; Moynihan, M; Friedman, J; Valeri, L; Vazquez, C; Kampa, D; Harwood, E; Bender, J; Alexander, B. Building Resilient Agricultural Communities. Midwest Rural Agricultural Safety and Health (MRASH). January 27-29, 2018. Council Bluffs, IA. January 2018.

Surveillance for Zoonotic Diseases in Agricultural Workers in Minnesota II:

- Klumb C, Ireland, M, Scheftel, J. A One Health Approach to Improving Health and Safety at the Human-Animal Interface. United States Animal Health Association Annual Meeting, Minneapolis, MN October 2022.
- Klumb C, Smith M, Wustenberg W. Best Practices and Resources for Preventing Infectious Diseases at Agritourism Operations. International Workshop on Agritourism, Burlington, VT August 2022.
- Klumb, C. Fair Best Practices and the Veterinarian's Role. Minnesota Veterinary Medical Association Annual Meeting, Virtual February 2022.
- Klumb, C. Risks from Animals in Public Settings: Agritourism Outreach in Minnesota. American Veterinary Medical Association Convention, Virtual Annual Meeting, July 2021.
- Scheftel, JS. Enteric Diseases in Agricultural Workers and from Animal Contact Venues. American Veterinary Medical Association, Virtual Annual Meeting, July 2021.
- Scheftel, JS. One Health in action: State public health response to HPAI outbreaks in Minnesota. Invited speaker, The MITRE Corporation not-for-profit organization One Health Approach lecture series, July 2022.
- Scheftel, JS. State Public Health Response to 2015 HPAI Outbreak. Invited speaker, President's Advisory Committee on Combating Antibiotic Resistance (PACCARB) Public Meeting, March 2022.
- Scheftel, JS. High Path Avian Influenza for Small Flock Owners. University of Minnesota Extension Webinar May 2022
- Scheftel, JS. COVID Potpourri. Minnesota Veterinary Medical Association Virtual Annual Meeting. February 2022.
- Scheftel, JS. COVID Vaccination and Returning from Curbside Care. Minnesota Veterinary Medical Association webinar May 2021
- Scheftel, JS. Vet Med: COVID Vaccination; and, COVID-19 and One Health: Effect of a human disease on Vet Med and Animal Ag. Invited speaker, Mississippi Veterinary Medical Association Virtual Annual Meeting, May 2021.
- Scheftel, JS. COVID Vaccination Lunch n' Learn. Minnesota Board of Animal Health Work Conference, June 2021.
- Scheftel, JS and Frumholtz, M. COVID-19 and Minnesota Business. Minnesota Chamber of Commerce virtual meeting, November 2020.
- Scheftel, JS. CWD and Human Health. Minnesota Board of Animal Health Farmed Cervidae Advisory Committee, virtual meeting November 2020.
- Scheftel JS. State Public Health Veterinarian Interactions with the Meat Packing Industry. United States Animal Health Association (USAHA) One Health Committee, USAHA Virtual Annual Meeting October 2020.
- Scheftel JS. COVID-19 and Recycling and Composting Facilities in Minnesota. Minnesota Recycling and Composting Association, April 2020.
- Bender, Jeff. Biosecurity and Zoonotic Disease Prevention. Webinar. Welcome to the Healthy Farms Healthy Agriculture (HFHA). Virtual. November 2020.
- Bender, Jeff. There's a reason we don't "kiss the calves." Webinar. The Dairy Signal. Virtual. August 2020.
- Klumb, Carrie. Agritourism: Keeping your visitors, your animals, and your assets safe and healthy. Oral presentation. MN Organics Conference. St. Cloud, MN. January 2020.
- Klumb, Carrie; Scheftel, J.; Smith, K. Animal Agriculture Exposures among Minnesota Residents with Zoonotic Enteric Infections, 2012-2016. Oral presentation. International Society for Agricultural Safety and Health. Des Moines, IA. June 2019.
- Bender, Jeff. Biosecurity and Zoonotic Disease Prevention: Keeping our guests and animals healthy and safe. Oral presentation. 2019 North American Livestock Show and Rodeo Manager's Annual Meeting and Conference. Bloomington, MN. May 2019.
- Klumb, Carrie; Hedeen, Nicole; Connery, Russ; Scheftel, Joni, Agritourism Workshop: A One Health Approach Improving Health and Safety at Agritourism Venues. FUSION Conference hosted by the American Farm Bureau Federation, Milwaukee, WI. March 15-18, 2019.
- Klumb, Carrie. Hosting an on Farm Event. LEAP Conference hosted by the Minnesota Farm Bureau. January 26, 2019. Bloomington, MN. January 2019.
- Klumb, Carrie; Scheftel, Joni. Educational Efforts for Agritourism and Farm Visit Providers in Minnesota. South Dakota One Health Seminar. Sioux Falls, SD. June 20, 2018.

- Klumb, Carrie; Saykao Samantha; Scheftel, Joni. Knowledge, Attitudes, and Beliefs About Agritourism and Zoonotic Diseases Among Minnesota State Fair Attendees, 2016. CSTE Annual Conference. West Palm Beach, FL. June 10-14, 2018.
- Klumb, Carrie. County Fairs and Agritourism Operations: Opportunities for Collaboration. Minnesota Environmental Health Association Conference. Deerwood, MN. May 10-11, 2018.
- Kampa, D; Peterson, C; Liebman A; Bender, JB; Alexander, BH. Dairy Worker Safety: Moving from Problem to Solution. 2018 NORA Symposium. Minneapolis, MN. May 3, 2018.
- Klumb, Carrie; Scheftel, Joni. Healthy Fairs and Agritourism Workshops: A One Health Approach to Improving Health and Safety at Agritourism Operations. Extension Risk Management Educators Annual Conference. Milwaukee, WI. April 11-12, 2018.
- Salzwedel, Marsha, Agritourism Emergency Response. WI Fresh Fruit and Vegetable Conference 2018. Wisconsin Dells, WI. January 2018.
- Scheftel, Joni, Risk for Enteric Pathogens as it Relates to People Who Live on Farms, Work on Farms, or Visit Farms. American Veterinary medical Association Annual Conference. July 2017.
- Klumb, Carrie; Hall Kirk, Peggy, Agritourism, Zoonotic Diseases and Legal Liability. National Ag Law Center Webinar Series. June 2017.
- Klumb, Carrie, Agritourism: The Next Frontier in Agriculture. Ag and Rural Law Institute, MN Bar Association Willmar, MN. June 2017.
- Klumb, Carrie, Surveillance for Zoonotic Diseases in Agricultural Workers in Minnesota II. Women in Agriculture Leadership. Chanhassen, MN. April 2017.

Longitudinal Study of Infectious Disease Risks at the Human-Swine Interface:

- Davies, Peter; Yang, My; Torremorell, Montse; Bender, Jeff. MRSA colonization and infection in swine veterinarians and companion animal veterinarians. Oral/podium presentation. Allen D. Leman Swine Conference. September 2021, St. Paul, MN.
- Sun J, Sreevatsan S, Knutson T, Marthale D, Yang M, Davies P., Characterization of staphylococcus aureus in swine and swine veterinarians and its transmission at the human- livestock interface. Poster Presentation. May 2017, NORA Symposium. Minneapolis, MN.

Optimizing Assessment of Virus-Containing Particles in Animal Agriculture:

- Adesina, Adepeju; Raynor, Peter C.; Aboubakr, Hamada; Goyal, Sagar M.; Yang, My; Torremorell, Montse. Assessing Exposure to Airborne Swine Influenza A Virus (IAV) in a Minnesota Wean-to-Finish Facility. Poster presentation. American Industrial Hygiene Conference and Exposition. Virtual. May 24, 2021.
- Raynor, Peter C. Assessing Airborne Hazards in Animal Agriculture. Oral presentation. College of Veterinary Medicine Research Seminar. St. Paul, MN. February 12, 2020.
- Aboubakr, Hamada A. Comparison of Air Samplers for Efficient Recovery of Airborne Viruses from Bioaerosols. Oral presentation. 2020 American Society for Microbiology Biothreats Conference. Arlington, VA. January 28, 2020.
- Aboubakr, Hamada; Adesina, Adepeju; Yang, My; Raynor, Peter C.; Torremorell, Montserrat; Goyal, Sagar M. Comparison of Air Samplers for Efficient Recovery of Airborne Viruses from Bioaerosols. Poster presentation. 2020 American Society for Microbiology Biothreats Conference. Arlington, VA. January 28, 2020.
- Adesina, Adepeju; Raynor, Peter C.; Aboubakr, Hamada; Yang, My; Torremorell, Montse; Goyal, Sagar M. A Comparison of Sampling Methods for Detection and Measurement of Airborne Viral Particle Concentration. Oral presentation. American Industrial Hygiene Conference and Exposition. Minneapolis, MN. May 21, 2019.
- Adesina, Adepeju; Raynor, Peter C.; Aboubakr, Hamada; Goyal, Sagar M.; Yang, My; Torremorell. A Comparison of Sampling Methods for Detection and Measurement of Airborne Viral Particle Concentrations. Poster presentation. American Industrial Hygiene Conference and Exposition. Minneapolis, MN. May 20, 2019.

- Adesina, Adepeju; Raynor, Peter C.; Aboubakr, Hamada; Goyal, Sagar M.; Yang, My; Torremorell, Montse. Detection and Measurement of Airborne Viral Particle Concentration. Poster presentation. 2019 NORA Symposium. Minneapolis, MN. May 2, 2019.
- Adesina, Adepeju; Raynor, Peter C.; Aboubakr, Hamada; Goyal, Sagar M.; Yang, My; Torremorell, Montse. Detection and Measurement of Airborne Viral Particle Concentration. Poster presentation. University of Minnesota School of Public Health Research Day, Minneapolis, MN. April 1, 2019.
- Adesina, Adepeju; Raynor, Peter C.; Aboubakr, Hamada; Goyal, Sagar M.; Yang, My; Torremorell, Montse. A Comparison of Sampling Methods to Measure Concentrations and Sizes of Airborne Virus-Containing Particles. Biology/Chemistry Seminar at St. Catherine University. St. Paul, MN. September 18, 2018.
- Raynor, Peter C.; Adesina, Adepeju; Aboubakr, Hamada; Yang, My; Torremorell, Montse; Goyal, Sagar M. Toward Identifying the Most Effective Samplers for Airborne Viruses. Allen D. Leman Swine Conference. St. Paul, MN. September 17, 2018.
- Adesina, Adepeju; Raynor, Peter C.; Aboubakr, Hamada; Goyal, Sagar M.; Yang, My; Torremorell, Montse. A Comparison of Sampling Methods to Measure Concentrations and Sizes of Airborne Virus-Containing Particles. Leman Swine Conference. St. Paul, MN. September 16, 2018.
- Peter C. Raynor. Factors Influencing Air Pollutant Levels in Swine Barns. Teleconference. August 2, 2018.
- Adepeju Adesina, Peter C. Raynor, Hamada Aboubakr, Sagar M. Goyal, and Montse Torremorell. Evaluating Aerosol Samplers for Characteristics Improving Their Limits of Detection for Influenza Virus. 2018 American Industrial Hygiene Conference and Exposition. May 21-23, 2018. Philadelphia, PA.
- Adesina A, Aboubakr H, Raynor PC, Goyal S, Torremorell M. Evaluating Aerosol Samplers for Characteristics Improving their Limits of Detection for Influenza Virus. 2018 NORA Symposium. May 3, 2018, Minneapolis, MN.

Rural Firefighters Delivering Agricultural Safety and Health (RF-DASH)

- Bendixsen CB, Barnes KL. Rural Firefighters Delivering Agricultural Safety and Health (RFDASH). NORA Symposium. Minneapolis, MN. May 5, 2017.
- Bendixsen, Casper. RFDASH Curriculum Round Table Discussion. Marshfield, WI. June 7, 2017.
- Bendixsen, C., Barnes, K., Murphy, D., Hill, D., Keifer, M. Rural Firefighters Delivering Agricultural Health and Safety. International Society for Agricultural Safety and Health (ISASH). Logan, UT. June 25-28, 2017.
- Barnes, Kathrine. (2017). RF-DASH Curriculum Round Table Discussion. Marshfield WI.
- Bendixsen, Casper, Salzwedel, Marsha. Sharing the News of RF-DASH. Pittsville Area Fire Fighting Training. Pittsville, WI. September 25, 2017.
- Bendixsen, Casper. Rural Firefighters Delivering Agricultural Safety and Health: An Example in Disseminating Through Technology. Agricultural Safety and Health Council of America (ASHCA). Scottsdale, AZ. February 21-23, 2018.
- Bendixsen, C., Barnes, K. Innovative Uses of Technology in Ag Health and Safety – the RF-DASH Project. Agricultural Safety and Health Council of America. (ASHCA). Scottsdale, AZ. September 25-27, 2018.
- Zwaschka, J. RF-DASH. Southwest Regional Fire Department Association. Windom, MN. September 14, 2019.
- Zwaschka, James. (2020). EMS Panel. Panel discussion. 2020 Ag Symposium. Mankato, MN
- Bendixsen, C., Barnes, K., Koshalek, K. An Eager Audience for Farm Safety: Updates from Rural Firefighters. International Society for Agricultural Safety & Health (ISASH). Des Moines, IA. June 24-27, 2019.
- Bendixsen, C. Minor, G. Rural Firefighters Delivering Agricultural Safety and Health. Wisconsin Rural Partners. Virtual Presentation. June 18, 2020.
- Koshalek, K., Barnes, K., Bendixsen, C. Rural Firefighters Delivering Agriculture Safety and Health (RF-DASH) – Expanding a Program beyond its Regional Boarders. International Society for Agricultural Safety & Health (ISASH). Virtual Presentation. July 28, 2020.
- Swenson, A., Bendixsen, C., Barnes, K., Redmond, E., Koshalek, K., Pilz, M., Sauer, M. Rural Firefighters Delivering Agricultural Safety and Health: Social Network Analysis. International Society for Agricultural Safety & Health (ISASH). Virtual Presentation. July 26, 2020.
- Bendixsen, C., Barnes, K., Koshalek, K. Flexing Trust: Firefighters and Farmers Tacking Farm Safety Together. Wisconsin Towns Association (WTA). Virtual Presentation. October 14, 2020.

- Bendixsen, C. Flexing Trust: Firefighters and Farmers Tacking Farm Safety Together. Stand Up 4 Grain Safety Week: Emergency Action Plans. Virtual Presentation. April 2, 2021.
- Koshalek, K., Barnes, K., Swenson, A., Pilz, M., Sauer, M., Bendixsen, C. America's Two Most Admired Professions. Separate No More. ISASH. Virtual Presentation. June 22, 2021
- Bendixsen, C. Flexing Trust: Firefighters and Farmers Tackling Farm Safety Together. CASA. Virtual Presentation. August 12, 2021.
- Bendixsen, C. Flexing Trust: Firefighters and Farmers Tackling Farm Safety Together. NASAAEP. Virtual Presentation. August 11, 2021.
- Bendixsen, C. Flexing Trust: Firefighters and Farmers Tackling Farm Safety Together. CASA Conference. Virtual Presentation. October 21, 2021.
- Bendixsen, C. Prevention of Farm Incidents. Agriculture Rescue Training. Virtual Presentation. October 22-23, 2021.
- Koshalek, K. "Agriculture Rescue Training". NCRTA Trauma Conference. North Central Technical College, Wausau, WI. April 7th, 2022.
- Koshalek, K., Minor, G., Bendixsen, C. "Agricultural Rescue Training: Introduction to Farm Emergencies". Trauma Webinar Series. August 25, 2022.
- Koshalek, K. "Pre-Planning and Mapping Farms". Ag Incident Training. Stratford, WI. September 07, 2022.

Promoting Safety and Worker Health for Immigrant Dairy Workers

- Bender, Jeff. Dairy Work Group. Oral/podium presentation. Dairy Work Group. March, 2022.
- Bender, Jeff. Safety is a Team Sport. Oral/podium presentation. United States Animal Health Association. Annual Meeting. Virtual. October 2021.
- Bender, Jeff. COVID-19 Awareness and Preparedness of Minnesota and Wisconsin Dairy Farms. Oral/podium presentation. Legal Action of Wisconsin. August 2021.
- Vazquez, Chela; Bender, Jeff; Liebman, Amy; Kirsch, Jonathan. Immigrant Dairy Worker Health and Safety Trainings Wisconsin and Minnesota. 2021 Virtual Forum for Migrant and Community Health. Virtual. March 2021.
- Vazquez, Chela. Protecting the health of immigrant dairy workers. Oral/podium presentation (Lightning Talk). North American Agricultural Safety Summit. Virtual. March 2021.
- Vazquez, Chela; Bender, Jeff; Liebman, Amy; Kirsch, Jonathan. Protecting the health of immigrant dairy workers. Abstract. North American Agricultural Safety Summit. March 2021.
- Vazquez, Chela; Bender, Jeff; Liebman, Amy; Kirsch, Jonathan. Protecting the health of immigrant dairy workers. Poster. North American Agricultural Safety Summit. March 2021.
- Bender, Jeff. COVID-19 Preparedness for Ag Workers. Webinar. Minnesota Veterinary Medicine Association. Virtual. February 2021.
- Bender, Jeff. Safety Teams. Keynote speaker. UMASH Online Expo. Virtual. August 2020.
- Liebman, Amy. Agricultural Worker Health & COVID-19. Oral/podium presentation. UMASH Online Expo. Virtual. August 2020.
- Bender, Jeff. Agriculture is a team sport. Keynote speaker. Minnesota Dairy Initiative Coordinators Conference. St. Cloud, MN. March 2020.
- Liebman, Amy. The immigrant's journey to work and what this means for health. Webinar for a multi-disciplinary health sciences class. September 2019.
- Bender, Jeff, Liebman, Amy. How Safe Is Your Dairy Farm? Minnesota Milk Producers Association Dairy Webinar. September 25, 2018.
- Vazquez, Chela. Working Across Language and Cultural Barriers in Agriculture. 2018 North American Manure Expo, Brookings, SD. August 15, 2018.
- Bender, Jeff. One Health and the Immigrant Worker. Minneapolis, MN. July 20, 2018.
- Vazquez, Chela. Promoting Worker Health and Safety for Immigrant Dairy Workers. Agricultural Worker Project. Saint Peter, MN. April 20, 2018.

- Kampa D, Peterson C, Liebman A, Bender J, Alexander BH. Dairy worker safety: moving from problem to solution. Poster Presentation. 2017 NORA Symposium. Minneapolis, MN.
- Liebman A, Reyes I, Juárez-Carrillo P, Ninco Sanchez Y, Keifer M. Culturally appropriate health and safety intervention for immigrant dairy workers. Poster Presentation. 2017 NORA Symposium. Minneapolis, MN.

Assessing and Preventing Occupational Injuries in Animal Agriculture:

- Schofield, Katie. Assessing lost-time work injuries in animal agriculture in Minnesota. June 12-16, 2022. ISASH- International Society for Agricultural Safety and Health Annual Conference, Fort Collins, CO
- Bender, Jeff. Needle Know How. November 28, 2018. National Hog Farmer Webinar
- Bender, Jeff, Alexander, Bruce. Injuries in Pork Production. March 2018. National Pork Board Safety Summit. Des Moines, IA.
- Green D, Evanson J Bender JB, Alexander BH. Missclassification of Animal Handling Injuries to Swine Workers. August 2017. 26th International Epidemiology in Occupational Health (EPICOH) Conference. Edinburgh, UK.
- Green D, Evanson J, Bender JB, Alexander BH. Injuries among swine workers related to swine-human interactions. May 2017. Poster Presentation. NORA Symposium. Minneapolis, MN.
- Bender J, Green DR, Evanson J, Alexander BH. Injuries among swine workers related to needlesticks. May 2017. Poster Presentation. NORA Symposium. Minneapolis, MN.
- Green DR, Evanson J, Bender J, Alexander BH. Misclassification of animal handling and the resultant burden on two swine farms. May 2017. Poster Presentation. NORA Symposium. Minneapolis, MN.

C.2. Website(s) or other Internet site(s) – include URL(s)

umash.umn.edu

C.3. Technologies or techniques

N/A

C.4. Inventions, patent applications, and/or licenses

N/A

C.5. Other products and resource sharing

See Outreach Program section of this report.

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

See each component.

D.2 Personnel updates

a. Level of Effort:

b. New Senior/Key Personnel:

c. Changes in Other Support:

d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

N/A

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

Overall, over the course of the last funding cycle, UMASH has engaged in effective administration, outreach, and research to address the health and safety of agricultural workers, families, and communities in the Upper Midwest. The impact of our projects has influenced policy and support industry changes. For example, our mental health outreach has gained broader support of other partners sharing resources and reach. This includes legislative initiatives to support TeleHealth and other policies to allow across State border support for mental health resources. In addition, there is a greater discussion of supporting underserved rural communities. Regarding health and safety training of dairy workers, there is more industry uptake and engagement of producers, such as the Idaho Dairy Association and the development of outreach and training materials. During COVID many of our researchers and staff provided timely information and resources to our rural communities.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

During the COVID-19 pandemic, many of our partners (Marshfield Research Foundation, Migrant Clinicians Network, Minnesota Department of Health, College of Veterinary Medicine, and the School of Public Health) have served on the frontlines. As such, it has been challenging to do much of our regular work and in-person engagement. However, UMASH has adapted and continues to conduct disease and injury prevention research and outreach in innovative ways to meet the existing, emerging, and reemerging issues in agricultural health and safety

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

N/A

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

N/A

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

N/A

G.2 Responsible Conduct of Research

N/A

G.3 Mentor's Research Report or Sponsor Comments

N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?

Yes

G.4.b Inclusion Enrollment Data

N/a, see induvial projects

G.4.c ClinicalTrials.gov

N/a

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?

N/a

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

No

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

No

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

No

G.8 Project/Performance Sites

Organization Name	UEI	Congressional District	Address
Primary: University of Minnesota	KABJZBBJ4B54	MN-005	University of Minnesota Twin Cities 450 McNamara Alumni Center Minneapolis, MN 55455-2070
University of Minnesota	KABJZBBJ4B54	MN-005	420 Delaware Street SE Minneapolis, MN 55455-0341
Marshfield Clinic Research Institute	JHKBV97FZUC5	WI-007	1000 North Oak Avenue Marshfield, WI 54449
Minnesota Department of Health	DHQVY2WCVHC5	MN-004	625 Robert Street N St. Paul, MN 55155
Migrant Clinicians Network, Inc.	Z8LUULUW1U55	MD-001	100 West Main Street Salisbury, MD 21801
Community Health Service, Inc.	HF6NE8JKLGV3	MN-007	810 4th Avenue S, Suite 10 Moorhead, MN
Colorado State University	LT9CXX8L19G1	CO-002	308 MRB Building Fort Collins, CO 80523

G.9 Foreign Component

No

G.10 Estimated Unobligated Balance

$617,000

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

No

G.11 Program Income

Is program income anticipated during the next budget period?

No

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?

No

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

UMASH has been referenced and used as a resource over 85 times, including on several websites (Extension sites, Farm Answers, Rural Health Information Hub, SAY Clearinghouse, Ag Safety Info, and more), in webinars, and more. Further, UMASH resources like hand washing posters, stress cards, training videos, and more have been distributed for use by a variety of populations in several settings including:

- outreach by community colleges for middle school students
- health and safety training on dairy and swine operations
- events for county Farm Bureau agents, at 4-H events for students and agents
- governmental agency information for field agents
- conferences for public health veterinarians
- trainings for Farm Business educators
- education for farm visitors

UMASH resources have been adopted into curriculums, policies, standards, and other components of agricultural health and safety practice, at least 50 times, including:

- Needlestick content is used in the University of Minnesota Veterinary Medicine program and by individual swine production systems
- Animal handling content is used in a course at The Ohio State University College of Veterinary Medicine and a University of Iowa online module about safe animal caretakers
- Dairy worker training videos are used to train an estimated 600 workers using mobile technology
- Farms use animal handling resources to train workers to meet Farm 2.0 ethics requirements
- UMASH videos used for youth farm safety training through University of Minnesota Extension, to educate agricultural education teachers, the Great Plains Center Core Course
- Livestock safety posters are posted across Kirkwood College and the nearby high school in Iowa
- A Quadbar representative sent out the ATV Farm Safety Checklist alongside their product and shared that clients are using the checklists
- Farms use agritourism materials to educate visitors; for example, one Garden Center included handwashing guidance and the "Farms, Fairs, and Fun" video on their ticket website, and an agritourism collective, North Star Farm Tours, changed their bylaws to require agritourism training for their members.

UMASH has been mentioned in the media over 300 times in a variety of outlets, including but not limited to: US News & World Report, RFDTV, DTN, Progressive Farmer, and Rural Radio Network. UMASH resources have been referenced on social media and newsletters almost 80 times from organizations including but not limited to: Pork Checkoff, NIOSH E-news, I-29 Moo University, and AgriSafe. The UMASH outreach team engaged in over 240 events over the course of the funding cycle, across 6 states in more than 30 cities. These events were attended by tens of thousands of people, and UMASH documented direct engagement with more than 1,500 attendees. UMASH's digital platforms, including the UMASH website, YouTube channel, U.S. Ag Center's collaborative YouTube channel, email communications, and social media (Facebook, Instagram, Twitter, and LinkedIn) have grown in terms of audience, reach, and engagement. Further, UMASH Success Stories (http://umash.umn.edu/success-stories/) provide another glimpse into the successful work facilitated by researchers and staff. These stories present a summary of the problem, the effective work to address it, and links to resources and additional information.

The **Surveillance for Zoonotic Diseases in Agricultural Workers in Minnesota II** research project developed the largest and most detailed data set on infectious diseases that come from contact with farm animals in this country. They demonstrated that these diseases occur among people with animal agriculture exposures far more often than previously known and that they are an important risk of farming. This team found that the number of enteric infections in people who live and/or work on farms with food production animals in Minnesota during 2012–2016 was 147 per 10,000 population, 8 times greater than for other Minnesotans (18.5 per 10,000). This team also engaged extensively with the agricultural community in Minnesota, providing tailored education, developing innovative resources and training, and convening essential stakeholders to address emerging issues.

The **Longitudinal Study of Infectious Disease Risks at the Human-Swine Interface** research project aimed to understand the risks to health that swine veterinarians may confront due to their occupational exposure to pigs, and specifically to three infectious agents (*Staphylococcus aureus*, including MRSA; Influenza A viruses; Hepatitis E virus) that are common in U.S. pigs and can cause human illness. To do so, the team collected data on relevant health events from both swine vets and a control population of companion animal vets, finding a higher prevalence of *S. aureus* (approximately two-fold) and MRSA (approximately four-fold) in swine vets (SV) compared to companion animal vets (CAV). Isolates from swine vets were dominated by livestock-associated variants, which were uncommon in CAV. While swine veterinarians have a greater potential for exposure to *S. aureus* of animal origin, there is no evidence that they are at higher risk of infection. The risk of injury was similar between companion animal and swine veterinarians. Given this study's findings, veterinarians and animal producers should continue to engage in preventative measures, such as wearing protective clothing and handwashing following animal contact, as well training and practices that reduce the risk of injury.

The **Optimizing Assessment of Virus-Containing Particles in Animal Agriculture** research project determined that a two-sampler strategy may be optimal during zoonotic influenza outbreak investigations in animal agriculture facilities. Using a high-flow, non-sizing sampler initially is the best option for detecting airborne viruses at low concentrations. Then, if viruses are detected, sampling with a lower-flow, size-separating sampler will provide the most accurate measurements of airborne virus concentrations and sizes. The project team designed and fabricated an intermediate-flow, size-separating Bioaerosol Cascade Virtual Impactor (BCVI) to improve assessment of airborne viral particle concentrations and sizes. This research is helping to determine the best ways to sample airborne viruses, not only influenza viruses in animal agriculture operations but also other types of viruses in other settings. In particular, the methods being developed in this study will be applicable in non-agricultural spaces and with other viruses such as SARS-CoV-2. A key use of the sampler and sampling protocols developed in this study will be to more rapidly determine if a potential pandemic agent may be transmissible through aerosols. This will benefit not only workers in animal agriculture, but workers and the public everywhere. Additionally, knowing more about the concentrations and sizes of influenza viruses and other pathogens in animal agriculture operations and elsewhere will help researchers and practitioners determine the most appropriate control technologies to reduce exposure to viral aerosols.

The **Rural Firefighters Delivering Agricultural Safety and Health (RF-DASH)** research project has conducted six trainings in both the U.S. and Canada, training 72 trainers who have gone out and trained dozens more. Trainers from 10 US states and five Canadian provinces have shown tremendous enthusiasm and buy-in to the RF-DASH program as they have gone on to train other fire/EMS departments, present at conferences and health organizations, and perform hazard analysis and preplanning with farmers and ranchers in their communities. Fire/EMS have also shown increased desire for the RF-DASH program that covers pre-planning and emergency response similar to standards enforced in urban and industrial municipalities. The program is also in line with many National Fire Protection Association (NFPA) standards, which serve as guidelines and policies for emergency personnel to follow. Overall, this project has effectively and innovatively built a model to increase the number of local and trusted safety consultants available to assist farmers in improving the safety of their farms and has the momentum to become a national and international network.

The **Promoting Safety and Worker Health for Immigrant Dairy Workers** research project has successfully engaged engagement with regional industry leaders, producers, and workers and adapted to their needs during the pandemic. 360 immigrant workers received health and safety training at 19 dairies in Minnesota and South Dakota. The training, which uses the award-winning *Seguridad en las Lecherias* educational model that includes worker training and *promotores de salud* (or Community Health Workers) to reduce worksite hazards and to improve worker knowledge and practices, included five one-hour lessons over a six month period. Results of these training demonstrated a statistically significant increase in knowledge after each lesson and improved communication between workers and producers. Further, in response to COVID-19, the project provided timely resources on access to COVID-19 testing and subsequent vaccination of dairy workers. Additionally, as a part of the project's One Health efforts, the team partnered with industrial hygiene faculty and the College of Veterinary Medicine to develop a safety audit tool for veterinarians to assess safe animal handling practices, infectious disease exposures on dairies, and worker safety.

The **Assessing and Preventing Work Related Injuries in Animal Agriculture** research project collected data from multiple sources on injuries to workers in animal agriculture to identify priorities for injury prevention. The project team identified patterns that should be considered for injury prevention efforts. Some injuries appeared to happen more often to newer workers, female workers, and workers conducting specific tasks. The patterns of injuries also differed between raising pigs and dairy cattle. This points to the importance of workers understanding and practicing appropriate animal handling techniques, which, in turn, will improve the well-being of animals. The training of these practices needs to be considered in the context of the tasks involved and the changing nature of the workforce. A more specific risk of injury involves the use of injections for disease prevention and treatment and other animal husbandry needs. Appropriate use and practice in injections, whether traditional or needleless systems, is essential in preventing these injuries. These injuries represent not infrequent events, which are usually of minimal consequence, but have the potential to be quite serious. The findings from this study have informed the development of UMASH training materials and resources for animal handling and preventing needlestick injuries, which have been well received and utilized by key stakeholders.

A. COVER PAGE

Project Title: Evaluation & Planning Core	
Grant Number: 5U54OH010170-10	**Project/Grant Period**: 09/30/2016 - 09/29/2022
Reporting Period: 09/30/2016 - 09/29/2022	**Date Submitted**: See overall
Program Director/ Principal Investigator JEFFREY B BENDER, DVM MS BS Phone number: 612-625-6203 Email: bende002@umn.edu	**Administrative Official Information** Kristina McReynolds 450 McNamara Alumni Center 200 Oak Street SE Minneapolis, MN 554552070
Change of Contact PD/PI:	
Human Subjects: N/A	**Vertebrate Animals:** N/A
hESC: N/A	**Inventions/Patents:** N/A

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The Upper Midwest Agricultural Safety and Health (UMASH) Center Evaluation and Planning Core coordinates the diverse research, education, and outreach components of the center such that the activities of experts working in their own areas benefit the work of all. Each project within the center has its own specific aims and objectives. The Evaluation and Planning Core facilitates and evaluates the combined center functions to catalyze the greatest possible impact. The Evaluation Program has the added advantage of creating a feedback loop for continuous strategic planning. The overall goal of the Planning Program is to coordinate the activities of UMASH to most effectively leverage the Center's resources. The specific aims of the Planning Program are as follows:

Aim 1. Facilitate communication and collaboration between UMASH partners and external stakeholders.

Aim 2. Implement the UMASH Strategic Plan through the Outreach, Emerging Issues, and Evaluation programs

Aim 3. Enhance collaboration with other NIOSH funded centers

Aim 4. Ensure appropriate management of Center resources, activities, budgets, records, and reports.

The overall goal of the Evaluation Program is to provide the evidence necessary to determine achievement of program outputs and desired short-, intermediate-, and long-term outcomes and impactful contributions to Center goals. The specific aims of the Evaluation Program are as follows:

Aim 1. Collaborate with Center Administration and relevant Center staff to plan, design, coordinate, implement, and evaluate key Center-wide work and related outcomes

Aim 2. Collaborate, contribute, and interact with other Agriculture Centers and NIOSH to develop and share evaluation best practices and to define and operationalize common, standardized process and outcome evaluation metrics that effectively and efficiently demonstrate the impact of the NIOSH Agricultural Center program.

B.2. What did you accomplish under these goals?

During this funding cycle, the UMASH Evaluation and Planning Program team 1) engaged in Center-wide and strategic planning, coordination, implementation, and evaluation to ensure appropriate management of Center resources, activities, budgets, records, and reports, 2) collaborated with and contributed to with other Agricultural Centers and NIOSH to enhance and demonstrate the impact of the NIOSH Agricultural Center program, and 3) facilitated bidirectional communication and collaboration between internal UMASH partners and external stakeholder to enhance the overall effectiveness of the Center. There is close coordination between the Evaluation Core and the Administration and Outreach Core and UMASH Center Coordinator, Megan Schossow, served as a key link between the leadership and functional teams to ensure evaluation activities address project needs and priorities and support project strategies and decisions.

Overall, Evaluation and Planning team members plan, coordinate, implement, and evaluate Center activities across the Evaluation and Planning, Research, Outreach, and Emerging Issues programs. To this end, we have effectively 1) promoted Center-wide collaboration, learning, and adapting, 2) supported the Outreach Core and Emerging Issues Programs, 3) built Center-wide evaluation capacity, 4) collaborated and coordinated with other US Ag Centers, and 5) mentored and supported graduate students.

Promoting Center-wide Collaboration, Learning, and Adapting

The Evaluation & Planning team worked across the Center to reflect on UMASH's experiences and understand progress toward intended goals, objectives, and outcomes. Center-wide meetings and events have served as important opportunities for this work. There is widespread consensus that we are implementing activities in line with our mission, vision, and goals. Those who participate in or partner with UMASH have expressed appreciation for our unique collaborations and partnerships, our interdisciplinary One Health approach to agriculture health and safety issues, and our filling of a critical zoonotic and infectious disease niche in the Upper Midwest region. In 2020 and

2021, the Evaluation & Planning team engaged in a focused strategic planning and needs assessment process to understand stakeholder perspectives about various indicators of organizational capacity and development and visions for UMASH's future work. Through Center meetings and one-on-one semi-structured interviews with UMASH staff, researchers, and personnel, this process generated the following key findings:

- Over time, UMASH has developed a variety of unique strengths. There are opportunities to leverage existing strengths to enhance continuity in our work.
- Relationships are integral to UMASH. Our network of stakeholders includes collaborators, EAB, other national Ag Centers, and formal and informal partnerships with both established entities (organizations, boards, etc.), individual people, and communities.
- Justice, equity, diversity, and inclusion (JEDI) are important to consider across the Center, particularly in terms of the representation and relevance of UMASH materials, as well as the makeup of the UMASH staff and stakeholder network.

These findings supported our team in generating an updated Strategic Plan for 2022-2027, which guided decision-making and planning for the 2022 renewal. Further, the Evaluation & Planning team generates reporting tools, data, and information resources (reports, infographics, dashboards, slide decks, brochures, logic models, etc.) to support collaboration, learning, and adapting across the multi-sited Center, functional teams, and partnerships. To understand, document, and share UMASH's outputs and outcomes, the Evaluation Team designs and implements data collection strategies and instruments, develops indicators and benchmarks for monitoring progress, and tracks project outcomes.

Supporting the Outreach Core

UMASH uses what is learned from our Center-wide collaboration, learning, and adapting processes, data analytics, and learning sessions to enhance our outreach strategies, increase partnership engagement, and strengthen cross-project collaborations. We share lessons learned about outreach successes within and beyond the Center through presentations, meetings, and other communication pathways. Early in the past funding cycle, the Evaluation & Planning team supported outreach projects, particularly those implemented in new venues, such as YouTube videos, social media, and website content. For example, to assess a video production project, the team analyzed interview transcripts to 1) determine markers in video footage to splice into promotional videos that corresponded to topics and points of interest for the outreach team and 2) identify perceived benefits of UMASH among internal staff and external farmers, workers, and community partners. In addition, the team has worked to establish a data management system to capture and learn from social media metrics to understand the reach and engagement of our agricultural health and safety messages. This data management system has been expanded and is continually refined to capture analytics from all online outreach platforms (Facebook, Twitter, Instagram, the UMASH website, email communications, YouTube channels). UMASH evaluation personnel work closely with outreach and communications personnel to align these analytics data with strategic outreach goals and objectives to apply action-oriented, data-informed recommendations. Further, the Evaluation & Planning team provides administrative and evaluation support to implement and understand the impact of and opportunities for improvement for UMASH events, like Annual Forums, the UMASH Expo, the Health & Safety Pavilion at Minnesota Farmfest, as well as online and print awareness campaigns, like National Farm Safety and Health Week (NFSHW) and the Agriculture Awareness Safety Program (ASAP) week.

Implementing and Supporting the Emerging Issues Program

The Evaluation & Planning Team provides internal and external support to monitor processes, evaluate outcomes, and share successes for funded Emerging Issues projects. To address a goal to scan the environment to identify emerging new and reemerging trends, the Evaluation Team worked with UMASH staff and leaders to design a 3-step process to identify the most pressing issues with feasible approaches to either conduct pilot research or assemble existing knowledge for education and raising awareness to address the issues: (1) scan the literature and environment and prioritize feasible topics; (2) design and plan an intervention, pilot research, or educational outreach project; and (3) design and implement an evaluation of intended outcomes and benchmark achievements in delivering output products. The model serves to galvanize staff across UMASH, especially Center leadership, around

annual topics that emerged as priorities, for example, mental health and stress, manure management, antimicrobial resistance in agricultural work, and aging on the farm.

New resources are developed in response to health or safety issues being addressed as part of the UMASH Emerging Issues program, and the Evaluation & Planning team helps to strategize, measure, evaluate, and share about their impact. For example, to address mental health and stress, a bilingual Signs and Symptoms of Stress card was developed and was widely disseminated regionally and co-branded by over 30 organizations for dissemination through their communications/outreach channels. A UMASH collaboration with Ag Health and Safety Alliance resulted in a short video and a new stress and mental health module incorporated into their training program for college students, reaching over 5,000 students globally. The Evaluation & Planning team has also evaluated and presented on the outcomes resulting from Emerging Issues projects to share lessons learned and innovative models for addressing these complex topics.

The arrival of the COVID-19 virus in early 2020 provides another example. UMASH quickly became involved in the development of and dissemination of COVID-related resources. The Evaluation & Planning team was critical in monitoring the reach and engagement of these resources and strategizing with the other Cores to improve their development and dissemination. With weekly meetings between the Evaluation and Outreach teams, for example, UMASH communications were responsive to the real-time needs of our stakeholders. To date, our COVID-19 resource webpage has been viewed over 3,000 times by over 2,600 unique users from across the Upper Midwest and the nation.

The Evaluation & Planning team also coordinates and evaluates Annual Forums that provide an opportunity to convene key stakeholders to strategize possible interventions for emerging issues topics. For example, to address Aging on the Farm, this team utilized a Wiki Survey tool to engage an audience, posing the question “which is a more significant health and safety concern for aging farmers?” The Wiki Survey was prepopulated with concerns for folks to compare, and there is also an option to share new ones. The tool was utilized live during the Annual Forum, as well as before and after online, resulting in 1,500 votes, with top concerns including financial worries, musculoskeletal and repetitive stress injuries, operating heavy machinery, fatigue and sleep issues, and balance and coordination problems. These findings helped to support the development of new resources including Parkinson’s adaptations in the workplace and prevention strategies for repetitive motion injuries in agriculture. Additionally, the Evaluation & Planning team documents information about Annual Forum attendance, engagement, and feedback to inform and improve future events.

Building Center-wide Evaluation Capacity

The Evaluation Team has developed and continued to refine data management and evaluation systems for Center-wide outreach reporting and outcomes tracking. For example, early in the grant cycle, the UMASH Outreach Data Management System (ODMS), was updated to more quickly and efficiently merge information into template reports. System updates continue to focus on creating and fine-tuning report templates to meet recurring needs for documenting, monitoring, and communicating Center outreach activities and outcomes. In response to the needs identified during the strategic planning and needs assessment process, this System provided the foundation for the development and pre-testing of a comprehensive Center-wide Monitoring, Evaluation, and Learning (MEL) system. This system is a Strategic Learning & Evaluation System (Preskill & Mack, 2013), informed by the contribution analysis approach. It is the result of 1) an evaluation vision that matches the needs and values of UMASH and those it serves, 2) a comprehensive strategy for evaluation, 3) specific, systematic, and coordinated evaluation activities, and 4) a supportive environment. Contribution analysis is an evaluation approach to develop a plausible theory for how a program goes from inputs to impacts by creating a logical theory of change and gathering evidence to support intermediate outcomes (Downes et al., 2019). UMASH evaluation work is guided by the Center logic model, core logic models (Outreach, Emerging Issues), as well as project-specific models. The system has four distinct and interrelated components: 1) monitoring outputs, 2) evaluating outcomes, 3) strategic reporting, and 4) learning and adapting. Each component includes strategies and tools that map to UMASH’s strategic goals and Center-wide logic model. This

expanded model for engaging in evaluation, monitoring, and learning will be piloted and fully implemented in the future grant cycle.

Further, the Evaluation Team provides technical assistance and evaluation training and development to the Center during Center meetings and to UMASH Research and Emerging Issues project teams as needed to support and enhance evaluation planning and implementation (i.e., developing evaluation questions, plans, logic models, and more).

Collaboration & Coordination with US Ag Centers

UMASH Evaluation & Planning personnel regularly attend, contribute to, and collaborate with other US Ag Centers at all Evaluation, Collaboration, and Outreach (ECO) meetings. UMASH team members consistently collaborate and share insights, tools, and models with this national group. For example, because the ECO group coordinates and participates in the National Farm Safety and Health Week (NFSHW) campaign, there was an expressed need to understand the collective impact of the collaborative campaign. To meet this need, the UMASH Evaluation Team designed, tested, and implemented a process to coordinate social media analytics reporting with other agriculture health and safety Centers. Most Ag Centers have participated in sharing analytics data and the results have facilitated effective discussion about lessons learned from the collaborative campaign during the ECO meetings. Further, these ECO meetings have provided opportunities to develop and share evaluation best practices and develop a common evaluation language to demonstrate the combined impact of the NIOSH Ag Center program. For example, UMASH participated in a contribution analysis process with other NIOSH-funded Ag Centers. UMASH collaborated with Centers in Iowa and Nebraska to conduct a joint contribution analysis with livestock worker health and safety as the primary focus area. Through this collaborative contribution analysis process led by NIOSH, the UMASH Evaluation Team identified and substantiated several intermediate outcomes for UMASH work or collaborations involving livestock handling, including:

- Adoption of hazard monitoring and safety policy programs on farms following dairy worker training
- Adoption of agritourism training program into the bylaws of an agritourism collective
- Adoption of dairy worker safety materials by farms, schools, and other non-profit organizations
- Use of livestock handling educational materials by farms, industry, researchers, and educators
- Views of the U.S. Ag Center and UMASH YouTube livestock safety videos
- Views and downloads of online livestock safety education materials

Since 2018, our Outreach Director and Coordinator has served on the advisory board for the Great Plains Center for Agricultural Health (GPCAH) in Iowa and the director of the High Plains Intermountain Center for Agriculture Health and Safety (HICAHS) served on our advisory board.

Additionally, national collaborations have provided support during unprecedented times. For example, Evaluation Team members participated in a “COVID-19 Evaluation Task Force” where evaluators from agricultural health and safety Centers met regularly during the beginning stages of the pandemic to plan and respond to COVID-19 evaluation needs. Finally, evaluation research assistant, Devon Charlier, has collaborated with other Ag Centers in Nebraska and Iowa to publish a manuscript describing and analyzing data from the Ag Centers’ collaborative YouTube channel (Beseler, et al. 2021).

Mentoring and Supporting Graduate Students

Each year, the UMASH Center hires and/or re-hires public health graduate students and students from other disciplines (e.g., business management, public health, evaluation, educational leadership and professional development) to serve as Research Assistants (RAs) to the UMASH Evaluation and Planning Team. Their work has been supervised by Megan Schossow, Outreach Director and Center Coordinator and Devon Charlier, Evaluation and Communications Manager, and advised by Dr. John LaVelle, Evaluation Director and faculty consultant for program evaluation activities. The Team meets weekly for a minimum of one hour to discuss works in progress and to expand discussions about the relationship of work projects to program evaluation and administration. Students are exposed to UMASH leadership and staff needs, the process of designing new and revising existing Center evaluation projects,

and the approach to engaging and raising awareness among the Center's evaluation stakeholders. Students are given opportunities, as they are ready, to lead discussions, present reports and data, and train staff in using data and data management systems. The exposure to agricultural worker safety and health often dovetails with the student's graduate work interests. UMASH RAs have expressed satisfaction in their exposure to the UMASH mission and projects in addition to their increased knowledge of the work related to evaluating the Center as a program rather than a research project. The Evaluation Team has also undertaken a project with goals to understand and reflect upon UMASH graduate research assistant (GRA) student experiences to 1) facilitate organizational development at the Center and to 2) identify strengths, limitations, and lessons learned. This analysis will yield a model for leveraging evaluation student development and applied experiences to support the evaluation capacity building needs of University-based centers.

References:
Cheryl L. Beseler, Kathryn J. Crawford, Devon E. Charlier & Athena K. Ramos. (2022) The NIOSH Agricultural Centers' YouTube Channel: Time Series Modeling of Viewership of Agricultural Health and Safety Videos, Journal of Agromedicine, 27:4, 368-377, DOI: 10.1080/1059924X.2021.2000907

Preskill, H., & Mack, K. (2013). Building a Strategic Learning and Evaluation System for Your Organization. FSG.

B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

Each year, the UMASH Center hires and/or re-hires public health graduate students and students from other disciplines (e.g., educational leadership and professional development) to serve as research assistants to the UMASH Evaluation Team. Their work has been supervised by Megan Schossow, Outreach Director and Center Coordinator and Devon Charlier, Evaluation and Communications Manager, and advised by Dr. John LaVelle, Evaluation Director and faculty consultant for program evaluation activities. The Team meets weekly for a minimum of one hour to discuss works in progress and to expand discussions about the relationship of work projects to program evaluation and administration. Students are exposed to UMASH leadership and staff needs, the process of designing new and revising existing Center evaluation projects, and the approach to engaging and raising awareness among the Center's evaluation stakeholders. Students are given opportunities, as they are ready, to lead discussions, present reports and data, and train staff in using data and data management systems. They are also invited to participate in agricultural safety and health and/or evaluation professional development opportunities, like workshops, conferences, and more. The exposure to agricultural worker safety and health often dovetails with the student's graduate work interests. UMASH RAs have expressed satisfaction in their exposure to the UMASH mission and projects in addition to their increased knowledge of the work related to evaluating the Center as a program rather than a research project.

B.5. How did you disseminate the results to communities of interest?

The evaluation team generates reporting tools, data, and information resources (reports, infographics, dashboards, slide decks, brochures, etc.) to support collaboration, learning, and adapting across UMASH collaborating centers and functional teams. Megan Schossow is the Center Coordinator and serves as a key link between the leadership and functional teams, ensuring information is promptly shared with all relevant stakeholders. Additionally, regular center-wide meetings provide an opportunity for the evaluation team to share and review results and insights with the broader UMASH team.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

The UMASH evaluation team, in collaboration with outreach and research cores, will continue to implement a Center-wide Monitoring, Evaluation, and Learning (MEL) system in the next 2022-2027 grant cycle, with four distinct and interrelated components: 1) monitoring outputs, 2) evaluating outcomes, 3) strategic reporting, and 4) learning and

adapting. All outputs are documented at regular intervals or as they occur. Outputs are collected in various ways, including an Output Reporting Tool (survey for individuals to report publications, presentations, media appearances, etc.), a biannual survey of project teams, and forms that assist in planning and documenting outreach events. Outcome data are collected from weekly reviews of Google Alerts and similar tools to ascertain online mentions and use of resources, surveys of stakeholders and resource users, personal communications (email, media mentions, testimonials), online analytics data, emerging issues partner project final reports and evaluations, and regular literature and data reviews to glean information about the long-term impact on the burden of injury and illness among the populations of interest. UMASH is invested in learning from evaluation results. To facilitate this, the evaluation team engages in regular internal reporting which involves strategic discussions to ensure that monitoring and evaluation results are used to enhance collaboration, learning, and adapting across the Center.

C. PRODUCTS

C.1. Publications, conference papers, and presentations

Publications:

- Charlier, Devon; Hall, Suness; Kinzer, Hannah; LaVelle, John. (in preparation). Integrating Evaluation into a University-Based Research Center: Triangulating on Graduate Students' Experiences.
- Schossow, Megan; Charlier, Devon; Hall, Suness; Bender, Jeff. (2022). "It Takes a Village: A Novel Process for Responding to Emerging Issues in Agricultural Health and Safety", Journal of Agromedicine, DOI: 10.1080/1059924X.2022.2147114
- Beseler, Cheryl L.; Crawford, Kathryn J.; Charlier, Devon E.; & Ramos, Athena K. (2021). "The NIOSH Agricultural Centers' YouTube Channel: Time Series Modeling of Viewership of Agricultural Health and Safety Videos", Journal of Agromedicine, https://doi.org/10.1080/1059924X.2021.2000907

Presentations:

- Ploeckelman, Melissa; Charlier, Devon; Edlund, Cassandra; Irvine, Kelsey; Heiberger, Scott; Wickman, Amanda; Schossow, Megan. Get your science shared by building a Media Toolkit. Oral/podium presentation. International Society for Agricultural Safety and Health. Fort Collins, CO. June 2022.
- Ploekelman, Melissa; Heiberger, Scott; Charlier, Devon; Leonard, Stephanie; Duysen, Ellen; Palm, Kelsey; Rautiainen, Risto; Yoder, Aaron; Schossow, Megan. Telling a Story to Save a Life - Creating an Impactful First Person Narrative. Oral/podium presentation. International Society for Agricultural Safety and Health. Fort Collins, CO. June 2022.
- Hall, Suness. From the Experts: Contextual Factors in Agricultural Health and Safety. Oral/podium presentation. National Occupational Research Agenda Symposium. Virtual. May 2022.
- Yoder, Aaron; Duysen, Ellen; Charlier, Devon; Heiberger, Scott; Ploeckelman, Melissa; Leonard, Stephanie. Telling the Story: How one farmer's story provided impactful worker training and outreach. Poster presentation. North American Agricultural Safety Summit. Las Vegas, Nevada. March 2022.
- Charlier, Devon; Kampa, Diane; Bertrand, Maria; Schossow, Megan. Strategies for Social Media Evaluation. Oral/podium presentation. 2021 International Society for Agricultural Safety and Health Conference. Virtual. June 2021.
- Charlier, Devon; Schossow, Megan; Abderholden, Sue; Sampson-Bernstrom, Wil; McHale, Hayley; Bender, Jeff. Partnering in Mental Health Support: A Partnership Between the Upper Midwest Agricultural Safety and Health Center and NAMI Minnesota. Poster presentation. Midwest Regional Agricultural Safety and Health Conference. Virtual. November 2020.
- Charlier, Devon; VanBrocklin, Molly; Bertrand, Maria. Building Effective Data Visuals. Webinar. 4th Quarterly NIOSH Extramural Communication Community of Practice. Virtual. November 2020.

- Schossow, M.; Macy, K.; Moynihan, M.; Friedman, J.; Valeri, L.; Vazquez, C.; Kampa, D.; Harwood, E.; Bender, J.; Alexander, B. Building Resilient Agricultural Communities. Poster presentation. 2019 NORA Symposium. Minneapolis, MN. May 2019.
- Kampa, Diane M.; Peterson, Carol M.; Schossow, Megan; Feng Yun-Han,; Harwood, Eileen; Bender, Jeffrey B; Alexander, Bruce H. Implementing a Monthly Farm Safety Check Tool. Midwest Rural Agricultural Safety & Health (MRASH). January 27-29, 2018. Council Bluffs, IA. January 2018.
- Schossow, M; Macy, K; Moynihan, M; Friedman, J; Valeri, L; Vazquez, C; Kampa, D; Harwood, E; Bender, J; Alexander, B. Building Resilient Agricultural Communities. Midwest Rural Agricultural Safety and Health (MRASH). January 27-29, 2018. Council Bluffs, IA. January 2018.

C.2. Website(s) or other Internet site(s) – include URL(s)

N/A

C.3. Technologies or techniques

N/A

C.4. Inventions, patent applications, and/or licenses

N/A

C.5. Other products and resource sharing

N/A

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
JBBENDER	Y	Bender, Jeffery B.		PI/PD	1.80	0.0	0.0			
JMLAVELLE	Y	LaVelle, John Matthew		Co-I	0.93	0.0	0.0			
CTREFRY	N	Peterson, Carol M.		Outreach Coordinator	3.00	0.0	0.0			
MSCHOSSOW	Y	Schossow, M.		Center Coordinator	6.88	0.0	0.0			
	N	Charlier, D.(RA)		Evaluation/ Comm. Manager	5.50	0.0	0.0			
	N	Hall, S.(RA)		Graduate Student RA	1.68	0.0	0.0			
	N	Archibald, Joy		Web Coordinator	1.2	0.0	0.0			

D.2 Personnel updates

a. Level of Effort:

b. New Senior/Key Personnel:

c. Changes in Other Support:

d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

N/a

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

During this funding cycle, the Evaluation and Planning Program has successfully 1) engaged in Center-wide and strategic planning, coordination, implementation, and evaluation to ensure appropriate management of Center resources, activities, budgets, records, and reports, 2) collaborated with and contributed to with other Agricultural Centers and NIOSH to enhance and demonstrate the impact of the NIOSH Agricultural Center program, and 3) facilitated bidirectional communication and collaboration between internal UMASH partners and external stakeholder to enhance the overall effectiveness of the Center. These activities are essential to ensuring the Center's activities are complimentary translated into its intended outcomes, ultimately, improving the health and safety of agricultural workers, families, and communities in the Upper Midwest.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

With recent retirements, we have added new personnel to continue to build our evaluation Team (i.e. Devon Charlier) and the addition of Dr. John LaVelle.

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

N/A

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

N/A

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

G.2 Responsible Conduct of Research

N/A

G.3 Mentor's Research Report or Sponsor Comments

N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?

N/A

G.4.b Inclusion Enrollment Data

G.4.c ClinicalTrials.gov

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

N/A

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

N/A

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

N/A

G.8 Project/Performance Sites

See overall

G.9 Foreign Component

N/A

G.10 Estimated Unobligated Balance

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

G.11 Program Income

Is program income anticipated during the next budget period?

N/A

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?

N/A

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets
Note: project outcome information will be made public in NIH RePORTER

The UMASH Evaluation and Planning Program team successfully 1) engaged in Center-wide and strategic planning, coordination, implementation, and evaluation to ensure appropriate management of Center resources, activities, budgets, records, and reports, 2) collaborated and contributed with other Agricultural Centers and NIOSH to enhance and demonstrate the impact of the NIOSH Agricultural Center program, and 3) facilitated bidirectional communication and collaboration between internal UMASH partners and external stakeholders to enhance the overall effectiveness of the Center.

There is widespread consensus within the Center and its advisory board that we are implementing activities in line with our mission, vision, and goals. Those who participate in or partner with UMASH have expressed appreciation for our unique collaborations and partnerships, our interdisciplinary One Health approach to agriculture health and safety issues, and our filling of a critical zoonotic and infectious disease niche in the Upper Midwest region. The Evaluation and Planning Program developed an updated Strategic Plan to guide activities for 2022-2027 and has increased capacity and developed architecture to engage in Center-wide evaluation, monitoring, and learning more efficiently and effectively, using frameworks like contribution analysis. Further, the Evaluation Team provides technical assistance and evaluation training and development to the Center during Center meetings and to UMASH Research and Emerging Issues project teams as needed to support and enhance evaluation planning and implementation.

The Evaluation and Planning Program has consistently collaborated and shared insights, tools, and models with other Agricultural Health and Safety Centers to elevate the collective work to improve agricultural health and safety, including coordinating the implementation and evaluation of coordinated media campaigns, participating in collaborative logic modeling, collaborating on manuscripts and analyses, and responding to emerging issues like the COVID-19 pandemic. Finally, this team emphasizes training and mentoring students and early career professionals. UMASH RAs have expressed satisfaction in their exposure to the UMASH mission and projects in addition to their increased knowledge of the work related to evaluating the Center and its work. In reflecting upon UMASH graduate research assistant (GRA) student experiences, this team is promoting organizational development at the Center and developing a replicable model for leveraging evaluation student applied experiences to support the evaluation capacity building needs of University-based centers.

Overall, the outcomes of the Evaluation and Planning Program are supportive of the sustainability and outcomes of the other components of the Center, as well as progress toward improving the health and safety of agricultural workers, families, and communities in the Upper Midwest.

A. COVER PAGE

Project Title: Outreach Core	
Grant Number: 5U54OH010170-10	**Project/Grant Period**: 09/30/2016 - 09/29/2022
Reporting Period: 09/30/2016 - 09/29/2022	**Date Submitted**: See overall
Program Director/ Principal Investigator Jeff Bender	**Administrative Official Information** Kristina McReynolds 450 McNamara Alumni Center 200 Oak Street SE Minneapolis, MN 55455-2070
Change of Contact PD/PI: N/a	
Human Subjects: **No**	**Vertebrate Animals: No**
hESC: N/a	**Inventions/Patents: N/a**

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The UMASH Outreach Core prioritizes stakeholder and community engagement and outreach – to listen, engage, raise awareness, provide expertise, collaborate, build partnerships, and promote interdisciplinary One Health approaches to addressing agricultural health and safety issues. The specific aims of the Core are as follows:

Aim 1. Summarize and translate to practice information generated by UMASH activities through communications with stakeholders.

- Objective 1. Increase and expand our network of stakeholders with an interest and/or need to be connected with the UMASH Center.
- Objective 2. Build engagement using traditional and social media/marketing tools and web-based content for UMASH to connect with stakeholders in the region and beyond.

Aim 2. Directly connect with stakeholders to continue a two-way communication path that will keep UMASH work relevant to stakeholder needs and enhance and expand UMASH reach and effectiveness.

- Objective 1. Identify additional forums, including meetings, fairs, and educational venues to deliver outreach and education material and directly interact with stakeholders.
- Objective 2. Incorporate stakeholder feedback into UMASH programs, planning, and evaluation.

Aim 3. Find new or previously unidentified outreach mechanisms and opportunities that support the mission of UMASH.

- Objective 1. Collaborate with researchers, staff, and outreach personnel at the other nine NIOSH-funded Ag Centers as well as regional institutions and organizations to create appropriate materials for delivery to the stakeholders.

B.2. What did you accomplish under these goals?

Aim 1. Summarize and translate to practice information generated by UMASH activities through communications with stakeholders.

- Objective 1. Increase and expand our network of stakeholders with an interest and/or need to be connected with the UMASH.

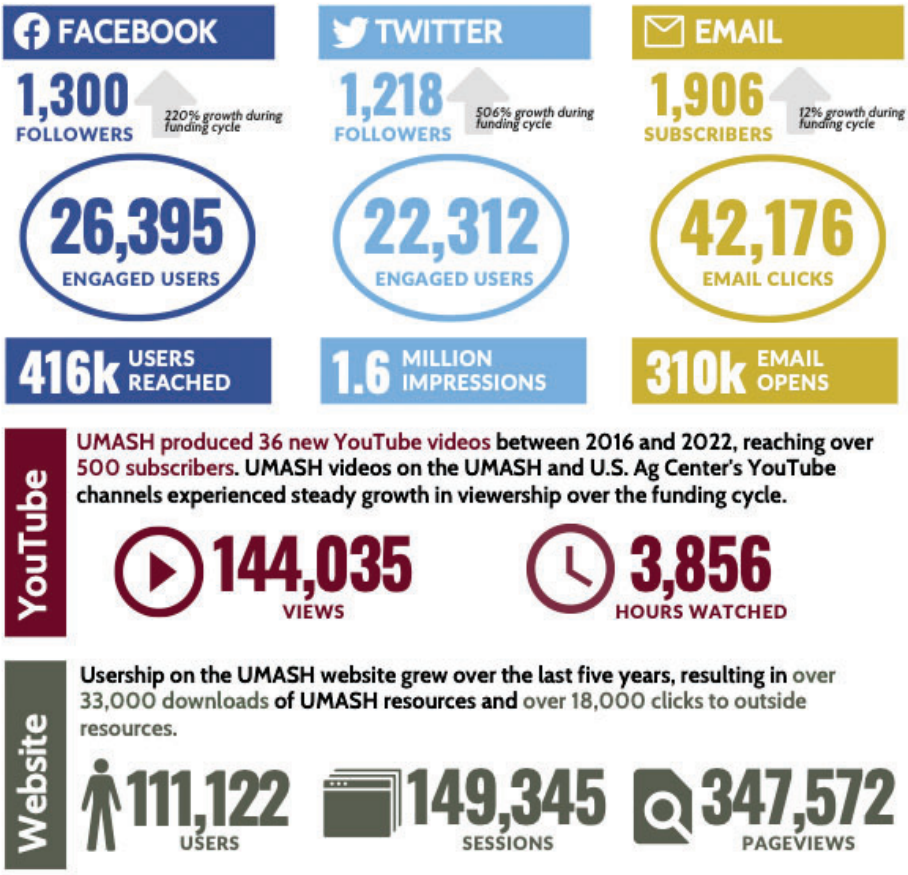
  We substantially grew our network of regional stakeholders in our 5-state region through email, social media, personal interaction at agriculture events, meetings, and other events. As a result, we have continued to see partnership development, substantial website use, meeting/speaker requests, collaborative/co-branded projects, a growing social media following, attendance and engagement in UMASH-facilitated discussions and events, and more. Our Needs Assessment from 2020-21 indicated that partnerships are a strength of UMASH, particularly in Minnesota, which informs strategic efforts throughout our region.

  We leveraged our External Advisory Board and insight from meeting with this board to grow UMASH through their networks. Core members of the UMASH Outreach team leverage this insight in weekly communications meetings and bi-monthly strategy meetings to consider how we can continue to grow the impact of our work in sustainable ways. During this reporting period, we attended new conferences and meetings in new areas of our region, which is reflected in this report.

  We've sponsored and collaborated on events and meetings, increasing and expanding our network, while preserving UMASH time, responsibility, and input. For example: Down of the Farm Workshops (12 farm stress workshops hosted by the Minnesota Department of Agriculture), Women in Agriculture Network, farm stress workshops in Wisconsin, organic conferences, and more.
  UMASH staff serve on external boards, discussed later, and work with groups like the Farm Safety Working Group to advance our work and expand the UMASH network.

- Objective 2. Build engagement using traditional and social media/marketing tools and web-based content for UMASH to connect with stakeholders in the region and beyond.

We've continued to increase engagement with our community throughout this grant reporting period. Our online engagement infographic is indicative of the engagement we've built. On Facebook, we grew our following by 220%, had 26,395 engaged users, and reached over 416,000 users. On Twitter, we grew our following by 506%, and had 22,313 engaged users and 1.6 million impressions. We've grown our website in content and usage and expanded social media channels to meet young users in particular. During this reporting period, we established a strong base on Instagram, grew our multimedia resources on YouTube, and made appearances on numerous podcasts. Our weekly email blasts and quarterly newsletters have reached 1,906 subscribers.



Knowing the population we serve, we've maintained and grown our traditional media engagement. One partnership in particular with a nationally syndicated radio program that incorporated UMASH's 2020 Online Expo's audio clips into their radio content, which had over 1 million impressions. We have leveraged advertisements in print media while also accomplishing print-media stories. For example, the RF-DASH project was highlighted in a four-part series in Progressive Dairyman with a national audience.

To be responsive to emerging issues in agricultural health and safety, the outreach team also developed several online 'toolkits' that support the agricultural workforce. Topics included drought, respirators during COVID-19, and cold stress.

Aim 2. Directly connect with stakeholders to continue a two-way communication path that will keep UMASH work relevant to stakeholder needs and enhance and expand UMASH reach and effectiveness.

- Objective 1. Identify additional forums, including meetings, fairs, and educational venues to deliver outreach and education material and directly interact with stakeholders.

As you can read in B5, we engaged in over 260 events in this reporting period that were attended by tens of thousands of individuals. We've leveraged information from the External Advisory Board and the Needs Assessment to inform strengths and areas where UMASH has the opportunity to improve interactions with stakeholders. During this period, we've grown our participation in events that support women in agriculture (e.g. Dairy Girl Network), immigrant workers in agriculture (e.g., HACER), and agricultural educators (e.g., the University of Minnesota agricultural communication program and Iowa 4H). During this reporting period, we

also established a large health and safety area at Farmfest, one of the Midwest's largest farm shows which attracts ~30,000 attendees from Minnesota, South Dakota, and Iowa in particular. The annual event typically brings nearly 50 partners together to provide health screenings, live demonstrations, resources, and more.

- Objective 2. Incorporate stakeholder feedback into UMASH programs, planning, and evaluation.

  We leverage events and other mechanisms to solicit feedback and input into UMASH work. We use our network's insight to prioritize the topics we work on, what kind of resources we create, which events we attend, our communications strategy, and more. We leverage tools like the Wiki Survey, which allows individuals to vote and prioritize issues, face-to-face interactions, our communication channels (email, phone, inboxes on social media accounts), and forms/surveys. For example, the input gathered led to UMASH prioritizing work on grain bin safety issues as incidents continually crept up during a time within this grant. We extensively leveraged the External Advisory Board to influence which topics or issues needed addressing. This has informed the development of many of our YouTube videos and series (YouTube.com/UMASHCenter) and Farm Safety Check topics. Our work with Christensen Farms on the External Advisory Board led to the development of many of our swine videos, including some planned for the future.

Aim 3. Find new or previously unidentified outreach mechanisms and opportunities that support the mission of UMASH.

- Objective 1. Collaborate with researchers, staff, and outreach personnel at the other nine NIOSH-funded Ag Centers and regional institutions and organizations to create appropriate materials for delivery to the stakeholders.

  During this cycle, we established several innovative outreach and intervention mechanisms. For example, we developed a section of our website that supports educators in incorporating agricultural health and safety into their curriculum. We also developed an innovative project that established an assignment in an upper-level college course. In the agricultural communication course, UMASH wrote an assignment to create an agricultural health and safety public service announcement (PSA). Students are required to interact with health and safety information and understand an agricultural operation's potential hazards and risks. They can submit the PSA to a UMASH-sponsored project with awards in addition. We've seen these resources be integrated into other national competitions and win prestigious awards.

  We work with partners and other organizations to collaboratively produce or co-brand resources for our community. We prioritize resources that make farm safety approachable (Farm Safety Check, which has over 40 topics), posters (which we have developed with partners), training programs (along with dairy groups and swine partners), and more. We developed the 'Signs and Symptoms of Stress' resource in response to a clear need from our community and fellow organizations. This resource has been given out tens of thousands of times, co-branded with at least 20 organizations, translated (Spanish is the most prominent translation), and incorporated into programs like Gear Up for Ag ™ and agricultural QPR.

  Additionally, we have worked extensively to implement national communication campaigns to improve awareness of agricultural hazards and resources available from the US Ag Health and Safety Centers. UMASH has taken the lead in writing, promoting, implementing, and evaluating National Farm Safety and Health Week. We work closely with the American Farm Bureau Federation on the implementation of Agricultural Safety Awareness Program (ASAP) Week. This annual spring campaign reaches across the country and reminds farmers, ranchers, and workers of the importance of safety as spring planting begins.

Overall, the Outreach Core has effectively implemented a multi-disciplinary approach to engage stakeholders through outreach activities and events, raising awareness, building relationships, and disseminating knowledge and resources through various communications strategies and channels.

B.3. Competitive Revisions/Administrative Supplements N/a

B.4. What opportunities for training and professional development did the project provide?

The following list includes a subset of professional development opportunities in which students, staff, and collaborators engaged throughout the grant:

- International Society for Agricultural Safety and Health Conference
- Midwest Rural and Agricultural Safety and Health Conference
- Continuing Education (AgriSafe webinars, IRB Lunch and Learn, NIOSH Extramural presentations, University of Minnesota Communicators Forum)
- Evaluator, Coordinator, Outreach (ECO) Group
- Hiring and mentoring/developing student employees
- Regional meetings and trainings such as: Women in Ag Network, Minnesota Department of Health Emerging Issues Meetings
- Extension Risk Management Education National Conference
- Women Food and Agriculture Network

Each year, the UMASH Center hires and/or re-hires students to serve on the outreach and communications teams. Their writing, editing, and design work have been supervised by Megan Schossow, Outreach Director and Center Coordinator, and Devon Charlier, Evaluation and Communications Manager, to meet the needs of UMASH and to support their professional and skill development. Students are also invited to participate in agricultural safety and health and/or professional development opportunities, like workshops, conferences, and more. The exposure to agricultural worker safety and health often dovetails with the student's interests. Additionally, we've partnered with two doctoral occupational health programs to host capstone students. These students have extensive training in occupational therapy, and join UMASH to learn about program development, typically focusing on resources and interventions. These students, who are now Doctors in Occupational Therapy, created a large series of resources ranging from farming with Parkinson's Disease to reducing lower back pain in crop farming. They have gone on to clinical practice and community development work, further advancing UMASH's mission after they've left.

B.5. How did you disseminate the results to communities of interest?

UMASH leverages several strategies to disseminate resources and information to our stakeholders and target audiences which include in-person outreach events, a robust digital presence, incorporating suggestions from our advisory board (e.g. webinars with Professional Dairy Producers Workers of Wisconsin, stress and mental health concerns with COVID-19 and animal depopulation related to animal disease) and developing strong connections with key organizations across our region who inform and amplify the work of our center.

UMASH staff members hold board and advisory positions at numerous organizations (for example, Great Plains Center for Agricultural Health, High Plains Center for Agricultural Health and Center, and Minnesota Farmer Veteran Coalition). These service opportunities serve as critical dissemination avenues, avenues for bilateral communication with the community we serve, and opportunities to integrate health and safety into the work of many diverse organizations and stakeholders.

We leverage digital technology to provide timely, relevant, and usable information to stakeholders and target audiences across our region (and beyond). Our website provides 24/7/365 access to our resources and is frequently updated with news, events, In the Field updates (highlighting many of UMASH's outreach efforts), Spotlight Stories, which feature an in-depth look at a project, person, or resource, UMASH resources, and more. Weekly email blasts highlight these and other timely information and resources such as the Farm Safety Check topics, Signs and Symptoms of Stress resource, education and training videos, safety posters, fact sheets, etc. We have an active presence on social media (Facebook, Twitter, LinkedIn, YouTube, and Instagram) where these and other relevant news and safety resources are shared.

We continue to build and strengthen relationships with key stakeholders and communications staff through in-person, email, and social media communication channels which have led to more organizations (commodity groups, extension, professional farm organizations, agricultural media, agriculture educators, women in agriculture groups, etc.) mentioning UMASH and sharing our content and inviting UMASH to participate in future events. We use monthly targeted ads on social media and occasional ads in print or online publications to increase the visibility and reach of our center and resources. We invite agricultural health and safety leaders and organizations to be part of our communications and promote their work and resources through Spotlight Stories and In the Field posts.

In this reporting period, the Telling the Story Project was a collaboration between UMASH, the Great Plains Center for Agricultural Health (GPCAH), and the Central States Center for Agricultural Safety and Health (CS-CASH). This project has received extensive print, online, and broadcast media attention, including US News & World Report, Nebraska and Iowa public television, and an editorial in the Omaha World Herald. The project website provides easy access to the stories 24/7/365. Discussion guides created for the stories are also being promoted to agricultural educators for classroom use.

UMASH has increased collaboration with the National Children's Center for Agricultural and Rural Health and Safety to promote agritourism resources on the SafeAgritourism.org website and to co-develop and implement an agritourism social media awareness campaign (Feb-April 2019). UMASH researchers at the Minnesota Department of Health conduct agritourism workshops each year and present on agritourism and the prevention of zoonotic diseases at several regional conferences.

Outreach activities, methods, and results, including campaign toolkits, resources are shared with the other U.S. Agricultural Safety and Health Centers and attendees at agricultural safety and health conferences, such as the International Society for Agricultural Safety and Health (ISASH), Extension Risk Management Education Conference (ERME), Midwest Regional Agricultural Safety and Health conference (MRASH), the Women in Ag Network (WAGN) and Women and Agricultural Leadership (WALC) conferences, and through on-going participation in the U.S. Agricultural Safety and Health Centers Evaluator, Coordinator and Outreach (ECO) group calls and meetings.

We intentionally network and engage with a variety of vendors/exhibitors and media outlets at farm shows and commodity events to increase our network of organizations participating in agricultural safety awareness events and sharing safety resources. For example, we focused on conferences focused on agricultural education, women in agriculture, non-traditional agriculture, and agricultural and trade-related organizations.

We actively seek out educational workshops and other events to offer UMASH resources to event organizers for sharing with attendees. At these events, we have provided dairy stockmanship and needlestick prevention resources for several dairy-related workshops and events. We have collaborated with the Minnesota Department of Agriculture to provide Signs and Symptoms of Stress cards which have been co-branded extensively, with thousands printed and given out during this reporting period.

Additionally, we've partnered with two doctoral occupational health programs to host capstone students. These students have extensive training in occupational therapy and join UMASH to learn about program development, typically focusing on resources and interventions. These students, who are now Doctors in Occupational Therapy, created a large series of resources ranging from farming with Parkinson's Disease to reducing lower back pain in crop farming. They have gone on to clinical practice and community development work, further advancing UMASH's mission after they've left.

Annually, UMASH outreach staff located at the National Farm Medicine Center attend the National FFA Convention. This is a key dissemination event for health and safety resources targeting youth and young adults. We annually survey the student attendees to inform outreach, resource development, and strategic priorities. The resulting information is also shared in public-facing infographics, including topics like health and safety values and beliefs,

safety training, agritourism, and more. This event was successfully hosted online in 2020 due to COVID-19, which got critical health and safety information out during a time when in-person outreach was difficult or not possible.

As discussed in this report, we host a prominent health and safety area at Farmfest, a Midwest farm show that attracts 30,000 attendees. We've held the Wellness Pavilion in-person for three years, which offers health screenings, live demonstrations on safety, and exhibits full of resources and experts in farm health and safety. Thousands of attendees have been reached with this event, with deep partnerships with over 50 organizations who commit to attending or supporting the event in some form.

The UMASH outreach team engaged in over 240 events over the course of the funding cycle, across 6 states in more than 30 cities. These events were attended by tens of thousands of people, and UMASH documented direct engagement with more than 1,500 attendees. Outreach events between 09/30/2016 - 09/29/2022 included:

- Suicide & Mental Health Continuing Ed Conference for Professionals. Managed or worked at a UMASH booth, Glencoe, MN, 09/2022.
- Great Plains Center Regional Advisory Council, Formally presented an update or introduced UMASH and our work at a meeting., Iowa City, IA, 09/2022.
- Farm Progress Show 2022, Managed or worked at a UMASH booth., Boone, Iowa, 08/2022.
- Farmfest 2022, The UMASH team organized a Wellness Pavilion with exhibitors and demonstrators, Redwood Falls, MN, 08/2022.
- Farm Tech Days, Managed or worked at a UMASH booth., Loyal, WI, 07/2022.
- Wisconsin Association of Agricultural Educators , Managed or worked at a UMASH booth, La Crosse, WI, 06/2022.
- Emerging Issues Fair at Minnesota State FFA, Formally presented an update or introduced UMASH and our work at a meeting., Minneapolis, MN, United States 04/2022.
- Respirator Fit Test training, Formally presented an update or introduced UMASH and our work at a meeting., Willmar, MN, 04/2022.
- Respirator Fit Test Training, Formally presented an update or introduced UMASH and our work at a meeting., Mankato, MN, 04/2022.
- Respirator Fit Testing and WPS training, Informally discussed UMASH with event attendees., Mankato, Willmar, MN, 04/2022.
- Women's Agricultural Leadership Conference, Managed or worked at a UMASH booth., Chaska, MN, 04/2022.
- North American Farm and Power Show, Managed or worked at a UMASH booth., Owatonna, MN, 03/2022.
- North American Farm and Power Show, Managed or worked at a UMASH booth., Owatonna, MN, 03/2022.
- Farm City Hub Club, Managed or worked at a UMASH booth., New Ulm, MN, 03/2022.
- Carver County Dairy Expo 2022, Managed or worked at a UMASH booth., Norwood, MN, 02/2022.
- Cottonwood County Elementary Fall Field Days, Managed or worked at a UMASH booth, Lamberton, MN 09/2021.
- Healthy Harvest Fall Field Day, Informally discussed UMASH with event attendees, Aitkin, Minnesota 08/2021.
- Washington County Water Consortium, Formally presented an update or introduced UMASH and our work at a meeting., Stillwater, MN 08/2021.
- Minnesota Farmfest 2021, Managed or worked at a UMASH booth, Morgan, MN 08/2021.
- Farm Technology Days , Managed or worked at a UMASH booth, Eau Claire, Wisconsin 07/2021.
- The Rural Resiliency Project Kickoff , Informally discussed UMASH with event attendees., Eau Claire, Wisconsin 07/2021.
- Minnesota Department of Agriculture Drought Check-in , Formally presented an update or introduced UMASH and our work at a meeting., Minneapolis, Minnesota, United States 07/2021.
- Forty Acre Cooperative's Annual Juneteenth Celebration, Informally discussed UMASH with event attendees., Sandstone, MN 06/2021.
- Minnesota Public Health Association 2021 Conference: Bold and Humble - Engaging in Anti-Racist Public Health, Informally discussed UMASH with event attendees, Virtual 04/2021.
- Agricultural Safety and Health Council's 2021 Safety Summit, UMASH booth, Virtual 03/2021.

- 7th Annual Agricultural Safety Connection, UMASH presentation, Shell Lake, WI, Virtual 01/2021.
- Speaking Silage Safety, Dairy News and Views, Iowa State University, Podcast 11/2020.
- Midwest Rural Agricultural Safety and Health Conference (MRASH), Topics included zoonotic diseases, outreach and social media, and mental health. 11/2020.
- #RuralFarmHealth Twitter Chat, Topic: Rural healthcare for agricultural communities, broadband access, and farmworker health. 11/2020.
- Communicating Complex Information is a Team Effort at UMASH, NIOSH Extramural Communication Community of Practice Group, Virtual 11/2020.
- 2020 Women, Food, and Ag Network Annual Conference: Cultivating (Bio)diversity - Seeding Our Stories, Growing Our Power, Conference attendance, Virtual 11/2020.
- Harvest Safety, Ag Country Rural Perspectives Podcast 09/2020.
- Don't Kiss the Calves: Professional Dairy Producers of Wisconsin, The Dairy Signal, podcast 08/2020.
- Dairy News and Views from ISU: Silage Safety with UMASH, Podcast interview, IA 08/2020.
- Barnesville Area Helpers & UMASH, Mailed UMASH resources, Barnesville, MN 08/2020.
- UMASH at the UMASH Online Expo, Minneapolis, MN, Virtual 08/2020.
- Staying Safe and Staying in Business: a Farmfest Panel, Virtual 08/2020.
- Safe Farming Practices During COVID-19; Land 'O Lakes and National Council of Farmer Cooperatives, Minneapolis,MN, Virtual 07/2020.
- Aging on the Farm, Community Forum; Minnesota/North Dakota, Virtual 06/2020.
- Aging on the Farm, Community Forum; Minnesota/Wisconsin, Virtual 06/2020.
- Wyoming Department of Agriculture & Extension, UMASH presentation, WY, Virtual 06/2020.
- Providing Mental Health Support for Rural Communities; Public Health Institute, University of MInnesota 06/2020.
- NORA Symposium: Creating an Age-Friendly Workplace; Virtual 04/2020.
- Our Invisible Guardians: A Modern Story of Public Health, UMASH work and personnel featured, Documentary 04/2020.
- Wiki Survey: What Are Your Top Health & Safety Concerns for Aging Farmers? We'd Like to Know. 04/2020.
- Keeping Producers/Ag Workers and their Families Safe during the COVID-19 Pandemic", Agrisafe Webinar 4/7/ 2020
- Farm City Hub Club Farm Show, UMASH booth, New Ulm, MN 03/2020.
- 2020 Ag Symposium, UMASH booth, Mankato, MN 02/2020.
- EMS Panel at Ag Symposium, UMASH presentation, Mankato, MN 02/2020.
- Carver County Dairy Expo, UMASH booth, Norwood-Young America, MN. 02/2020.
- 2020 Women in Ag Network, Wilmar, MN 02/2020.
- College of Veterinary medicine Research Seminar, St. Paul, MN 02/2020.
- 2020 American Society for Microbiology Biothreats Conference, Arlington, VA 01/2020.
- Rural Mental Health Check In Meeting, Saint Paul, MN 01/2020.
- UMASH meeting with UMN Occupational Therapy, Minneapolis, MN 01/2020.
- MN Organics 2020, Saint Cloud, MN 01/2020.
- Minnesota Milk Producers Association Expo, Welch, MN 12/2019.
- Gear Up for Ag Health and Safety- South Central College, Mankato, MN 12/2019.
- Mental Well-Being and Resilience Learning Community- November, Minneapolis, MN 11/2019.
- Minnesota Farmers Union Annual Meeting, Minneapolis, MN 11/2019.
- Minnesota Farm Bureau Annual Meeting 2019, Minneapolis, MN 11/2019.
- Women in Sustainable Agriculture, St. Paul, MN 11/2019.
- Multicultural Networking Meeting: Islam 101 (Intro to Islam) by Dr. Mohammad M. Yamin, Mankato, MN 11/2019.
- 2019 Midwest Regional Agricultural Safety and Health Conference Exhibit, Marshalltown, IA 11/2019.
- November 2019 Regional Advisory Council, Marshalltown, IA 11/2019.
- Farm Safety Working Group, St. Paul, MN 11/2019.
- National FFA Convention, Indianapolis, IN 10/2019.

- Women in Sustainable Agriculture participant., Saint Paul, MN 10/2019.
- UMASH Annual Forum: Antimicrobial Resistance: Is it a workers Health and Safety Issue?, St Paul, MN 09/2019.
- Enhanced Farmers Market for President Gabel's Inauguration, Minneapolis, MN 09/2019.
- Southern Research and Outreach Center Open House, Waseca, MN 09/2019.
- Minnesota Crop Insurance Conference, Mankato, MN 09/2019.
- Fall Field Day with Cottonwood County, Lamberton, MN 09/2019.
- Meeting with Cargill- Make the Change, Wayzata , MN 08/2019.
- UMASH Advisory Board Meeting/Call, Minneapolis, MN 08/2019.
- Stress and Mental Health with National Council of Farmer Cooperatives, Minneapolis, MN 08/2019.
- Minnesota Farmfest 2019, Morgan, MN 08/2019.
- Ag Media Summit 2019, Bloomington, MN 07/2019.
- Minnesota Farm Working Group, St. Paul, MN 07/2019.
- Minnesota Association of Agricultural Educators (MAAE), Breezy Point, MN 07/2019.
- 2019 International Society for Agricultural Safety and Health, Des Moines, IA 06/2019.
- University of Minnesota Communicators Forum Annual Conference, Minneapolis, MN 06/2019.
- Stearns County Breakfast on the Farm 2019, Kimball, MN 06/2019.
- Minnesota Ag Communicators Meeting, St. Paul, MN 05/2019.
- 2019 North American Livestock Show and Rodeo Manager’s Annual Meeting and Conference, Bloomington, MN 05/2019.
- University of Minnesota, College of Veterinary Medicine, St. Paul, MN 05/2019.
- American Industrial Hygiene Conference and Exposition, Minneapolis, MN 05/2019.
- MN Farm Safety Working Group Call 05/2019.
- Connecting Call with Goodhue County Community Health - Jessica Seide, Minneapolis, MN 05/2019.
- 2019 NORA Symposium, Minneapolis, MN 05/2019.
- Minnesota FFA 2019 Convention, Minneapolis, MN 04/2019.
- Rural Mental Health Round-table with Congresswoman Angie Craig, Wabasha, MN 04/2019.
- Southern Minnesota Multicultural Networking Meeting, Mankato, MN 04/2019.
- Minnesota Dairy Health Conference 2019, St. Paul, MN 04/2019.
- Dairy Health Conference 2019, St. Paul, MN 04/2019.
- Upper Midwest Dairy Association Conference Rochester, MN 04/2019.
- Upper Midwest Dairy Association Conference Saint Cloud, MN 04/2019.
- Ag Awareness Day 2019, Minneapolis, MN 04/2019.
- Farmfest planning meeting with SCC, North Mankato, MN 04/2019.
- Women's Agricultural Leadership Conference (WALC), Chaska, MN 04/2019.
- Connecting Call with Workplace Safety and Preventions Services, Minneapolis, MN 04/2019.
- UMASH Outreach Discussion, Consultation with Gill Patterson and Amy Fannon, Minneapolis, MN 04/2019.
- Compeer - Mental Health In Agriculture, Mankato, MN 04/2019.
- Central Plains Dairy Expo, Sioux Falls, SD 03/2019.
- GPCAH Regional Advisory Council Meeting via Zoom 03/2019.
- FUSION Conference hosted by the American Farm Bureau Federation; Milwaukee WI 03/2019.
- Wisconsin Ag LEAD Summit, Appleton WI 03/2019.
- Minnesota Agricultural Communicators Group Quarterly Meeting; St. Paul, MN 03/2019.
- Meeting with Safety in Ag for Youth (SAY) and National Farm Medicine Center (NFMC); Minneapolis, MN 02/2019.
- Partnership Development Meeting with MN FFA; St. Paul, MN 02/2019.
- Midwest Organic and Sustainable Education Service (MOSES) 2019 Exhibit Hall; LaCrosse, WI 02/2019.
- Carver County Dairy Expo; Norwood-Young America, MN 02/2019.
- The Resilient Option - seminar on stress and mental health in agriculture, North Mankato, MN 02/2019.
- Women in Ag Network (WAGN), promoted Ag Safety Awareness Program (ASAP) week - Shine a Light on Farm Safety; Willmar, MN 02/2019.

- 4th International Conference on One Medicine One Science Chiang Mai, Thailand 02/2019.
- MN Farm Bureau Leadership Education Advocacy Promotion (LEAP) conference, Provided Ag Center Brochures & Agritourism Brochures for attendee packets; Bloomington, MN 01/2019.
- Meeting with Minnesota Milk Producers (MMPA); Buffalo, MN 01/2019.
- Meeting with Minnesota Turkey Growers Association; Buffalo, MN 01/2019.
- Farmfest Meeting with U of MN Masonic Cancer Center; Minneapolis, MN 01/2019.
- Introductory call with National Pesticide Safety Education Center (NPSEC); Minneapolis, MN 01/2019.
- Minnesota Association of Agricultural Educators; St. Cloud, MN 01/2019.
- Lincoln Memorial University, Harrogate, TN 01/2019.
- Farmfest Meeting with Clinical Trials Network; Minneapolis, MN 01/2019.
- Minnesota Organics Conference; St. Cloud, MN 01/2019.
- Meeting with Progressive Ag Safety and MN Safety Council; St. Paul, MN 12/2018.
- Resilience in the Face of Change seminar - Dennis Hoiberg presenter; St. Paul, MN 12/2018.
- Gear Up for Ag Safety and Health; North Mankato, MN 12/2018.
- Minnesota Milk Producers Association (MMPA) Annual Meeting; Welch, MN 11/2018.
- Midwest Rural Agricultural Safety and Health (MRASH) conference; Council Bluffs, IA 11/2018.
- Great Plains Center for Agricultural Health (GPCAH) Advisory Committee meeting; Council Bluffs, IA 11/2018.
- Farm Bureau Annual Meeting; Bloomington, MN 11/2018.
- Garrett Steede, Ag Education meeting; University of Minnesota - Department of Ag Education; St. Paul, MN 11/2018.
- Midwest Rural Agricultural Safety & Health (MRASH) Conference; Pella, IA 11/2018.
- Farmfest Planning Conference Call with IDEAg; Minneapolis, MN 11/2018.
- Gear Up for Ag Health and Safety Program, Provided resources for college students;Cedar Rapids, IA 11/2018.
- Minnesota Department of Health (MDH) Emerging Issues Breakfast; St. Paul, MN 11/2018.
- National Association of Farm Broadcasters Annual Convention; Kansas City, MO 11/2018.
- Minnesota Milk Producers Association (MMPA) Spanish Workshop; St. Cloud, MN 11/2018.
- National FFA Convention; Indianapolis IN 10/2018.
- Ag Education meeting with Troy McKay- University of Minnesota, Department of Ag Education; St. Paul, MN 10/2018.
- Wisconsin Science Festival at the Marshfield Clinic Research Institute; Marshfield, WI 10/2018.
- Meeting with AgriSafe; Minneapolis, MN 10/2018.
- Men's Night Out, American Legion; Mauston WI 10/2018.
- Agricultural Safety and Health Council of America (ASHCA); Scottsdale, AZ 09/2018.
- National Farm Medicine Center's (NFMC) Auction of Champions; Marshfield, WI 09/2018.
- Meeting with Local County University of Minnesota Extension Staff; Minneapolis, MN 09/2018.
- Biology/Chemistry Seminar at St Catherine University, St. Paul MN 09/2018.
- UMASH Advisory Board and Center Meeting, Minneapolis, MN 09/2018.
- Leman Swine Conference, Saint Paul MN 09/2018.
- Suicide Prevention Walk; Provided Stress resources, Hutchinson, MN 09/2018.
- Big Iron Farm Show 2018; Fargo, ND 09/2018.
- Targeted Email campaign to regional stakeholders to promote Farm Safety Partner Campaign; Minneapolis, MN 09/2018.
- Farm Progress Days; Boone , IA 08/2018.
- Ag for Life Meeting; Minneapolis, MN 08/2018.
- North American Manure Expo; Brookings SD 08/2018.
- Child Injury Prevention Workshop; Marshfield, Wisconsin 08/2018.
- MN Farmfest; Morgan, MN 08/2018.
- Introductory Call with Brownfield Radio about UMASH; Minneapolis, MN 07/2018.
- American Veterinary Medical Association, Denver CO 07/2018.
- Farm Technology Days 2018; Marshfield, WI 07/2018.
- International Society for Agricultural Safety and Health (ISASH) 2018; Halifax, Nova Scotia, Canada 06/2018.

- South Dakota "One Health" Meeting, Sioux Falls SD 06/2018.
- Council of State and Territorial Epidemiologists (CSTE) Annual Conference; West Palm Beach FL 06/2018.
- Breakfast on the Farm; Sauk Centre, MN 06/2018.
- Minnesota Agricultural Communicators Group Quarterly Meeting; Red Wing, MN 05/2018.
- Veterinary Medicine Bio-security Class, University of Minnesota, St Paul MN 05/2018.
- Meeting with Dean Herzfeld (Extension) regarding Pesticide Applicator Program; Minneapolis, MN 05/2018.
- American Industrial Hygiene Conference and Exposition, Philadelphia PA 05/2018.
- Minnesota Environmental Health Association Conference, Deerwood MN 05/2018.
- 2018 National Occupational Research Agenda (NORA) Symposium; Minneapolis, MN 05/2018.
- Minnesota Farm Bureau Safety Conference, Eagan MN 04/2018.
- Multicultural Networking Meeting at the Minnesota State University at Mankato; Mankato, MN 04/2018.
- Agricultural Worker Project Meeting, St Peter MN 04/2018.
- Minnesota Dairy Health Conference; St. Paul, MN 04/2018.
- 2018 Women's Agricultural Leadership Conference (WALC); Chaska, MN 04/2018.
- Extension Risk Management Education Conference (ERME); Milwaukee WI 04/2018.
- Agriculture Awareness Day 2018 - University of Minnesota; Minneapolis, MN 04/2018.
- Central Minnesota Farm Show; St. Cloud, MN 03/2018.
- Great Plains Center for Agricultural Health (GPCAH) Regional Advisory Committee Teleconference; Iowa City, IA 03/2018.
- Down on the Farm Workshops (am/pm), Thief River Falls, MN 03/2018.
- Down on the Farm Workshops (am/pm), Grand Rapids, MN 03/2018.
- Central Minnesota Farm Show, St. Cloud, MN 02/2018.
- Ag Safety Day at Wisconsin Indianhead Technical College, New Richmond, WI 02/2018.
- 2018 Organic Farming Conference (MOSES), LaCrosse, WI 02/2018.
- Down on the Farm Workshops (am/pm), Austin MN 02/2018.
- Down on the Farm Workshops (am/pm), No. Mankato, MN 02/2018.
- Marshfield Farm Show, Marshfield, WI 02/2018.
- ASCHA annual conference vendor, Scottsdale, AZ 02/2018.
- Carver County Dairy Expo, Norwood Young America, MN 02/2018.
- National Pork Board Unified Committee Meetings, Des Moines, IA 02/2018.
- Extension Management Leadership Series - Dairy, Litchfield, MN 02/2018.
- Down on the Farm Workshops (am/pm), Willmar, MN 01/2018.
- Down on the Farm Workshops (am/pm), Marshall, MN 01/2018.
- GrassWorks Grazing Conference, Wisconsin Dells, WI 01/2018.
- Managing Stresses in Farming, Families and Finances Workshop,Bismarck, ND 01/2018.
- UMASH Meeting with the Center for Rural Health (SPH), Minneapolis, MN 01/2018.
- Lake County Extension Round Up, Devils Lake, ND 01/2018.
- Emily Wilmes Master's Presentation on UMASH Pilot Project, Communication Strategies to Support Agricultural Innovations 12/2017.
- Minnesota Milk Producers Association Annual Meeting, Welch, MN 11/2017.
- Minnesota Department of Health's Emerging Issues Breakfast, Saint Paul MN 11/2017.
- Minnesota Township Annual Conference, Rochester, MN 11/2017.
- Committee Meeting, Pella IA 11/2017.
- Midwest Rural Agricultural Safety & Health Conference, Pella, IA 11/2017.
- FFA National Convention, Indianapolis, IN 11/2017.
- National Association of Farm Broadcasters, Kansas City, MO 11/2017.
- UMASH meeting with ECHO/Twin Cities Public TV (TPT), Saint Paul, MN 11/2017.
- Minnesota Milk Producers Association (MMPA) Spanish Workshop, St. Cloud, MN 11/2017.
- MN Farm Safety Working Group, Eagan MN 11/2017.
- University of Minnesota School of Public Health Community Partner, Award Ceremony to recognize Monica Cruz Zorilla 11/2017.

- World Dairy Expo, Madison, WI 10/2017.
- National Farm Medicine Center's Auction of Champions, Marshfield WI 09/2017.
- Committee Teleconference, Iowa City, IA 09/2017.
- Big Iron Farm Show, Fargo, ND 09/2017.
- Conference, Edinburgh, UK 08/2017.
- Minnesota Milk Producers Association, Spanish Workshop, Rochester, MN 08/2017.
- Minnesota Farmfest 2017, Redwood Falls, MN 08/2017.
- U of IA Extension, Visit IA Farms program teleconference, Minneapolis, MN 07/2017.
- International Society for Agricultural Safety and Health (ISASH), Logan UT 06/2017.
- Children's Agricultural Safety Network Meeting, Logan UT 06/2018.
- Work, Stress and Health: The 12th International Conference on Occupational Stress and Health 06/2017.
- 2017 NORA Symposium, Minneapolis, MN 05/2017.
- UMASH meeting with Minnesota Milk Producers Association's Education Director 04/2017.
- Minnesota Institute for Sustainable Agriculture: Local Advisory Committee 04/2017.
- Women in Agriculture Leadership, Chaska, MN 04/2017.
- University of Minnesota Ag Awareness Day, Minneapolis, MN 04/2017.
- Committee Teleconference, Iowa City, IA 04/2017.
- Manure Pit Safety Seminar, Plover, WI 04/2017.
- WI Agrability Summit, Marshfield WI 03/2017.
- MN Veterinary Medicine Assn Annual Convention, Hyatt Regency, Minneapolis MN 02/2017.
- KIKV Winter Ag Show, Alexandria MN 02/2017.
- Meeting with Minnesota Milk Producers Assn, Buffalo MN 02/2017.
- MN Turkey Growers, Buffalo MN 02/2017.
- MN Ag Expo, Mankato MN 01/2017.
- Upper Midwest Regional Fruit and Vegetable Growers Conference, Saint Cloud MN 01/2017.
- R. Swenson pilot project – provided UMASH resources to be distributed to pilot project participants (producers, ag media) 12/2016.
- MN Farmers Union Annual Meeting, Ramada Plaza, Minneapolis MN 11/2016.
- Minnesota Farm Bureau Annual Meeting, Bloomington MN 11/2016.
- Midwest Regional Agricultural Safety and Health Conference, Ag Health and Safety Expo, Sioux Center IA 11/2016.
- AgriGrowth Council Meeting, Minnesota 11/2016.
- National FFA Annual Convention, Indianapolis IN 10/2016.
- World Dairy Expo, Madison WI 10/2016.

The UMASH team also participated in over 130 media interviews to disseminate messaging and resources to agricultural communities and those who influence them:

- Megan Schossow, Midwest Farm Report, Radio, 09/2022.
- Kyle Koshalek , Dairy Star, Print, newspaper or magazine, 09/2022.
- Megan Schossow, AgDay TV, Television, 08/2022.
- Megan Schossow, WAXX radio, Radio, 04/2022.
- Megan Schossow, Linder Farm Network, Radio, 04/2022.
- Megan Schossow, Red River Farm Network, Radio, 04/2022.
- Jeff Bender, Almanac, Print, newspaper or magazine, 04/2022.
- Jeff Bender, School of Public Health, Print, newspaper or magazine, 04/2022.
- Jeff Bender, UMN News, Print, newspaper or magazine, 04/2022.
- Megan Schossow, Dairy News & Views with Iowa State University , Other:, podcast 03/2022.
- Jeff Bender, Minnesota Public Radio, Radio 12/2021.
- Megan Schossow, Flatwater Free Press, Print, newspaper or magazine 11/2021.
- Jeff Bender, WCCO TV; Minneapolis, Television 11/2021.
- Jeff Bender, WCCO TV, Television 11/2021.

- Jeff Bender, AgriSafe Network, Podcast 10/2021.
- Carol Peterson, Linder Farm Network; Corn Update, Radio 09/2021.
- Megan Schossow, Red River Farm Network, Radio 09/2021.
- Megan Schossow, Linder Farm Network; Corn Update, Radio 09/2021.
- Jeff Bender, Minnesota Farm Guide, Print, newspaper or magazine 08/2021.
- Cassandra Edlund, KLGR interview with Scott Colombe, Radio 08/2021.
- Megan Schossow, DairyStar, Print, newspaper or magazine 06/2021.
- Megan Schossow, Dairy Star, Print, newspaper or magazine 06/2021.
- Kyle Koshalek , Spectrum News 1, Television 05/2021.
- Jeff Bender, Minnesota Farm Guide, Print, newspaper or magazine 03/2021.
- Casper Bendixen, The Grand Island Independent, Print, newspaper or magazine 02/2021.
- Megan Schossow, Minnesota Farm Guide and Farm & Ranch Guide, Print 01/2021.
- Peter Davies, West Central Tribune, Print 01/2021.
- Megan Schossow, KEYC, Print 11/2020.
- Megan Schossow, Iowa Farmer Today, Print 11/2020.
- Megan Schossow , Faribault Daily News, Print 10/2020.
- Megan Schossow, Growing On Podcast with Georgia Farm Bureau, Podcast 10/2020.
- Megan Schossow, AgWeek TV, Television 09/2020.
- Megan Schossow, KRVN/Rural Radio Network, Radio, 09/2020.
- Megan Schossow, KASM Radio, Radio 09/2020.
- Megan Schossow, Rural Perspectives Podcast for AgCountry Farm Credit Services, Podcast 09/2020.
- Megan Schossow, RFD Radio Network, Radio 09/2020.
- Jeff Bender, The Land Online, Print 08/2020.
- Jeff Bender, National Corn Growers, Print 08/2020.
- Megan Schossow, Minnesota Corn Growers, Print 07/2020.
- Megan Schossow, Minnesota Soybean - UMASH Expo, Print 07/2020.
- Megan Schossow, 40 Square Cooperative - UMASH Expo, Print 07/2020.
- Megan Schossow, In Her Boots, Print 07/2020.
- Megan Schossow, In Her Boots, Print 07/2020.
- Megan Schossow, RFD Radio Network, Radio 07/2020.
- Megan Schossow, AgWeek Media, Television 06/2020.
- Megan Schossow, Successful Farming, Radio 06/2020.
- Megan Schossow, Minnesota Corn - Spring Safety, Print 04/2020.
- Megan Schossow, Linder Farm Network- Spring Planting Corn Matters, Radio 04/2020.
- Megan Schossow, Red River Farm Network, Radio 04/2020.
- Jeff Bender, Fox 9, Television 03/2020.
- Jeff Bender, RRFN, Radio 03/2020.
- Jeff Bender, UMN Swine Group, Print 03/2020.
- Jeff Bender, KFGO, Radio 03/2020.
- Jeff Bender, MN News Network - Mental Health, Radio 02/2020.
- Megan Schohssow, Fargo Forum - Chris Hagen, Print 02/2020.
- Jeff Bender, University of Minnesota -U Relations, Online feature 02/2020.
- Megan Schossow, Grain Safety Week- RRFN, Radio 02/2020.
- Megan Schossow, Ag State of Mind, Podcast 02/2020.
- Casper Bendixsen, Successful Farming, Print 02/2020.
- Megan Schossow, RFD TV, Television 01/2020.
- Megan Schossow, Linder Farm Network, Radio 01/2020.
- "Casper Bendixsen, Off-Farm Income: Agricultural Health & Safety Special Edition | Casper Bendixsen | Director Of The National Farm Medicine Center
- https://player.fm/series/off-farm-income/ofi-732-agricultural-health-safety-special-edition-caspe r-bendixsen-director-of-the-national-farm-medicine-center, Podcast 12/2019."

- Megan Schossow and Carol Peterson, KDHL the Mighty 920, Radio 11/2019.
- Melissa Ploeckelman, Brownfield News, Radio 11/2019.
- Melissa Ploeckelman, Springfield IL, WFMB, Radio 11/2019.
- Scott Heiberger, KQLX, Fargo, Radio 11/2019.
- Melissa Ploeckelman, Texas Farm Bureau, Radio 11/2019.
- Scott Heiberger, Carrollton, MO, KMZU, KRLI, The Grenade 101.3, Radio 11/2019.
- Scott Heiberger, Watseka, IL, WGFA, WIBK, Radio 11/2019.
- Melissa Ploeckelman, Michigan Ag Today, Radio 11/2019.
- Scott Heiberger, Meredith Agrimedia, Des Moines, IA, Radio 11/2019.
- Scott Heiberger, Off-Farm Income, Weekly Podcast, Ag Curriculum and Marketing, Radio 11/2019.
- Kyle Koshalek, Madison, WI, NBC Channel 15 News, Television 11/2019.
- Scott Heiberger, Texas Farm Bureau, Radio 11/2019.
- Melissa Ploeckelman, Ag Marketing Firm, Radio 11/2019.
- "Casper Bendixsen, Daily Dispatch - Daily News for America's Fire Service
- https://www.dailydispatch.com/StateNews/WI/2019/November/14/Madison.Program.trains.first .responders.to.respond.to.farm.accidents.aspx 11/2019."
- Melissa Ploeckelman, USDA Radio, Radio 11/2019.
- "Scott Heiberger , Successful Farming, Farmers and firefighters
- https://www.agriculture.com/podcast/successful-farming-radio-podcast/farmers-and-firefighters, Radio 11/2019."
- Megan Schossow, Global Ag Network, Ag State of Mind by Jason Meadows, podcast 11/2019.
- Megan Schossow, Linder Farm Network, Radio 10/2019.
- Megan Schossow, Red River Farm Network, Radio 10/2019.
- Megan Schossow, The Farmer Magazine, Print 10/2019.
- Scott Heiberger, RF-DASH National Training Press Release 10/2019.
- Diane Kampa, Linder Farm Network Radio, Radio 09/2019.
- Diane Kampa, National Association of Farm Broadcasting News Service, Radio 09/2019.
- Bruce Alexander, KLGR Radio, Redwood Falls MN, Radio 09/2019.
- Jeff Bender, TPT SPH Documentary, Television 12/2019.
- "Casper Bendixsen, Dairy Radio Now
- https://dairyradio.com/program-teaches-rural-9-1-1-response/, Radio 08/2019."
- Megan Schossow, Diane Kampa, Jeff Bender, Joni Scheftel, University of Minnesota Alumni Association, Print 08/2019.
- Bruce Alexander, Brownfield Ag News, Print 08/2019.
- Megan Schossow, Georgia Farm Bureau, Podcast 09/2019.
- "Casper Bendixsen, Dairy Radio Now
- https://dairyradio.com/improving-farm-safety/, Radio 07/2019."
- Diane Kampa, MN News Network affiliated with Linder Farm Network of 80 affiliates in MN), Radio 07/2019.
- "Kyle Koshalek
- https://www.producer.com/2019/08/online-tools-help-analyze-hazards/ , Print 08/2019."
- Bruce Alexander , University of Minnesota Relations, Print 07/2019.
- Diane Kampa, Red River Farm Network Radio, Radio 05/2019.
- Diane Kampa, Linder Farm Network, Radio 05/2019.
- Bruce Alexander, Morrison County Record, Print, newspaper or magazine 04/2019.
- Carrie Klumb, Dairy Star - an online journal for dairy farmers 02/2019.
- Casper Bendixsen, Kelly Rocheleau. Auburnpub.com 09/2018.
- Bruce Alexander, MN Corn Minute, Linders Farm Network, Radio 09/2018.
- Bruce Alexander, MN Corn Minute; Red River Farm Network, Radio 09/2018.
- Bruce Alexander, MN Corn Growers , Other:, Free Lance writer for MN Corn Growers 09/2018.
- Bruce Alexander, KLGR Radio - RedWood Falls, Radio 09/2018.
- Carol Peterson, KFGO - AM radio, Fargo ND, Radio 09/2018.

- Diane Kampa, Farmer's Hotline, Print Ad 09/2018.
- Diane Kampa, Agriview, Print Ad 09/2018.
- Diane Kampa, MN Soybean, Radio 09/2018.
- Bruce Alexander, Linder Farm Network, Radio 08/2018.
- Carol Peterson, KLGR Radio - Redwood Falls, MN, Radio 08/2018.
- Bruce Alexander, Your Ag Network, Radio 07/2018.
- Melissa Ploeckelman, KORN, Radio 07/2018.
- Diane Kampa, WDLB-AM 1540 - Seehafer Broadcasting, Radio 07/2018.
- Melissa Ploeckelman, Midwest, Eastern, Southern Farm and Livestock Directory https://farmandlivestockdirectory.com/raising-farm-safety-awareness-through-personal-stories/ 07/2018.
- Melissa Ploeckelman, Country Today http://www.thecountrytoday.com/Farm/Farm News/2018/07/02/div-class-libPageBodyLinebreak-New-project-helps-farmers-share-stories-safety messages-br-div.print 07/2018.
- Casper Bendixsen, Matthew Alfutis. Cornell Small Farms Program 06/2018.
- Melissa Ploeckelman, Farms.com https://www.farms.com/ag-industry-news/farmers-sharing-safety stories-490.aspx 06/2018.
- Melissa Ploeckelman, Farm Journal's Pork https://www.porkbusiness.com/article/new-project-helps farmers-share-stories-safety-messages 06/2018.
- Melissa Ploeckelman, Morning Ag Clips: https://www.morningagclips.com/new-project-helps farmers-share-safety-messages/ 06/2018.
- Diane Kampa, radio interview with KASM Radio, Central Mn Farm Show, St Cloud MN 02/2018.
- Melissa Ploeckelman, radio interview with Brownfield Ag News, National Association of Farm Broadcasters Conference, Kansas City MO 11/2017.
- Bruce Alexander, radio Interview with KASM Radio, Albany MN 10/2017.
- Bruce Alexander, radio interview with KFGO radio, Fargo, ND 09/2017.
- Bruce Alexander, radio interview with Linder Farm Network, Owatonna MN 09/2017.
- Diane Kampa, radio interview with KELO radio, Souix FallsDiane Kampa, radio interview with KELO radio, Sioux Falls SD 08/2017.
- Bruce Alexander, media interview with Dairy Star 07/2017.
- Ag media interview for MN CORNerstone Blog 03/2017.
- Radio Interview with Linder Farm Network 02/2017.
- Radio Interview with Red River Farm Network 02/2017.
- Ag media interview for Iowa Farm Bureau article 01/2017.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

N/A

C. PRODUCTS

C.1. Publications, conference papers, and presentations

Publications:

- Charlier, Devon, et al., (06/2022)."Assessing Self-reported Occupational Hazards of Manure Applicators in the Upper Midwest", Journal of Agromedicine, https://doi-org.ezp2.lib.umn.edu/10.1080/1059924X.2022.2089423
- Schossow, Megan, et al., (04/2022)."Building Resilient Agricultural Communities: A Process for Addressing Mental Health Challenges in Agricultural Communities", Journal of Agromedicine, https://www.tandfonline.com/eprint/QZMUEYTEGGP4XA8UGDHQ/full?target=10.1080/1059924X.2022.2058138
- Peterson, Carol, (09/2019). "Shift Farm Safety into High Gear", Messenger Newspaper, Fort Dodge IA, https://www.messengernews.net/

- Lin, H., Liu, W., Gan, J., Wang, Y., & Hu, B. (2018). Simulation of hydrogen sulfide emission from deep-pit manure storage during agitation. Transactions of the ASABE, 61(6), 1951-1967. https://doi.org/10.13031/trans.12866
- Coventry, Martha. (03/2019). "Staying Resilient in Farm Country", University of Minnesota School of Public Health News, https://www.sph.umn.edu/news/staying-resilient-in-farm-country/
- Wilmes, Emily and Swenson, Rebecca. (03/2019). "Engaging Dairy Farmers in Safety Messages: Values, Moral Norms, Barriers, and Implications for Communication", Journal of Applied Communications: Vol. 103: Iss. 1. https://doi.org/10.4148/1051-0834.2204
- Weichelt B, Bendixsen C, Keifer M. (01/2019). "Farm Owners and Workers as Key Informants in User-Centered Occupational Health Prototype Development: A Stakeholder-Engaged Project." J Med Internet Res 2019;21(1):e9711. http://doi.org/10.2196/jmir.9711
- Bender, Jeff, (10/2018), "Stress Less with Safe Animal Handling", Farmer's Hotline, http://viewer.zmags.com/publication/9d14c42b#/9d14c42b/9
- Swenson, Rebecca, (07/2018), "Safely through the Gate: Exploring Media Coverage and Journalists Decisions on the Flow of Farm Safety Stories", Journal of Applied Communications, https://doi.org/10.4148/1051-0834.1840

Presentations:

- Bender, Jeff. CS-CASH Grand Rounds. Oral/podium presentation. CS-CASH. Omaha, NE. 09/2022.
- Ploekelman, Melissa; Heiberger, Scott; Charlier, Devon; Leonard, Stephanie; Duysen, Ellen; Palm, Kelsey; Rautiainen, Risto; Yoder, Aaron; Schossow, Megan. Telling a Story to Save a Life - Creating an Impactful First Person Narrative. Oral/podium presentation. International Society for Agricultural Safety and Health. Fort Collins, CO. 06/2022.
- Ploeckelman, Melissa; Charlier, Devon; Edlund, Cassandra; Irvine, Kelsey; Heiberger, Scott; Wickman, Amanda; Schossow, Megan. Get your science shared by building a Media Toolkit. Oral/podium presentation. International Society for Agricultural Safety and Health. Fort Collins, CO. 06/2022.
- Galvan, Alma; Liebman, Amy. Diversity, Equity, Inclusion, and Justice Workshop. Oral/podium presentation. International Society for Agricultural Safety and Health Conference 2022. Fort Collins, CO. 06/2022.
- Bender, Jeff.Highly Pathogenic Avian Influenza (HPAI) Outbreaks: A One Health Perspective . Oral/podium presentation. NORA AgFF Spring 2022 Meeting. 05/2022.
- Maddock, Kelli. Carriage of Antimicrobial Resistant Flora and Enteric Pathogens Among Veterinary Professionals. Oral/podium presentation. National Occupational Research Agenda Symposium. Virtual. 05/2022.
- Edlund, Cassandra. A Strategic Approach to Assessing and Leveraging Resources. Oral/podium presentation. National Occupational Research Agenda Symposium. Virtual. 05/2022.
- Bender, Jeff. The Changing Nature of Work: Impacts of COVID-19 on our Health Care Workforce. National Occupational Research Agenda Symposium. Virtual. 05/2022.
- Schossow, Megan. Women in Agricultural Leadership. Oral/podium presentation. Women in Agricultural Leadership Conference. Chaska, MN. 04/2022.
- Schossow, Megan. Managing Assets: Keeping People on the Farm Healthy. Oral/podium presentation. Wisconsin AgrAbility Summit 2022. Cashton, WI. 04/2022.
- Yoder, Aaron; Duysen, Ellen; Charlier, Devon; Heiberger, Scott; Ploeckelman, Melissa; Leonard, Stephanie. Telling the Story: How one farmer's story provided impactful worker training and outreach. Poster presentation. North American Agricultural Safety Summit. Las Vegas, Nevada. 03/2022.
- Schossow, Megan. Risk on the Farm. Oral/podium presentation. Han San Lake Insurance Annual Meeting 2022. Maple Lake, MN 03/2022.
- Bender, Jeff. Safety Talk with Minnesota Soil. Panel discussion. Minnesota Soil Meeting. Elk River, MN 03/2022.
- Bender, Jeff. Food Safety with Manure. Oral/podium presentation. UMN Extension Food Safety Meeting. 03/2022.

- Schossow, Megan and Peterson, Carol. Breaking: Safety is Sustainable. Webinar. Minnesota FFA Ag Communications Career Development Events and Leadership Conference. Virtual. 12/2021.
- Schossow, Megan; Ploeckelman, Melissa; Davidson, Jana. You've Got Mail: emailing your audience and measuring success. Panel discussion. 2021 Midwest Rural and Agricultural Safety and Health Conference. Virtual. 11/2021.
- Schossow, Megan. Drought and Agricultural Health. Oral/podium presentation. Washington County Water Consortium - September Meeting. 09/2021.
- Schossow, Megan. Collaborative Centers: Co-branding at US Ag Health and Safety Centers. Oral/podium presentation. NIOSH Extramural Communications meeting. Virtual. 08/2021.
- Bender, Jeff. Zoonotic Disease and Food Safety on the Farm. Oral/podium presentation. Healthy Harvest Fall Field Day. Aitkin, Minnesota 08/2021.
- Schossow, Megan. Minnesota Agricultural Cooperative Safety Directors. Oral/podium presentation. Minnesota Agricultural Cooperative Safety Directors Quarterly July Meeting. Spicer, Minnesota. 07/2021.
- Charlier, Devon; Ploeckelman, Melissa; Schossow, Megan. Collaborative Campaigns: Understanding Impact. Oral/podium presentation. 2021 International Society for Agricultural Safety and Health Conference. Virtual. 06/2021.
- Gibbs, Jenna; Sheridan, Carolyn; Brihn, Gus; Sullivan, David; Walls, Kayla. Protecting Livestock Workers, Their Families, and Animals from Zoonotic Disease: Evaluation of New AMR Curriculum in the Gear Up for Ag Program. Oral/podium presentation. 2021 International Society for Agricultural Safety and Health Conference. Virtual. 06/2021.
- Charlier, Devon; Schossow, Megan. Partnering in Mental Health Support. Oral/podium presentation. 2021 International Society for Agricultural Safety and Health Conference. Virtual. 06/2021.
- Schossow, Megan; Olson, Averi; Bender, Jeff. Aging on the Farm. Oral/podium presentation. 2021 International Society for Agricultural Safety and Health Conference. Virtual. 06/2021.
- Charlier, Devon; Wilson, Melissa; Modderman, Chryseis; Cortus, Erin; Janni, Kevin; Peterson, Carol; Schossow, Megan; Bender, Jeff. Assessing Occupational Risks of Manure Applicators in the Upper Midwest. Oral/podium presentation. 2021 International Society for Agricultural Safety and Health. Virtual. 06/2021.
- Charlier, Devon; Wilson, Melissa; Modderman, Chryseis; Cortus, Erin; Janni, Kevin; Peterson, Carol; Schossow, Megan; Bender, Jeff. Assessing occupational risks of manure applicators in the Upper Midwest. Poster presentation. National Occupational Research Agenda (NORA) Symposium. Virtual. 05/2021.
- Sellman, Jonathan. COVID-19 in the Workplace: Creating Safe Workspaces. Panel discussion. National Occupational Research Agenda (NORA) Symposium. Virtual. 04/2021.
- Sheridan, Carolyn; Gibbs, Jenna; Brihn, Gus; Walls, Kalya; Sullivan, David. Protecting Livestock Workers, Their Families, and Animals from Zoonotic Disease: Evaluation of New AMR Curriculum in the Gear Up for Ag Program. Poster presentation. National Occupational Research Agenda (NORA) Symposium. Virtual. 04/2021.
- Olson, Averi; Schossow, Megan; Gaugler, Joseph; Bender, Jeff. Aging on the Farm: Supporting Healthy Aging Across the Lifespan. Poster presentation. National Occupational Research Agenda (NORA) Symposium. Virtual. 04/2021.
- Olson, Averi; Haskins, Tara; Pickett, Kristen; Mullins, Amy. Parkinson's Disease and Aging in Agriculture. Webinar. AgriSafe & UMASH Continuing Education Webinar. Virtual. 04/2021.
- Schossow, Megan. Aging on the Farm. Oral/podium presentation. North American Agricultural Safety Summit. Virtual. 03/2021.
- Schossow, Megan. Tools of the Trade: Dairy Producer Training Guides. Oral/podium presentation. North American Agricultural Safety Summit. Virtual. 03/2021.
- Charlier, Devon; Wilson, Melissa; Modderman, Chryseis; Cortus, Erin; Janni, Kevin; Peterson, Carol; Schossow, Megan; Bender, Jeff. Assessing occupational risks of manure applicators in the Upper Midwest. Poster presentation. North American Agricultural Safety Summit. Virtual. 03/2021.
- Schossow, Megan. Talking Stress, Talking Solutions. Oral/podium presentation. 2021 Women in Ag Network Conference. Virtual. 02/2021.
- Schossow, Megan; Younggren, Dan; Olson, Averi. Aging on the Farm. Oral/podium presentation. Aging on the Farm at Midwest Regional Ag Safety and Health Conference. Virtual. 11/2020.

- Schossow, Megan; Duysen, Ellen; Cheney, Marsha. Striving to Conduct Effective Agricultural Safety and Health Outreach During a Pandemic: From John Deere Masks to Plexiglass. Oral/podium presentation. Midwest Regional Agricultural Safety and Health Conference. Virtual. 11/2020.
- Charlier, Devon; Schossow, Megan; Abderholden, Sue; Sampson-Bernstrom, Wil; McHale, Hayley; Bender, Jeff. Partnering in Mental Health Support: A Partnership Between the Upper Midwest Agricultural Safety and Health Center and NAMI Minnesota. Poster presentation. Midwest Regional Agricultural Safety and Health Conference. Virtual. 11/2020.
- Bertrand, Maria; Charlier, Devon; VanBrocklin, Molly. Oral/podium presentation. Leveraging Social Media to Promote Agricultural Health and Safety. Midwest Regional Agricultural Safety and Health Conference. Virtual. 11/2020.
- Charlier, Devon; VanBrocklin, Molly; Bertrand, Maria. Building Effective Data Visuals. Webinar. 4th Quarterly NIOSH Extramural Communication Community of Practice. Virtual. 11/2020.
- Schossow, Megan; Ploeckelman, Melissa; Pennington, Whitney; Pate, Michael; Yoder, Aaron; Fetzer, Linda. Safety For All. Panel discussion. Fall FANRE Professional Development Conference. Virtual. 09/2020.
- Schossow, Megan. ISASH Lunch & Learn: National Farm Safety and Health Week. Webinar. ISASH Lunch and Learn. Virtual. 09/2020.
- Schossow, Megan. Something for Everyone: US Ag Centers. Oral/podium presentation. UMASH Online Expo. Virtual. 08/2020.
- Ploeckelman, Melissa. Telling the Story. Oral/podium presentation. UMASH Online Expo. Virtual. 08/2020.
- Bender, Jeff. CDC Guidelines & Ag Employer Checklist: COVID-19. Webinar. COVID-19 Guidance with NFCF and LOL. Virtual. 07/2020.
- Bender, Jeff. SAR-CoV-2 and its Impact on Animals. Panel discussion. AgriSafe. Virtual. 05/2020.
- Bender, Jeff. No Longer Invisible – Public Health during the COVID-19 Pandemic. Panel discussion. University of Minnesota School of Public Health. Virtual. 04/2020.
- Bender, Jeff. Keeping Producers/Ag Workers and their Families Safe during the COVID-19 Pandemic. Webinar. AgriSafe. Virtual. 03/2020.
- Schossow, Megan. Public Engagement Case Study: Farmfest Partnering with Minnesota: Connecting the University with Urban, Suburban, and Rural Communities through Public Engagement. Oral/podium presentation. Minneapolis, MN. Virtual. 03/2020.
- Schossow, Megan. Social Media Campaigns. Oral/podium presentation. UMN Communicator Forum. Minneapolis, MN. 02/2020.
- Schossow, Megan. Annie's Project. Oral/podium presentation. Saint Cloud, MN. 02/2020.
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- Alexander B.H.; Bender J.; Keifer M.C. Building Partnerships In Agricultural Health And Safety, Upper Midwest Agricultural Safety And Health Center (Umash). Poster presentation. 2019 NORA Symposium. Minneapolis, MN. 05/2019.
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- Sheridan C. & Kampa, D. Stress And Mental Health Conversations With Gear Up For Ag Health And Safety. Poster presentation. 2019 NORA Symposium. Minneapolis, MN. 05/2019.
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- Peterson, Carol & Schossow, Megan. Oral presentation Women's Agricultural Leadership Conference (WALC). Chaska, MN. 04/2019.
- Peterson, Carol; Schossow, Megan. How Safe is Your Farm? Midwest Organic and Sustainable Education Service (MOSES) 2019. February 21-23, 2019. LaCrosse, WI 02/2019.
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- Alexander BH. One Health and Occupational Health. 1st Annual Forum on Environmental and Occupational Health, University of Philippines, Manila 11/2018.

- Kampa, Diane M.; Peterson, Carol M.; Moreno, Ada; Bender, Jeff; Alexander, Bruce H. MRASH 2018. November 27-29, 2018. Council Bluffs, Iowa. 11/2018.
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- Peterson, Carol. UMASH Center Overview. Extension Livestock Gathering. St. Paul, MN. August 17, 2018. 08/2018.
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- Are Accidents Waiting to Happen?. 2017 Dairy Plant and Field Reps Conference. Eau Claire WI. 08/2017.
- Bender, Jeff, Needlestick Prevention in Agriculture. Seminar presentation to medical students. Minneapolis, MN. 08/2017.

- Keifer, Matt; Glamm, David; Ramirez, Marizen; Metz, Gary; Aasen, Paul, Farm Safety: Protecting you, your family, your visitors, and your bottom line. Minnesota Farmfest. 08/2017."
- Wilmes, E., Swenson R., Engaging dairy producers with stockmanship and messages; research findings and implications for communication strategies. International Society for Agricultural Safety and Health. 06/2017.
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- Walker R, Munoz-Zanzi C, Schotthoefer A.,Characterizing the Epidemiology of Positive Lyme Confirmatory Tests in North-Central Wisconsin: 2000-2015. Poster Presentation. 2017 NORA Symposium. 05/2017.
- Stinebaugh K, Schotthoefer A, Walker R, Munoz-Zanzi C, Tick-borne disease knowledge, attitudes and practices among U.S. Forest Services Workers. Poster Presentation. 2017 NORA Symposium. Minneapolis, MN. 05/2017.
- Swenson R and Wilmes E., Engaging dairy producers with stockmanship and messages; research findings and implications for communication strategies. Poster Presentation. 2017 NORA Symposium. Minneapolis, MN. 05/2017.
- Walker R, Munoz-Zanzi C, Schotthoefer A., Characterizing the demographic, spatial, and environmental epidemiology of lyme disease cases in north-central Wisconsin: 2000-2015. Poster Presentation. 2017 NORA Symposium. Minneapolis, MN. 05/2017.
- Swenson R, Wilmes E, Thofson P., Engaging dairy workers with stockmanship and safety messages: research findings and implications for communication strategies. Poster Presentation. 2017 NORA Symposium. Minneapolis, MN. 05/2017.
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C.2. Website(s) or other Internet site(s) – include URL(s)

umash.umn.edu

C.3. Technologies or techniques
N/a

C.4. Inventions, patent applications, and/or licenses
N/a

C.5. Other products and resource sharing
Through collaboration with UMASH project teams, partner organizations and experts, UMASH outreach has successfully employed a unique and effective strategy for resource development. By partnering content experts with our communications and graphic design experts, UMASH has produced new evidence-based user-focused resources that communicate knowledge about risks and recommendations with appropriate messaging and impactful design/layout, with co-developed strategies for dissemination to relevant audiences.

A simple yet enduring and successful UMASH resource has been the Farm Safety Check (http://umash.umn.edu/umash-farm-safety-check/) initially launched in 2016 has grown to over 40 topical checklists with relevant resources that can be used and adapted by farmers to fit their operation. New checklists are vetted by content experts, including research investigators and NIOSH-funded colleagues, and existing lists have been reviewed and updated for sharing at appropriate times throughout the year. This tool has also provided a vehicle for UMASH to build and expand relationships with content experts and organizations to incorporate new and existing resources.

Another new and noteworthy resource, the Telling the Story Project, was developed in collaboration with the Great Plains Center for Agricultural Health (GPCAH)and the Center States Center for Agricultural Safety and Health (CS-CASH). This innovative outreach method utilized storytelling to "tell a story - save a life" to raise awareness and share prevention messages. In addition to using stories, the project expanded to include guides for high school agricultural teachers for classroom projects and discussion.

Additional resources, including posters, videos, and more are compiled for easy access by farmers, workers, producers, and those that serve them in a Resource Database on the UMASH website (English: http://umash.umn.edu/resources and Spanish: http://umash.umn.edu/spanish-resources).

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
JBBENDER	Y	Bender, Jeffrey B.		PI/PD	0.48	0.0	0.0			
MSCHOSSOW	Y	Schossow, Megan		Center Coordinator						
	N	Peterson, Carol		Outreach Coordinator	4.8	0.0	0.0			
	N	Vazquez, Chela		Community Health Liaison	1.2	0.0	0.0			
	N	Yoder, C.(RES)		Technical expert	1.8	0.0	0.0			
	N	Edlund, C.		Student	4.8	0.0	0.0			
	N	Li, M.		Student	5.6	0.0	0.0			

D.2 Personnel updates

a. Level of Effort:
b. New Senior/Key Personnel:
c. Changes in Other Support:
d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?
N/A

E.2 - What is the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

UMASH engages in 1) a spectrum of research to identify and document the nature of occupational health and safety issues and effective strategies for intervention and 2) community-engaged, collaborative, and culturally responsive outreach to translate such evidence into practice and respond to emerging issues. As a multi-sited collaborative Center grounded in a One Health approach, we offer transdisciplinary expertise in public health and safety, veterinary medicine, occupational medicine, immigrant worker populations, and agricultural disciplines. The Outreach Core fills

the critical role of translating the knowledge generated from UMASH and other sources to stakeholders through resource development, relationship building, and direct community engagement.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures
N/a

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them
N/a

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents
None

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

G.2 Responsible Conduct of Research
N/A

G.3 Mentor's Research Report or Sponsor Comments
N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?
No

G.4.b Inclusion Enrollment Data

G.4.c ClinicalTrials.gov

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?
No

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?
No

G.7 Vertebrate Animals

Does this project involve vertebrate animals?
No

G.8 Project/Performance Sites
See overall

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance
G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

G.11 Program Income
Is program income anticipated during the next budget period?
No

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
No

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

UMASH has been referenced and used as a resource over 85 times, including on several websites (Extension sites, Farm Answers, Rural Health Information Hub, SAY Clearinghouse, Ag Safety Info, and more), in webinars, and more. Further, UMASH resources like hand washing posters, stress cards, training videos, and more have been distributed for use by a variety of populations in several settings including,

- outreach by community colleges for middle school students
- health and safety training on dairy and swine operations
- events for county Farm Bureau agents, at 4-H events for students and agents
- governmental agency information for field agents
- conferences for public health veterinarians
- trainings for Farm Business educators
- education for farm visitors

UMASH resources have been adopted into curriculums, policies, standards, and other components of agricultural health and safety practice, at least 50 times, including:

- Needlestick content is used in the University of Minnesota Veterinary Medicine program
- Animal handling content is used in a course at The Ohio State University College of Veterinary Medicine and a University of Iowa online module about safe animal caretakers
- Dairy worker training videos are used to train an estimated 600 workers using mobile technology
- Farms use animal handling resources to train workers to meet Farm 2.0 ethics requirements
- UMASH videos used for youth farm safety training through University of Minnesota Extension, to educate agricultural education teachers, the Great Plains Center Core Course

- Livestock safety posters are posted across Kirkwood College and the nearby high school in Iowa
- A Quadbar representative sent out the ATV Farm Safety Checklist alongside their product and shared that clients are using the checklists
- Farms use agritourism materials to educate visitors; for example, one Garden Center included handwashing guidance and the "Farms, Fairs, and Fun" video on their ticket website, and an agritourism collective, North Star Farm Tours, changed their bylaws to require agritourism training for their members.

Testimonials about UMASH include:

- “I use some of the resources on needle safety and farm safety with students as we invite them on the farm to work with livestock. They have been important resources to be sure our "learners" know how to stay safe! Honestly, I haven't been able to find better resources than yours!”
- “This DVD has been a hit with several producers I have been able to share it with. I gave one to a producer over by Shawano, WI. The next day I got a call from the producer. His wife made him call to thank me for the DVD."
- "[Producers/workers] really like the Spanish videos."
- "Being a farm kid and being raised around this stuff all our lives, we don't realize all the unsafe things we are around, so seeing [the video] made me realize that little everyday things I'm doing or around are not always as safe as I think they are"
- "A well done [needlestick] resource for farm managers, for agribusinesses, veterinary services, and healthcare clinicians to have on hand in their offices."

UMASH Success Stories (http://umash.umn.edu/success-stories/) provide another glimpse into the successful work facilitated by researchers and staff. These stories present a summary of the problem, the effective work to address it, and links to resources and additional information. Highlighted successes include but are not limited to:

- **Needlestick injury.** UMASH addressed the problem of needlestick injury by developing educational tools for farm managers, workers, and veterinarians. These resources include bilingual (English and Spanish) training videos for dairy and swine operations and accompanying fact sheets describing in more detail the do’s and don’ts when handling sharps. They have been featured in publications including Hoard’s Dairyman, National Hog Farmer, Midwest Marketer, Bovine Veterinarian, and others, used by a veterinarian supplier for training on the safe handling of pharmaceuticals on dairies, used with mobile technology (iPads) to train 2,000 dairy workers on site in SW United States, included in the OSHA Guidance Documents for Dairy Local Emphasis Program in Wisconsin, and more.
- **Animal handling.** UMASH collaborated with dairy and swine faculty at the University of Minnesota to produce educational materials related to stockmanship or low-stress handling. The bilingual (English and Spanish) resources include 5 short videos demonstrating the techniques used in positive animal handling. These resources have been well received by producers, veterinarians, and businesses who serve farmers, featured in Farmers Hotline, Hoards, Agriview, Living in the Country, Blooming Prairie, and other media outlets, incorporated in a Gear Up for Ag Health and Safety™ program delivered to 1,500 college students, included as ethics training for the FARM 3.0 Program, and used as an in the field training resource on iPads for 2,000 dairy workers in the southwest United States.
- **Farm Safety Check.** UMASH launched the Farm Safety Check in January 2017 to provide farmers with a simple tool to identify and fix potential hazards before they cause harm to families or employees. The checklists can be easily adapted to the needs of an individual farm. Addressing safety topics in smaller segments can provide a manageable approach while also serving as an ongoing reminder about risk management. Many news outlets and farm organizations have shared Farm Safety Checks. They have been viewed more than 40,000 times on the UMASH website and cobranded as resources by insurance companies for use by their policyholders.
- **Mental health.** UMASH funded three innovative partner projects to understand and address the mental health issues faced by those in agriculture. NAMI Minnesota trained 318 farm community members with QPR (Question, Persuade, Refer) Suicide Prevention trainings and 2 Mental Health First Aid Trainings, which

reached over 800 people. Participants reported improvements in awareness, perceived skills, and preparedness. The Cultivating Resiliency Project or Women in Agriculture with American Agri-Women & the U of MN Extension provided virtual telehelp webinars, online early stress-detection questionnaires, in-person presentations, and online coffee chats, reaching thousands of participants. Stress and Mental Health Conversations with the Next Generation of Agriculture with Gear Up for Ag Health and Safety™ educates students at agricultural colleges by integrating mental health and stress content into the curriculum through a motion graphic and a toolkit for community-based conversations. Since December 2019, Gear Up for Ag Health and Safety™ has been delivered 26 times to over 3,000 students across multiple continents, including the US, Canada, Sweden, Australia, and more. These projects continue their work beyond the initial funding cycle to deliver positive, sustainable impacts in the agricultural community.

- **Aging in place.** UMASH learned from aging farmers and their support systems that their biggest concerns about aging on the farm were accessing healthcare, managing stress and anxiety, maintaining balance and coordination, and preventing musculoskeletal injuries. UMASH responded to these concerns by partnering with innovative teams in the Upper Midwest. Healthy Aging on the Farm United Church of Christ and Normandale established a team of five faith-based organizations in a rural Minnesota county to ask farmers about their concerns about aging in place on the farm and how the community could best support them. Farmers shared their greatest challenges of aging on the farm: maintaining their overall health and mobility and finding help with chores. University of Minnesota Occupational Therapy (OT) facilitated virtual programming to five rural farmers across Minnesota to reduce pain, improve balance and mobility, and continue activities of daily living. OT students gained clinical experience working with rural farmers, designing two webinars for rural farmers to access on the UMASH website. 80% of farmers felt better able to manage changes related to aging after participating in the program. University of Wisconsin Occupational Therapy and American Parkinson's Disease Association's Wisconsin Chapter created and distributed "Active@Home" toolkits to 30 Wisconsin households with a family member with Parkinson's disease. The toolkits contained exercise and adaptive equipment, such as a modified jar opener, to manage symptoms and increase independence. They also offered telehealth programming to educate how to use each item to improve their symptoms, piloting a model for improving access to support services in rural areas. Rural Minnesota Memory Loss Connection - Big Stone offered training, community gatherings, and memory loss kits to reduce symptoms of dementia, increase awareness of dementia, and enhance the quality of dementia care in their community. Over 120 physicians, nurses, and community members were trained to improve the quality of care for older adults with dementia. The training built connections between healthcare providers and a local neuropsychologist, making diagnosing and referring patients to dementia care easier and quicker. Over 215 community members gathered for "memory loss cafes" to build community, share resources, and increase their understanding of dementia. 25 memory loss kits were checked out more than 80 times from a local library. The kits included items like toy tractors and farm magazines to reduce the anxiety of memory loss and bring back memories of life on the farm.

UMASH has been mentioned in the media over 300 times in a variety of outlets, including but not limited to: US News & World Report, RFDTV, DTN, Progressive Farmer, and Rural Radio Network. UMASH resources have been referenced on social media and newsletters almost 80 times from organizations including but not limited to: Pork Checkoff, NIOSH E-news, I-29 Moo University, and AgriSafe. The UMASH outreach team engaged in over 240 events over the course of the funding cycle, across 6 states in more than 30 cities. These events were attended by tens of thousands of people, and UMASH documented direct engagement with more than 1,500 attendees. UMASH's digital platforms, including the UMASH website, YouTube channel, U.S. Ag Center's collaborative YouTube channel, email communications, and social media (Facebook, Instagram, Twitter, and LinkedIn) have grown in terms of audience, reach, and engagement.

A. COVER PAGE

Project Title: Surveillance for Zoonotic Diseases in Agricultural Workers in Minnesota II	
Grant Number: 5U54OH010170-10	**Project/Grant Period**: 09/30/2016 - 09/29/2022
Reporting Period: 09/30/2016 - 09/29/2022	**Date Submitted**: See overall
Program Director/ Principal Investigator Dr. Kirk Smith, DVM, PhD	**Administrative Official Information** Kristina McReynolds 450 McNamara Alumni Center 200 Oak Street SE Minneapolis, MN 554552070

Change of Contact PD/PI:	
Human Subjects: **No**	**Vertebrate Animals:** N/A
hESC: N/A	**Inventions/Patents:** N/A

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

Minnesota Department of Health (MDH), through this UMASH project, has demonstrated that infections from animals associated with agriculture are a much more important occupational hazard than previously thought. This project's overarching goal was to reduce the number of illnesses among agricultural workers, their families, and others who are exposed to animal agriculture settings. Following are the specific aims:

Aim 1. Perform prospective enteric disease surveillance: Interview people who had an animal agriculture exposure before their zoonotic enteric illness to describe affected populations, burden of disease, and any patterns or trends.

Aim 2. Identify specific risk factors for illness for the most important pathogens (i.e., *Campylobacter, Salmonella, Cryptosporidium parvum*, and Shiga toxin-producing *E. coli*) and develop ways to prevent infection or minimize risk of illness.

Aim 3. Collaborate with neighboring states (e.g., North Dakota, South Dakota, Wisconsin, Iowa, and Nebraska), which together represent a large proportion of animal agriculture in the U.S., to estimate the burden of enteric disease among agricultural workers regionally.

Aim 4. Collaborate with Dr. Peter Davies to determine whether *Staphylococcus aureus* (MRSA and MSSA) strains known to colonize pigs are causing clinical illness in humans, which is currently unknown in the United States.

Aim 5. Identify, respond to, and describe emerging zoonotic infections and issues related to human health and animal agriculture

B.2. What did you accomplish under these goals?

We conducted prospective enteric disease surveillance, collecting detailed data on animal agriculture exposures in sporadic (i.e., non-outbreak-associated) domestically acquired cases with reportable enteric pathogen infections. Illnesses caused by *Cryptosporidia*, *Campylobacter*, *Salmonella, E. coli* O157:H7 and other Shiga toxin-producing *E. coli* (STEC) are reportable to the Minnesota Department of Health (MDH). All ill people are interviewed with a

questionnaire that includes questions about agricultural exposures (i.e., living on, working on, or visiting a farm, petting zoo, fair, or another venue with animals). Since 2012, patients who report a food animal agriculture exposure have been re-interviewed with a more detailed questionnaire about their interactions with the animals. These data were analyzed to identify specific risk factors for acquisition of the most important zoonoses by agricultural workers. We also characterized outbreaks caused by *Salmonella*, STEC, *Cryptosporidium*, or *Campylobacter* related to animal contact. MDH's population-based surveillance data were also used to identify occupational risk for infectious diseases including rabies, Q fever, tick-borne diseases, blastomycosis, histoplasmosis, methicillin-resistant *Staphylococcus aureus* infection, and *Clostridioides difficile* infection among agricultural populations. Further, we utilized these surveillance systems to effectively detect, respond to, and characterize emerging zoonoses related to animal agriculture statewide, including highly pathogenic avian influenza (HPAI), influenza viruses of swine origin, and COVID-19.

The COVID-19 pandemic created a major disruption to this project, as MDH staff were redeployed to work full-time on the pandemic response. While this impacted our ability to accomplish as much as we would have liked on some of our UMASH aims, we did achieve or make substantial progress on most of them. We assimilated, collected, analyzed, and disseminated a tremendous amount of data in this budget cycle. Our MDH UMASH team was very much involved in helping agricultural business and the veterinary profession in Minnesota manage through the pandemic and keep running. We have created strong relationships with numerous academic, agricultural industry, commodity, and state animal agency partners that continue to be the key to ongoing data collection and analysis, as well as a coordinated, effective response to emerging issues.

These partnerships include but are not limited to those with FFA, 4-H, Minnesota Milk, Minnesota Pork Board, Minnesota Turkey Growers Association, Farmers Union, Minnesota Farm Bureau, state animal health agencies, and the Minnesota Zoo. Further, our work has been presented to a wide variety of audiences at national, regional, and state conferences, including the American Veterinary Medical Association, Minnesota Veterinary Medical Association, Council of State and Territorial Epidemiologists, United States Animal Health Association, Minnesota and National Environmental Health Associations, Midwest Rural Agricultural Safety and Health Conference, MN Federation of County Fairs, Minnesota and Wisconsin Farm Bureau, International Society for Agricultural Safety and Health, Extension Risk Management Education, Ag and Rural Law Institute, AgriGrowth Council, and Women's Agricultural Leadership. UMASH has contributed to numerous publications and graduate student theses, providing the foundation for the next generation of agricultural health and safety researchers.

Aims 1 and 2. Perform prospective infectious disease surveillance among cases who report an animal agriculture exposure and identify specific risk factors for illness for the most important pathogens

Enteric Pathogens (*Campylobacter, Salmonella*, Shiga toxin-producing *E. coli, Cryptosporidium parvum*)

Through our UMASH-supported enhanced surveillance, we have demonstrated that zoonotic enteric disease is a greatly under-appreciated risk associated with farming. In 2020, we published data from the first 5 years of this population-based study in *Epidemiology and Infection* (Klumb et al. 2020). We found that the estimated cumulative incidence of zoonotic enteric infections for people who live and/or work on farms with food production animals in Minnesota during 2012–2016 was 147 per 10,000 population, 8 times greater than for other Minnesotans (18.5 per 10,000) and up to 20 times greater for specific pathogens. Other key findings included that 23% (1708/7560) of the enteric disease cases in the study reported an animal agriculture exposure in their incubation period, including a remarkable 60% (344/571) of *Cryptosporidium parvum* cases, 28% (934/3391) of *Campylobacter* cases, and 22% (85/383) of STEC O157 cases.

A surprising 61% of enteric pathogen cases with an agricultural exposure lived or worked on a farm, upending the widely held assumption that common enteric infections don't occur as often in farmers as in urban/suburban people. Twenty-nine percent of cases visited a private farm and 10% of cases visited a public animal agriculture venue. Cattle were by far the most commonly reported animal type among cases infected with *C. parvum*, *Campylobacter*, STEC O157, and non-O157 STEC. Poultry, primarily chickens, was the most commonly reported animal type among *Salmonella* cases, and the second most commonly reported animal

type among *Campylobacter* cases. Several years of data have been added since 2016. In total, from 2012 to 2021, 15,931 laboratory-confirmed illness cases among Minnesotans have been eligible for our study. Of these, 3,482 (22%) reported an animal agriculture exposure in Minnesota during their exposure period, consistent with our previous findings.

Outbreaks Associated with Animal Agriculture Settings

Outbreaks can result in financial hardship to agricultural businesses through loss of business and litigation. They are important to characterize as they provide direct insight into pathogens transmitted in agricultural settings, types of animals that are the source of these pathogens, and specific risk factors for transmission, all of which aid in identifying preventive measures. Since 2000 we have investigated and documented 131 animal contact outbreaks caused by *Salmonella,* STEC*, Cryptosporidium*, or *Campylobacter*. The majority of these outbreaks were associated with animal agriculture settings: private farms where residents, workers, and/or visitors were affected; farms serving as agritourism venues; county and state fairs; educational programs (i.e., day camps for elementary-aged children); petting zoos; poultry hatcheries; and other public venues. Of increasing frequency and concern are outbreaks associated with preschool, kindergarten, and elementary school field trips to working farms that often occur due to unfamiliarity with basic prevention measures such as availability of hand washing facilities.

Every outbreak was investigated and documented in detail, and contributing factors were identified. All investigations included a personalized consultation including recommendations tailored to the specific venue regarding preventive measures that should be taken to reduce the risk of further illnesses. Furthermore, we used contributing factors and lessons learned from outbreaks to develop our educational disease prevention programs.

Antimicrobial Resistance in *Salmonella* and *Campylobacter*

We compared antimicrobial resistance among *Salmonella* isolates from UMASH cases to a sample of *Salmonella* isolates from Minnesota residents who did not have animal agriculture exposure (Siebman 2021, MPH thesis). Of the 644 *Salmonella* isolates from 2012-2018 included in the study, 201 (31%) were resistant to at least one of the antimicrobials tested, and 70 (11%) were multidrug-resistant. *Salmonella* cases with an animal agriculture exposure were significantly more likely to have a *Salmonella* isolate that was resistant to multiple antimicrobials including ampicillin (odds ratio [OR], 1.59, CI: 1.1, 2.4), chloramphenicol (OR, 2.55, CI: 1.3, 4.8), cephalothin (OR, 2.53, CI: 1.4,4.7), ceftriaxone (OR, 2.34, CI: 1.2, 4.6), and tetracycline (OR, 1.62, CI: 1.1, 2.4). Among those who lived and/or worked on a farm, exposure to cattle (OR, 1.84, CI: 1.0, 3.3) and swine (OR, 3.13, CI: 1.58, 6.2) were associated with having a multidrug resistant *Salmonella* infection.

Our UMASH team has collaborated extensively with researchers at the University of Minnesota Center for Animal Health and Food Safety on antimicrobial resistance in Salmonella isolates from swine and cattle, and on the emergence of a multidrug-resistant clade of S. I 4,5,12:i:- in the United States (Elnekave et al., 2018, 2019, 2020; Hong et al. 2016). This work has identified multiple important resistance issues in *Salmonella* isolates from food animals, including resistance to the critically important antibiotic classes of fluoroquinolones and cephalosporins. There are clear parallels between the resistance patterns from animal Salmonella isolates and Salmonella isolates from ill people who reported animal agriculture exposures; this potential relationship needs to be examined in detail.

The MDH Public Health Laboratory also contributed to a study on the emergence of a clonal group of multidrug-resistant *Salmonella* Reading in commercial turkey production and people (Miller et al. 2020); human infections are primarily foodborne, but cases in family members of turkey workers in Minnesota have been identified.

Resistance in *Campylobacter* isolates from UMASH cases were evaluated by a University of Minnesota PhD student (Sorley 2018, PhD dissertation). A higher proportion of *Campylobacter* cases who lived and/or worked on a farm with swine had isolates that were resistant to azithromycin (adjusted prevalence difference

[aPD], 15.1, CI: -16.7, 46.9), ciprofloxacin (aPD, 10.2, CI: -23.5, 44.0), both azithromycin and ciprofloxacin together (aPD, 26.7, CI: -14.2, 67.5), and that were multidrug-resistant (aPD,10.2,CI: -23.5, 43.9). Most of these findings were not statistically significant, but the signals merit further study.

Diarrheagenic *Escherichia coli* pathotypes other than Shiga toxin-producing *E. coli* (STEC)

Animal agriculture exposures are a well-established source of STEC infections. However, there are several other pathotypes of diarrheagenic *E. coli* that affect humans, and the increasing use of a multiplex PCR gastrointestinal illness panel by clinical laboratories is revealing that these other pathotypes are commonly detected in humans. The MDH team has published two studies documenting that enteroaggregative *E. coli* (EAEC) and enterotoxigenic *E. coli* (ETEC) are common causes of gastroenteritis in Minnesota (Beczkiewicz et al. 2019; Buuck et al. 2020). These pathotypes have historically been considered to primarily affect residents of and travelers to developing countries, but we found that well over half of cases due to each pathotype were actually domestically acquired. The sources of non-STEC *E. coli* pathotypes for domestically acquired infections in Minnesota (and the rest of the U.S.) are largely unknown. Various types of *E. coli*, including ETEC, are common pathogens or colonizers of food animals, and thus food animals represent a potential source of various diarrheagenic *E. coli* pathotypes for humans, including agricultural populations, that should be investigated.

Rabies

Our work in the first two UMASH cycles demonstrated that exposures to rabid animals are a relatively frequent occurrence in agricultural settings in Minnesota. From 1999 to 2022, 837 animals (other than bats) tested positive for rabies; of these 267 (32%) were encountered in an agricultural setting. Three hundred sixty-eight individuals were advised to receive rabies post-exposure prophylaxis (PEP) as a result of their exposure. Exposures to rabid cattle accounted for 30% of PEP recommendations in agricultural settings, rabid dogs for 25%, rabid cats for 25%, and rabid horses for 11%. Agricultural populations remain an important target of our efforts to raise rabies awareness and prevent rabies exposures and the need for PEP.

Q Fever

Q fever is primarily an occupationally acquired illness associated with goats, sheep, and cattle, and MDH attempts to collect occupation information for all Q fever cases. During 1997-2021, 74 confirmed or probable Q fever cases were reported to MDH. Of these, 21/54 (39%) with information available reported living and/or working on a farm with animals. Sixty-seven percent of these cases lived and/or worked on a farm with cattle, 19% with goats, and 5% with sheep. Of the Minnesota cases who were exposed on a farm and had information available, 70% were hospitalized for a median of 7 days (range, 2 to 9 days).

In 2017, we worked with University of Minnesota College of Veterinary Medicine researchers to publish a spatiotemporal analysis of human Q fever cases during 1997-2015 and the distribution of domestic ruminants in Minnesota (Alvarez et al. 2018). We found that the number of sheep flocks at the county level helped to explain the observed number of human cases, whereas no statistically significant association with cattle or goat populations was observed. Q fever transmission risk is an area that merits further study as most recent outbreaks in the U.S. have been due to exposure to aborting goats.

Blastomycosis

Blastomycosis is a systemic fungal illness cause by *Blastomyces dermatitidis* or *B. gilchristii*, soil organisms that are highly endemic in northeastern and northcentral Minnesota (Ireland et al. 2020). We assessed whether workers in the forestry, logging, or agricultural sectors were disproportionally affected by the disease. From 2012 (when prospective surveillance began) to 2021, 508 cases of blastomycosis were reported to MDH. Of these 14 (2.8%) reported forestry, logging or agriculture work prior to illness onset; 9 reported forestry or logging and 5 reported farming. The number of blastomycosis cases in Minnesota that could be

attributed to forestry, logging, or other agricultural exposures is small. However, blastomycosis can be fatal, so outreach about disease risks to workers in these industries should include information about blastomycosis.

Histoplasmosis

As part of a joint enhanced-surveillance study with CDC, MDH attempted to interview all confirmed and a subset of probable histoplasmosis cases from July 1, 2018 to June 30, 2019. Of 97 interviewed cases, 7 (7%) reported agricultural occupations. When data were combined across states, they illustrated the importance of histoplasmosis as a work-related illness, particularly for agriculture and construction (Benedict et al. 2020).

Clostridioides difficile

Clostridioides difficile (formerly *Clostridium difficile*) is now well-established as a common cause of community gastrointestinal illness in humans, including in Minnesota. *C. difficile* also has been isolated from food animals in the U.S. and other countries, and indistinguishable strains have been found in humans and other mammals in several countries; therefore, food animals are a potential reservoir for *C. difficile* for humans, through food or animal contact. In particular, toxinotype V/PCR ribotype 078 or 054/PFGE subtype NAP7 have been increasingly identified as predominant strains in cattle and pigs in the U.S. and Europe, and as pathogens in humans.

Since 2009, MDH has conducted population-based sentinel site surveillance for *C. difficile* infection and began receiving *C. difficile* toxin-positive stool samples from patients diagnosed in health care facilities that together serve 240,078 people in an area of central Minnesota that is rich in animal agriculture. In addition, in collaboration with the University of Minnesota Medical School and College of Veterinary Medicine, human community-associated *C. difficile* surveillance isolates from 2012 were compared molecularly to animal isolates (mostly from food animals) collected from the same area from 2011 to 2013, and source groups were compared using discriminant analysis (Shaughnessy et al. 2018). Overall, the 81 animal source isolates and 208 human source isolates were highly diverse genetically. Molecular traits segregated strongly by animal versus human origin. Only five (2.5%) human source isolates were classified as animal source.

Our work to date does not support that food-producing animals or foods of animal origin are important sources of community-associated *C. difficile* in the central Minnesota study region. However, whole genome sequencing of human *C. difficile* isolates is now routinely conducted and will be a much better indicator of phylogenetic relationships between human and animal isolates.

Aim 3. Collaborate with neighboring states (e.g., North Dakota, South Dakota, Wisconsin, Iowa, and Nebraska) to estimate how many agricultural workers are affected by these infections regionally, which represents a large proportion of animal agriculture in the U.S.

We made little progress on this aim during this budget cycle. The COVID-19 pandemic created a major disruption to this project, which is conducted by MDH staff who were redeployed to work full-time on the pandemic response. Consequently, we were able to conduct only a baseline level of UMASH work from March 2020 to the fall of 2021.

Aim 4. Collaborate with Dr. Peter Davies to determine whether *Staphylococcus aureus* (MRSA and MSSA) strains known to colonize pigs are causing clinical illness in humans, which is currently unknown in the United States.

MDH began prospective, laboratory-based, sentinel surveillance for community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA) in 2000 and active, population-based, surveillance for invasive MRSA infections in 2010. Our surveillance framework has enabled us to address the question of whether agricultural animals are an important source of clinical CA-MRSA infections for humans. One molecular subtype of MRSA, ST398, has been identified in humans and many species of food-animals, and is referred to as “livestock-associated” MRSA. Studies in Canada, Iowa, and Minnesota (the UMASH work of Peter Davies’ team) have identified high carriage rates of ST398 in swine, swine farm workers, and swine veterinarians.

One approach we used to assess the significance of ST398 as a human pathogen was to look at the MDH-PHL MRSA isolate collection. None of the 7,680 isolates were untypeable by pulsed-field gel electrophoresis, and therefore none were likely ST398. However, Dr. Davies' team subsequently identified other MRSA subtypes in common between swine and swine veterinarians (who were colonized, not infected). Therefore, our next step was to obtain *S. aureus* isolates from clinically infected patients seen at a hospital and associated outpatient facilities in the most swine-dense county in Minnesota. Isolates identified from June 2016 to June 2017 were characterized to identify commonalities with swine MRSA strains. Among 92 *S. aureus* isolates (75 methicillin-resistant *S. aureus* [MRSA], 16 methicillin-sensitive *S. aureus* [MSSA], 1 *Staphylococcus* spp.), the most common spa types were t008 (ST8; 32 isolates) which is of human origin, and t002 (ST5; 14 isolates) which is also a human clinical variant, although genetically distinct livestock associated ST5/t002 variants also occur. Two isolates were identified as spa type t034, which is predominant among isolates of the ST398 lineage in pigs in the U.S. Both cases involved foot wound infections. This study indicated that clinical infections with livestock-associated *S. aureus* ST398 do occur in people in this swine dense region of Minnesota, but they account for only a very small proportion of clinical infections. Recent studies in other parts of the U.S. indicate that workers who are occupationally exposed to swine are at increased risk for intranasal carriage of MRSA and can develop clinical infections with livestock-associated strains of *S. aureus*; therefore, continued surveillance is warranted.

Aim 5. Identify, respond to, and describe newly emerging zoonotic infections and issues related to human health and animal agriculture.

COVID-19 pandemic

Dr. Scheftel served as lead of the MDH Critical Infrastructure Workplaces Team and was engaged in helping meat packers, agricultural businesses and the veterinary profession respond to the COVID-19 pandemic. Dr. Scheftel, with the Minnesota Department of Agriculture (MDA), the Board of Animal Health (BAH), and the Minnesota Department of Labor and Industry created policy and guidance for COVID-19 prevention in Minnesota meat and vegetable processing plant workers, animal agriculture workers, and veterinary personnel. MDH consulted with all 40 swine, turkey, beef, and chicken processing plants in Minnesota about best practices for employee safety and performed three onsite visits. We also met virtually with 17 swine, dairy, and poultry producers and 55 veterinary clinics to go over best practices for COVID-19 prevention. When COVID-19 vaccine became available, Dr. Scheftel gave virtual COVID-19 vaccination presentations for employees and management of these businesses. Throughout the pandemic, Dr. Scheftel provided updates on COVID-19 to regular meetings of the BAH, MVMA, the University of Minnesota (UMN) College of Veterinary Medicine, and industry and commodity groups. Dr. Scheftel co-authored a paper on COVID-19 among workers in U.S. food processing, food manufacturing and agriculture workplaces (Waltenburg et al. 2020) and Dr. Smith co-authored a paper involving SARS-CoV-2 whole genome sequencing of case-isolates from two meat processing plant outbreaks (Lehnartz et al. 2021).

MDH UMASH staff assisted the UMN Extension 4-H program with a COVID prevention plan for the 4-H State Livestock Showcase, allowing 4-H kids to safely finish their livestock and poultry projects for the year. As part of BAH permitting, MDH and BAH contacted 36 Minnesota cattle, sheep, swine, and poultry event managers about COVID prevention best practices. Dr. Scheftel and Carrie Klumb helped develop COVID prevention and mitigation strategies for animal exhibitions and 4-H housing at the 2021 Minnesota State Fair.

Highly pathogenic avian influenza (HPAI) outbreaks

The role of MDH in the response to highly pathogenic avian influenza (HPAI) outbreaks include protecting human health, monitoring the health of exposed workers, providing guidance on infection control and use of PPE for poultry workers, and serving as a source of information for industry and the public.

In spring 2015, we responded to the highly pathogenic avian influenza (HPAI) H5N2 outbreak, in which over 48 million Minnesota turkeys either succumbed or were depopulated. As the zoonotic potential of the H5N2 virus was unknown, UMASH personnel Dr. Joni Scheftel and Carrie Klumb led an MDH team that interviewed 376 poultry workers from 110 infected farms and monitored them for 10 days after their last exposure to ill birds. We also worked with poultry company occupational health nurses, outpatient clinics and pharmacies to ensure that all 119 workers who agreed to take the recommended oseltamivir were able to receive it, even if they lacked a provider or medical insurance. We also arranged for influenza testing of 15 workers and worked with USDA responders to ensure that poultry producers working with federal personnel to depopulate infected birds were provided with personal protective equipment (PPE). We arranged for informational materials to be translated into Spanish, Karen, and Somali for non-English speaking workers. Monitoring protocols, talking points, interview forms, and databases were shared with state public health veterinarians and others nationwide and became national standards.

Since March 2022, as part of the HPAI H5N1 outbreak affecting Minnesota poultry, MDH has monitored 578 workers or responders and has arranged influenza testing for 23 people who experienced an influenza-like-illness; all were negative for influenza viruses. The response to this outbreak is ongoing.

Swine influenza

From 1996 to 2021, 20 human infections with variant influenza viruses of swine origin were identified in Minnesota (8 with H3N2v, 8 with H1N2v, and 4 with H1N1v). Six cases (including an immunocompromised child) reported working or living on a farm with swine, 6 were likely exposed at fair swine exhibitions, 6 were likely acquired at live animal markets selling swine, and 2 had unknown sources. Dr. Scheftel is the co-chair of the Swine Exhibitions Influenza Working Group, a national collaboration of state and federal public and animal health officials, researchers, and swine exhibition organizers that first gathered in December 2012 to develop and publish a set of "Measures to Minimize Influenza Virus Transmission at Swine Exhibitions." The group reviews and updates the document regularly based on new scientific findings. With the 2018 edition, a checklist was created for exhibition organizers and youth organization leaders: "Minimizing Influenza Transmission during Exhibitions – Checklist for Protecting Guests, Exhibitors, and Pigs."

Streptococcus suis

Prior to 2011, only 3 human cases of *Streptococcus suis* infection had been documented in the United States; all cases reported swine contact. In 2012, MDH received a report of a case of *S. suis* meningitis in a trucker who transported slaughter-weight hogs from farms in the Midwest to slaughterhouses in the region, which we published in the first UMASH cycle. In 2020, we received a report of a *S. suis* meningitis case in a 65-year-old swine worker who was hospitalized and suffered hearing loss. These cases demonstrate a rare but potentially under-recognized occupational hazard for swine workers in the U.S.

Occupational Hazards Survey of Veterinary Personnel

In 2016, we published results of an occupational hazards survey of 831 veterinary personnel, the first survey in the U.S. to include the entire clinical veterinary team (Fowler et al., 2016). Overall, 35% of respondents indicated that they suffered from a musculoskeletal disorder (MSD), and 27% reported acquiring at least one zoonotic infection during their career. The most common zoonotic infections reported were dermatophytosis (68%) and bite wound infections (48%); other zoonotic infections commonly reported included salmonellosis (7%) and cryptosporidiosis (6%). Dr. Scheftel also led a review of hazards to female reproductive health in veterinary practice (Scheftel et al. 2017).

Emerging Issues Gathering

Since 2015, MDH has hosted an annual Emerging Issues Gathering. These gatherings bring together people working at the intersection of human and animal health in Minnesota. More than 60 participants from 30 different agencies and entities have attended each year. The following groups (among many others) have been represented since the inception of this event: 4-H, FFA, MDH, Minnesota Department of Agriculture,

Minnesota Board of Animal Health, University of Minnesota, United States Department of Agriculture, Minnesota State Fair, Midwest Dairy Association, Minnesota Turkey Growers, Minnesota Poultry Federation, Minnesota Farmer's Union, Minnesota Farm Bureau, Minnesota Pork Board, Minnesota Zoo, AgriGrowth Council. The connections made during these gatherings are so valuable that we continued to host them virtually in 2020 and 2021. A spokesperson from each agency has 5 minutes to share emerging issues and challenges in their sector, and goals they have for the following year. This provides the big picture of One Health in Minnesota and provides situational awareness of emerging zoonotic issues to those working at the human-animal interface. New MDH collaborations developed as a result of this annual gathering include working with Minnesota FFA on Ag in the Classroom lessons covering One Health and zoonotic disease prevention and partnering with Minnesota Grown to promote our Safer FACEs program.

B.3. Competitive Revisions/Administrative Supplements

N/a

B.4. What opportunities for training and professional development did the project provide?

During the past budget cycle, MDH UMASH data were used by eight University of Minnesota School of Public Health graduate students to complete their MPH thesis (n=7) or PhD dissertation (n=1) (see list below in Product section). All of these students were mentored by MDH UMASH staff.

B.5. How did you disseminate the results to communities of interest?

MDH epidemiologists provided personalized, one-on-one consultations, education, and recommendations to the operators of public animal contact venues associated with an outbreak to prevent further illness. For sporadic illnesses associated with animal contact (those not associated with an outbreak), educational materials are provided and there is an open-door policy to call back an epidemiologist if they have more questions.

Additionally, we developed educational disease prevention programs based on research findings and the lessons learned from outbreaks. We launched "Safer FACES" a free web-based training program for agritourism operators and other public animal contact venues. The course is broken down into modules, which allows people to complete it at their own pace. The modules describe risks of illness and injury from farm animals and strategies for protecting visitors. Participants who complete the training receive a certificate acknowledging their completion. To date, over 300 people have enrolled in this training. In 2013, we began offering in-person "Healthy Fairs" workshops for county fair board members, co-hosted by MDH and the Minnesota Board of Animal Health. We hosted six workshops, which included 190 attendees from 30 different Minnesota counties. In 2015, we expanded to "Agritourism Workshops" co-hosted by MDH and the Minnesota Department of Agriculture. There have been six workshops offered in different locations, and 173 people have attended. Hundreds of laminated disease prevention and hand washing posters have been handed out at these workshops. Workshop evaluations showed that 97% of attendees thought the time was well spent and 93% planned on implementing things they had learned during the workshop at their fair/operation.

Due to the pandemic, we were unable to hold in-person workshops in 2020 or 2021. However, Carrie Klumb continued to present workshop material at regional and national conferences. In 2020, Ms. Klumb presented on agritourism at both the Minnesota Organics Conference and the MOSES Conference, a national gathering of organic farmers. In 2021, she presented on agritourism outreach at the American Veterinary Medical Association Annual Convention. In 2022, Ms. Klumb presented "Fair Best Practices and the Veterinarian's Role" at the Minnesota Veterinary Medical Association Annual Meeting, hosted a workshop titled "Best practices and resources for preventing infectious diseases at agritourism operations" for the International Workshop on Agritourism, and spoke to extension veterinarians about how to start these outreach activities in their own states at the United States Animal Health Association Annual Meeting.

We have produced and shared a number of posters, fact sheets, and handouts on the UMASH website (umash.umn.edu/resources/). Throughout this grant cycle, these resources received 1,001 pageviews and 347 downloads. We have created 5 educational videos, *Farms, Fairs, and Fun; Agritourism – Prepare and Plan, Animal Agritourism: Lay out a Plan for Success; Keep Food Safe- 4-H Food Sand Worker Training; and 6 Tips for Biosecurity – a*

Guide for Youth Livestock Exhibitors on the UMASH YouTube channel. The videos have received 12,209 views and 321.5 watch hours throughout the grant cycle.

Our disease prevention activities have been well-received by participants. For example, after participating in an Agritourism Workshop, the North Star Farm Tour (NSFT), an agritourism collective in the Upper Midwest, made health and safety as a priority and amended their bylaws so that all members were required to take the Safer FACES training. They created handwashing stations for all their member farms and published detailed schematics and directions on how to build the handwashing stations. They also worked with us to translate our handwashing poster into 19 languages. NSFT members also began co-presenting with MDH at agritourism workshops and conferences to provide the farmer perspective to the audience. This partnership also led to Carrie Klumb presenting this workshop to an international audience at the International Workshop on Agritourism in Vermont in 2022.

We have worked extensively with Minnesota 4-H to educate children participating in the livestock program. With additional grant funding from the Council for State and Territorial Epidemiologists (CSTE) we have been able to create a variety of fun and exciting educational tools to help K-12 kids learn about zoonoses and disease prevention. Products of this project include a board game called "Adventures in Agritourism: Farmstead Enterprise," a memory match game called "Pathogen Pair" for kids in grades K-2, a Germ-O card game, "Zoonotic Disease Detective" toolkits with all supplies necessary to teach six hands-on lessons, and breakout boxes. One-hundred-and-two board games, 350 Germ-O games, 1,300 Pathogen Pair games, 1,500 toolkits, and 10 breakout boxes were distributed to regional offices throughout the state so 4-H clubs could check them out for meetings. In 2019, we worked with 4-H to create a zoonotic disease prevention-themed mobile escape room. In 2019, the escape trailer traveled to 10 county fairs and all 12 days of the Minnesota State Fair where we had over 2,000 participants. In 2021 the trailer went to the Northeast Youth Livestock show where over 200 people went through it. In 2020, the mobile escape room won the National Association of 4-H Youth Development Professionals Excellence in Animal Science Programming award.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

N/A

C. PRODUCTS

C.1. Publications, conference papers, and presentations

Presentations

- Klumb C, Ireland, M, Scheftel, J. A One Health Approach to Improving Health and Safety at the Human-Animal Interface. United States Animal Health Association Annual Meeting, Minneapolis, MN October 2022.
- Klumb C, Smith M, Wustenberg W. Best Practices and Resources for Preventing Infectious Diseases at Agritourism Operations. International Workshop on Agritourism, Burlington, VT August 2022.
- Klumb, C. Fair Best Practices and the Veterinarian's Role. Minnesota Veterinary Medical Association Annual Meeting, Virtual February 2022.
- Klumb, C. Risks from Animals in Public Settings: Agritourism Outreach in Minnesota. American Veterinary Medical Association Convention, Virtual Annual Meeting, July 2021.
- Scheftel, JS. Enteric Diseases in Agricultural Workers and from Animal Contact Venues. American Veterinary Medical Association, Virtual Annual Meeting, July 2021.
- Scheftel, JS. One Health in action: State public health response to HPAI outbreaks in Minnesota. Invited speaker, The MITRE Corporation not-for-profit organization One Health Approach lecture series, July 2022.
- Scheftel, JS. State Public Health Response to 2015 HPAI Outbreak. Invited speaker, President's Advisory Committee on Combating Antibiotic Resistance (PACCARB) Public Meeting, March 2022.
- Scheftel, JS. High Path Avian Influenza for Small Flock Owners. University of Minnesota Extension Webinar May 2022

- Scheftel, JS. COVID Potpourri. Minnesota Veterinary Medical Association Virtual Annual Meeting. February 2022.
- Scheftel, JS. COVID Vaccination and Returning from Curbside Care. Minnesota Veterinary Medical Association webinar May 2021
- Scheftel, JS. Vet Med: COVID Vaccination; and, COVID-19 and One Health: Effect of a human disease on Vet Med and Animal Ag. Invited speaker, Mississippi Veterinary Medical Association Virtual Annual Meeting, May 2021.
- Scheftel, JS. COVID Vaccination Lunch n' Learn. Minnesota Board of Animal Health Work Conference, June 2021.
- Scheftel, JS and Frumholtz, M. COVID-19 and Minnesota Business. Minnesota Chamber of Commerce virtual meeting, November 2020.
- Scheftel, JS. CWD and Human Health. Minnesota Board of Animal Health Farmed Cervidae Advisory Committee, virtual meeting November 2020.
- Scheftel JS. State Public Health Veterinarian Interactions with the Meat Packing Industry. United States Animal Health Association (USAHA) One Health Committee, USAHA Virtual Annual Meeting October 2020.
- Scheftel JS. COVID-19 and Recycling and Composting Facilities in Minnesota. Minnesota Recycling and Composting Association, April 2020.
- Bender, Jeff. Biosecurity and Zoonotic Disease Prevention. Webinar. Welcome to the Healthy Farms Healthy Agriculture (HFHA). Virtual. November 2020.
- Bender, Jeff. There's a reason we don't "kiss the calves." Webinar. The Dairy Signal. Virtual. August 2020.
- Klumb, Carrie. Agritourism: Keeping your visitors, your animals, and your assets safe and healthy. Oral presentation. MN Organics Conference. St. Cloud, MN. January 2020.
- Klumb, Carrie; Scheftel, J.; Smith, K. Animal Agriculture Exposures among Minnesota Residents with Zoonotic Enteric Infections, 2012-2016. Oral presentation. International Society for Agricultural Safety and Health. Des Moines, IA. June 2019.
- Bender, Jeff. Biosecurity and Zoonotic Disease Prevention: Keeping our guests and animals healthy and safe. Oral presentation. 2019 North American Livestock Show and Rodeo Manager's Annual Meeting and Conference. Bloomington, MN. May 2019.
- Klumb, Carrie; Hedeen, Nicole; Connery, Russ; Scheftel, Joni, Agritourism Workshop: A One Health Approach Improving Health and Safety at Agritourism Venues. FUSION Conference hosted by the American Farm Bureau Federation, Milwaukee, WI. March 15-18, 2019.
- Klumb, Carrie. Hosting an on Farm Event. LEAP Conference hosted by the Minnesota Farm Bureau. January 26, 2019. Bloomington, MN. January 2019.
- Klumb, Carrie; Scheftel, Joni. Educational Efforts for Agritourism and Farm Visit Providers in Minnesota. South Dakota One Health Seminar. Sioux Falls, SD. June 20, 2018.
- Klumb, Carrie; Saykao Samantha; Scheftel, Joni. Knowledge, Attitudes, and Beliefs About Agritourism and Zoonotic Diseases Among Minnesota State Fair Attendees, 2016. CSTE Annual Conference. West Palm Beach, FL. June 10-14, 2018.
- Klumb, Carrie. County Fairs and Agritourism Operations: Opportunities for Collaboration. Minnesota Environmental Health Association Conference. Deerwood, MN. May 10-11, 2018.
- Kampa, D; Peterson, C; Liebman A; Bender, JB; Alexander, BH. Dairy Worker Safety: Moving from Problem to Solution. 2018 NORA Symposium. Minneapolis, MN. May 3, 2018.
- Klumb, Carrie; Scheftel, Joni. Healthy Fairs and Agritourism Workshops: A One Health Approach to Improving Health and Safety at Agritourism Operations. Extension Risk Management Educators Annual Conference. Milwaukee, WI. April 11-12, 2018.
- Salzwedel, Marsha, Agritourism Emergency Response. WI Fresh Fruit and Vegetable Conference 2018. Wisconsin Dells, WI. January 2018.
- Scheftel, Joni, Risk for Enteric Pathogens as it Relates to People Who Live on Farms, Work on Farms, or Visit Farms. American Veterinary medical Association Annual Conference. July 2017.

- Klumb, Carrie; Hall Kirk, Peggy, Agritourism, Zoonotic Diseases and Legal Liability. National Ag Law Center Webinar Series. June 2017.
- Klumb, Carrie, Agritourism: The Next Frontier in Agriculture. Ag and Rural Law Institute, MN Bar Association Willmar, MN. June 2017.
- Klumb, Carrie, Surveillance for Zoonotic Diseases in Agricultural Workers in Minnesota II. Women in Agriculture Leadership. Chanhassen, MN. April 2017.

Peer-Reviewed Publications

- Lehnertz NB, Wang S, Garfin J, et al. (2021). Transmission Dynamics of Severe Acute Respiratory Syndrome Coronavirus 2 in High-Density Settings, Minnesota, USA, March–June 2020. *Emerging Infectious Diseases*. 27(8):2052-63. doi:10.3201/eid2708.204838.
- Waltenburg, MA.; Rose, CE.; Victoroff, T et al. (2021). Coronavirus disease among workers in U.S. food processing, food manufacturing and agriculture workplaces. *Emerging Infectious Diseases*, https://doi.org/10.3201/eid2701.203821.
- Klumb, C., Scheftel, J.M., & Smith, K. (2020). "Animal agriculture exposures among Minnesota residents with zoonotic enteric infections 2012–2016", *Epidemiology and Infection*. 148:e55. https://dx.doi.org/10.1017%2FS0950268819002309.
- Miller EA, Elnakave E, Flores-Figueroa C et al. (2020). Emergence of a novel *Salmonella enterica* serotype Reading clonal group is linked to its expansion in commercial turkey production, resulting in unanticipated human illness in North America. Clinical Science and Epidemiology. 5(2):e00056-20.
- Ireland M, Klumb K, Smith K, Scheftel J. (2020). Blastomycosis in Minnesota, USA, 1999-2018. *Emerging Infectious Diseases.* 26(5): 866-75.
- Benedict K, McCracken S, Signs K et al. (2020). Enhanced surveillance for histoplasmosis -- 9 states, 2018-2019. *Open Forum Infectious Diseases*. 17;7(9):ofaa343. doi: 10.1093/ofid/ofaa343. https://pubmed.ncbi.nlm.nih.gov/32964064/.
- Buuck S., Smith K., Fowler RC et al. (2020) Epidemiology of enterotoxigenic *Escherichia coli* infection in Minnesota, 2016-2017. *Epidemiology and Infection*. 2020;148:e206. https://doi.org/10.1017/S0950268820001934.
- Elnekave E, Hong SL, Lim S et al. (2020). Transmission of multidrug-resistant *Salmonella enterica* subspecies enterica 4,[5],12:i:- sequence type 34 between Europe and the United States. *Emerging Infectious Diseases*. 26(12):3034–8. https://doi.org/10.3201/eid2612.200336.
- Elnekave E, Hong SL, Lim S et al. (2019). Circulation of plasmids harboring resistance genes to quinolones and/or extended-spectrum cephalosporins in multiple *Salmonella enterica* serotypes from swine in the United States. *Antimicrobial Agents and Chemotherapy*. 63(4):e02602-18. https://doi.org/10.1128/AAC.02602-18.
- Beczkiewicz A, Cebelinski E, Decuir M et al. (2019) High relative frequency of enteroaggregative *Escherichia coli* among patients with reportable enteric pathogens, Minnesota, 2016-2017. *Clinical Infectious Diseases.* 2019;69(3):473–9. https://doi.org/10.1093/cid/ciy890.
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- Alvarez J, Whitten T, Branscum AJ et al. (2018). Understanding Q fever risk to humans in Minnesota through the analysis of spatiotemporal trends. *Vector Borne and Zoonotic Diseases*. 18(2):89–95. https://doi.org/10.1089/vbz.2017.2132.

- Shaughnessy, MK, Snider T, Sepulveda R et al. (2018). Prevalence and molecular characteristics of *Clostridium difficile* in retail meats, food-producing and companion animals, and humans in Minnesota. *Journal of Food Protection.* ;81(10):1635-42.

- Scheftel JM, Elchos BJ, Rubin CS, Decker JA. (2017). Review of hazards to female reproductive health in veterinary practice. Journal of the American Veterinary Medical Association. 250 (8):862-872.

- Hong, S, Rovira, A, Davies, P et al. (2016). Serotypes and antimicrobial resistance in *Salmonella enterica* recovered from clinical samples from cattle and swine in Minnesota, 2006 to 2015. *PloS One.* 11(12):e0168016. https://doi.org/10.1371/journal.pone.0168016.

- Fowler HN, Holzbauer SM, Smith KE, Scheftel JM. (2016). Survey of occupational hazards in Minnesota veterinary practices in 2012. *Journal of the Amercian Veterinary Medical Association*. 248(2):207-18. doi: 10.2460/javma.248.2.207.

Other Publications

- Coyne, Jennifer. (2019). "Farmers at highest risk of contracting zoonotic diseases Take precautions as part of normal routine"", Diary Star, https://dairystar.com/Content/News/Daily-
- News/Article/Farmers-at-highest-risk-of-contracting-zoonotic-diseases/1/256/15350
- CDC One Health Office (2018). Influenza and Zoonoses Education among Youth in Agriculture, CDC One Health in Action, https://www.cdc.gov/onehealth/in-action/influenza-and-zoonoses-d

Graduate Student Theses and Dissertations using MDH UMASH Data

1. Siebman, Samantha. Association between Animal Agriculture Exposure and Antibiotic Resistance among individuals with confirmed Salmonella infection in Minnesota, 2012-2018. University of Minnesota School of Public Health Masters of Public Health Thesis. 2021.
2. Bryz-Gornia, Krista. Shiga Toxin-Producing *Escherichia coli* (STEC) Among Those with an Agricultural Animal Exposure in Minnesota, 2012 through 2016. University of Minnesota School of Public Health Masters of Public Health Thesis. 2018.
3. Jedlinski, Matthew. Nontyphoidal Salmonellosis Associated with Food Animal Agriculture, Minnesota, 2012-2016. University of Minnesota School of Public Health Masters of Public Health Thesis. 2018.
4. Vilen, Kelley. The Burden of Cryptosporidium parvum, Yersinia, and Non-typhoidal Salmonella in Minnesotans with Agricultural Animal Contact, Minnesota, 2003-2011. University of Minnesota School of Public Health Masters of Public Health Thesis. 2018.
5. Bauck, Leah. Burden of *Campylobacter* and Shiga Toxin-Producing *Escherichia coli* (STEC) Infections among Those with Agricultural Animal Exposure in Minnesota from 2003 to 2011. University of Minnesota School of Public Health Masters of Public Health Thesis. 2018
6. Finks, Kelsey. Zoonotic Disease Outbreaks in Minnesota: Descriptive Epidemiology Report. University of Minnesota School of Public Health Masters of Public Health Thesis. 2018.
7. Sorley, Evan. Campylobacteriosis in Poultry and Livestock Workers in Minnesota, 2012-2016. Univrsity of Minnesota School of Public Health Ph.D. Dissertation. 2018.
8. Saykao, Samantha. Knowledge, Attitudes, and Beliefs of Agritourism and Zoonotic Diseases among Minnesota State Fair attendees, 2016. University of Minnesota School of Public Health Masters of Public Health Thesis. 2016.

C.2. Website(s) or other Internet site(s) – include URL(s)

N/A

C.3. Technologies or techniques

N/A

C.4. Inventions, patent applications, and/or licenses

N/A

C.5. Other products and resource sharing

N/A

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
SmithK1	Y	Smith, Kirk		PI/PD	1.8	0.0	0.0			
SCHEF1	Y	Scheftel, Joni		Co-I	1.8	0.0	0.0			
CKLUMB1	Y	Klumb, Carrie		Study Coordinator	3.0	0.0	0.0			

D.2 Personnel updates

N/a

a. Level of Effort:

b. New Senior/Key Personnel:

c. Changes in Other Support:

d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

N/A

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

Over the course of the last five years, this project has compiled and published the most systematic and comprehensive dataset and analysis of the burden of zoonotic disease from food animal agricultural exposures anywhere. We documented that the burden of zoonotic enteric infections among agricultural workers and their families is substantial, and much greater than previously appreciated (Klumb et al. 2020). The estimated cumulative incidence of zoonotic enteric infections for people who live and/or work on farms with food production animals in Minnesota during 2012–2016 was 147 per 10,000 population, 8 times greater than for other Minnesotans (18.5 per 10,000). The burden of zoonotic infections among visitors to private farms and public agricultural animal contact venues was also substantial.

We have published many of our findings in the peer-reviewed scientific literature. We also have disseminated our findings, as well as information about disease prevention measures based on our work, at numerous scientific conferences and at webinars and training workshops for agricultural audiences. However, there is a need to analyze our data at a more granular level to identify specific populations, particularly vulnerable sub-populations, that are most at risk so that they can be targeted with specific prevention measures. There also is a need to evaluate the effect of disease prevention efforts, over and above tracking the incidence of disease in agricultural workers and their families. These needs will be addressed in the future if further UMASH funding becomes available.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

N/A

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

N/A

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

N/A

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

N/A

G.2 Responsible Conduct of Research

N/A

G.3 Mentor's Research Report or Sponsor Comments

N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects? Exempt, surveillance

G.4.b Inclusion Enrollment Data

N/a

G.4.c ClinicalTrials.gov

N/a

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?

N/a

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

No

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

No, it does not.

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

No

G.8 Project/Performance Sites

See overall

G.9 Foreign Component

No

G.10 Estimated Unobligated Balance

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

No

G.11 Program Income

Is program income anticipated during the next budget period?

No

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?

No

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

In the 2nd 5-year grant cycle of UMASH (2016-2021) the Minnesota Department of Health (MDH) focused on the most important infectious diseases of agricultural workers and their families. We now likely have the largest and most detailed data set on infectious diseases that come from contact with farm animals in this country. We have shown that these diseases occur among people with animal agriculture exposures far more often than previously known and that they are an important risk of farming. We found that the number of enteric infections in people who live and/or work on farms with food production animals in Minnesota during 2012–2016 was 147 per 10,000 population, 8 times greater than for other Minnesotans (18.5 per 10,000). We found that a surprising 61% of cases with an agricultural exposure lived or worked on a farm, upending the widely held assumption that common enteric infections don't occur as often in farmers as in urban/suburban people.

This project has been mentioned in the media several times, on platforms such as Farm Journal Ag Web, Bovine Veterinarian, Minnesota Institute for Sustainable Agriculture, Wisconsin Office of Rural Health, Wisconsin Farmer, among others.

The SAFER Faces training has been cited as a resource several times, by organizations including the Minnesota Department of Agriculture, Minnesota Board of Animal Health, Minnesota Grown, and extension offices. This resource, as well as other agritourism resources that arose from this project, were used in trainings by organizations such as the National Agricultural Law Center, The Ohio State University Extension Farm Office, and Texas Area Health Education Centers East. Our Animals in Public Settings Best Practices Checklist, Handwashing Posters, and the "Farms, Fairs, and Fun" video have been used in several settings, including to train volunteers at the Minnesota Organic Conference, to educate those within Minnesota Farmers Union, and to educate visitors at the Waldoch Farm Garden Center.

A notable outcome was a new partnership between UMASH, MDH and the North Star Farm Tour (NSFT; https://northstarfarmtour.org/) to create multilingual materials and signage for 20 farm tours to promote hand washing and best practices in animal settings. The NSFT board also changed their bylaws to require all participating farms to complete the on-line certification or in-person workshop to be included in the annual farm tour which can serve as an example for other agritourism operations to improve their health and safety practices.

Our work with 4-H has led to a newly established Zoonotic Diseases Prevention category for 4-H projects at county fairs and the Minnesota State Fair. As a result of this new category, *Team Future Generations* from Beltrami County chose to create a disease prevention video that is now being shared via Minnesota 4-H and MDH social media. The video is a direct result of the curriculum we have developed thus far, and we are very proud of the work they produced.

A. COVER PAGE

Project Title: Longitudinal Study of Infectious Disease Risks at the Human-Swine Interface	
Grant Number: 5U54OH010170-10	**Project/Grant Period**: 09/30/2016 - 09/29/2022
Reporting Period: 09/30/2016 - 09/29/2022	**Date Submitted**: See overall
Program Director/ Principal Investigator Dr. Peter Davies Dr. Montse Torremorell (after Nov 2021)	**Administrative Official Information** Kristina McReynolds 450 McNamara Alumni Center 200 Oak Street SE Minneapolis, MN 55455-2070
Change of Contact PD/PI: Montse Torremorell (after Nov 2021)	
Human Subjects: IRB#: 1608M93322	**Vertebrate Animals:** N/A
hESC: N/A	**Inventions/Patents:** N/A

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

This project conducted a 5-year longitudinal cohort study of US swine veterinarians, with a control group of companion animal veterinarians, to understand the exposure and health risks attributable to pig exposure for key zoonotic pathogens that are endemic in the US swine industry. This study's specific aims were:

Aim 1. Determine the relative risk of MRSA and multiple drug-resistant *Staphylococcus aureus* (MDRSA) exposure, and associated health events, in swine veterinarians and companion animal veterinarians;

Aim 2. Determine relative risks for influenza A virus (IAV) exposure and disease in swine veterinarians and a control population, and estimate the relative likelihoods of bidirectional transmission events;

Aim 3. Estimate the risk of Hepatitis E (HEV) exposure and seroconversion in swine veterinarians.

B.2. What did you accomplish under these goals?

This 5-year longitudinal cohort study of US veterinarians evaluated the exposure risks and health risks attributable to pig exposure for three zoonotic pathogens that are endemic in the US swine industry: 1) Livestock-associated *S. aureus* (SA), including MRSA; 2) Influenza A viruses; 3) Hepatitis E virus. This prospective study was unique in comparing the cohorts of swine veterinarians (SV) with a group of companion animal (CAV), and was remarkable for the response rates achieved for both sample submission (98.3%) and survey completion (94.4%) achieved.

Aim 1.

In SV, *S. aureus* (68%) and MRSA (11.8%) were markedly more prevalent than in CAV (26.7%, 2.8%), and only 8% of CAV, versus 44% of SV, were persistently colonized (>80% of swabs positive) with SA. The spa types isolated differed between the groups, with most SV isolates being spa types (t034, t571, t002, t337, t3446, t011, t3220, t4652, t242, t570) common in pigs, and therefore of likely livestock origin. In contrast, the predominant spa types in CAV were not those associated with livestock, apart from t034 isolates derived from one individual with daily horse contact. CAV self-reported a higher incidence of workplace injuries (4.0 per 100 person-months at risk) and skin and soft tissue injuries (9.8) than did SV (2.8, 5.8 respectively). However, the incidence of self-reported skin and soft tissue infections was higher in SV (0.93), than in CAV (0.40). No confirmed MRSA infections were reported, and only 3 confirmed methicillin susceptible SA infections were reported (2 SV, 1 CAV). In conclusion, elevated SA and MRSA colonization of SV attributable to swine exposure did not translate into substantial health risks to SV.

Aim 2 (Influenza) and Aim 3 (Hepatitis E):

Estimation of exposure for both pathogens was limited due to the COVID pandemic, but some exposure to influenza was shown in both groups by virus isolation, and seroprevalence of Hepatitis E in SV was 21%. For influenza, similar incidences in SV and CAV were seen for self-reported influenza like illnesses (4.1 vs. 3.2 cases per 100 person months respectively), medical appointments due to ILI (0.65, 1.0), confirmed influenza cases (0.19, 0.22) and workdays lost due to ILI (2.6 vs. 4.0). Only two events of liver related disease were reported, one from each group. Again, the self-reported disease data do not suggest substantially elevated risks in SV due to occupational exposure to these pathogens.

B.4. What opportunities for training and professional development did the project provide?

My Yang, Senior Research Scientist, was involved in all aspects of the project and coordinated the laboratory work. This project provided training to investigate disease transmission at the people/animal interface.

B.5. How did you disseminate the results to communities of interest?

We presented the results to the United States swine veterinary community (Leman Swine Conference) and are preparing manuscripts for peer review. Results are communicated anonymously to participants quarterly, usually prior to an upcoming sampling event. Sporadic communication also occurs with individual participants if questions

arise in interpreting their results or associated health questions. Further, insights have been shared with the UMASH outreach and communications team to engage the advisory board in findings and inform ongoing resource development for agricultural workers.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

N/A

C. PRODUCTS

C.1. Publications, conference papers, and presentations

Publications

- Davies, Peter; Yang, My; Torremorell, Montse; Bender, Jeff. Staphylococcus aureus colonization and self-reported health events in swine veterinarians and companion animal veterinarians in the United States (in preparation)
- Hau, S. J., Frana, T., Sun, J., Davies, P. R., & Nicholson, T. L. (2017). Zinc Resistance within Swine-Associated Methicillin-Resistant Staphylococcus aureus Isolates in the United States Is Associated with Multilocus Sequence Type Lineage. Applied and Environmental Microbiology, 83(15), e00756–17. http://doi.org/10.1128/AEM.00756-17

Presentations

- Davies, Peter; Yang, My; Torremorell, Montse; Bender, Jeff. MRSA colonization and infection in swine veterinarians and companion animal veterinarians. Oral/podium presentation. Allen D. Leman Swine Conference. September 2021, St. Paul, MN.
- Sun J, Sreevatsan S, Knutson T, Marthale D, Yang M, Davies P., Characterization of staphylococcus aureus in swine and swine veterinarians and its transmission at the human- livestock interface. Poster Presentation. May 2017, NORA Symposium. Minneapolis, MN.

C.2. Website(s) or other Internet site(s) – include URL(s)

N/A

C.3. Technologies or techniques

N/A

C.4. Inventions, patent applications, and/or licenses

N/A

C.5. Other products and resource sharing

N/A

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
MTORREMORELL	Y	Torremorell, Montse		PI/PD	0.24	0.0	0.0			
	N	Yang, My		Laboratory Scientist	3.0	0.0	0.0			

D.2 Personnel updates

Retirement of Peter Davies, 2021

a. Level of Effort:

b. New Senior/Key Personnel:

c. Changes in Other Support:

d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

N/A

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

The importance of the human-animal interface as a source of emerging infectious diseases is universally recognized. The three pathogens included in the study are recognized to be emerging concerns to occupational and or public health. Livestock associated MRSA was unknown prior to 2004 but is now known to be widespread in pigs in many countries. Pigs are long recognized reservoirs of influenza viruses, gaining added attention following the 2009 H1N1v pandemic. Hepatitis E viruses are diverse, with particular subtypes known to be prevalent in pigs, and some suggestion of increasing human cases with these subtypes in some European countries. Given the prevalence of these agents in pig populations, occupational exposure is assumed to be common in livestock workers, including veterinarians, but actual risks to health have not been quantified. This study is the first long term prospective study evaluating these risks in swine veterinarians and including an appropriate control group. For all three agents, the self-reported data of relevant health events collective prospectively did not clearly indicate substantial health risks associated with exposure to swine. The likely impact of a 'healthy worker effect" is acknowledged and these pathogens may pose greater risks to elderly or medically compromised individuals. While swine veterinarians have a greater potential for exposure to S. aureus of animal origin, there is no evidence that they are at higher risk of infection. The risk of injury was similar between companion animal and swine veterinarians. Veterinarians and animal producers should continue to engage in preventative measures, such as wearing protective clothing and handwashing following animal contact, as well training and practices that reduce the risk of injury.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

The project was impacted by the COVID pandemic due to interruption of sampling and a 4-month laboratory closure. This particularly impacted the influenza and Hepatitis E sampling, with relatively little impact on the S. aureus component, as one quarterly sampling was lost.

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

N/A

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

No changes from the original protocols except for effect of COVID on sample collection, submission, and processing. Changes were made to shipping and handling of nasal swabs due to the COVID pandemic. Shipping protocols for samples shifted from the postal system to a commercial transporter from 2020.

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

G.2 Responsible Conduct of Research

N/A

G.3 Mentor's Research Report or Sponsor Comments

N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?

Yes

G.4.b Inclusion Enrollment Data

117 subjects enrolled (68 swine veterinarians, 48 companion animal veterinarians)

G.4.c ClinicalTrials.gov

N/A

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?

No

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

No

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

No

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

No

G.8 Project/Performance Sites

See overall

G.9 Foreign Component

No

G.10 Estimated Unobligated Balance

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

G.11 Program Income

Is program income anticipated during the next budget period?

No

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?

No

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

The overriding goal of the study was to understand the risks to their health that swine veterinarians may confront due to their occupational exposure to pigs, and specifically to three infectious agents (*Staphylococcus aureus*, including MRSA; Influenza A viruses; Hepatitis E virus) that are common in U.S. pigs and can cause human illness. A novel component of this project was to prospectively collect data on relevant health events from both swine vets and a control population of companion animal vets. There was a higher prevalence of *S. aureus* (approximately two-fold) and MRSA (approximately four-fold) in swine vets (SV) compared to companion animal vets (CAV), and isolates from swine vets were dominated by livestock-associated variants, which were uncommon in CAV. Only three individuals (two swine vets and one companion animal vet) reported clinical *S. aureus* infections that were medically confirmed. None were MRSA, and all were minor localized infections. Table 1 compares the incidence of self-reported work-

related injuries (WRI), WRI receiving medical attention, skin and soft tissue infections, and *S. aureus* infections. Similarly, there was no indication of elevated risk of influenza-like illnesses or hepatic disease.

Table 1. Incidence of self-reported health events in Swine Veterinarians and Companion Animal Veterinarians (cases per 100 person-months at risk)

Health event	Swine vets	Companion animal vets
Work place injuries	2.8	4.0
Medical attention for work injury	0.2	0.4
Skin or soft tissue injuries	5.9	9.8
Medical attention for skin injury	0.50	0.40
Skin or soft tissue infections	0.93	0.40
Confirmed S. aureus infection	0.06	0.04

While swine veterinarians have a greater potential for exposure to *S. aureus* of animal origin, there is no evidence that they are at higher risk of infection. The risk of injury was similar between companion animal and swine veterinarians. Veterinarians and animal producers should continue to engage in preventative measures, such as wearing protective clothing and handwashing following animal contact, as well training and practices that reduce the risk of injury.

A. COVER PAGE

Project Title: Optimizing Assessment of Virus-Containing Particles in Animal Agriculture	
Grant Number: 5U54OH010170-10	**Project/Grant Period**: 09/30/2016 - 09/29/2022
Reporting Period: 09/30/2016 - 09/29/2022	**Date Submitted**: See overall
Program Director/ Principal Investigator Dr. Peter Raynor	**Administrative Official Information** Kristina McReynolds 450 McNamara Alumni Center 200 Oak Street SE Minneapolis, MN 55455-2070
Change of Contact PD/PI: N/A	
Human Subjects: **No**	**Vertebrate Animals: No**
hESC: No	**Inventions/Patents:** The Bioaerosol Cascade Virtual Impactor is being assessed by the University of Minnesota Office of Technology Commercialization for patent potential.

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

Those working in animal agriculture are at risk of airborne exposure to infectious viruses, such as zoonotic influenza viruses. Conventional wisdom suggests that most transmission of infectious viruses occurs by droplet transmission. However, recent research indicates that at least some viruses can be transmitted by the airborne route. To assess exposures to viral aerosols and manage them effectively, we must know the concentrations and sizes of particles with which infectious airborne viruses are associated. The objectives for this project were to develop a high-volume, field-portable, size-differentiating viral aerosol sampler and use it to measure worker exposures to viable airborne influenza viruses in animal agriculture facilities. The specific aims for the project were the following:

Aim 1. Evaluate existing samplers. We will assemble a wide range of existing samplers that collect viral aerosols by a variety of principles. They will be tested side-by-side in an isolation room using mechanically-generated influenza virus aerosols, and in animal agriculture facilities experiencing swine or avian influenza outbreaks to collect naturally-occurring viruses. These tests will determine the combinations of sampling parameters and technologies that collect the greatest quantity of viral RNA and live virus.

Aim 2. Design and build an improved sampler. Using the findings from Aim 1, we will design and build an improved sampler for measuring concentrations, sizes, and infectivity of virus-containing particles. We will utilize computational fluid dynamics to design the sampler. Size-dependent particle sampling efficiency will be established in laboratory tests.

Aim 3. Compare the improved sampler to existing samplers. In an isolation room, we will verify that the improved sampler built for Aim 2 recovers viral RNA and live virus more effectively than the most effective existing samplers determined from Aim 1.

Aim 4. Use the improved sampler to measure viruses in animal agriculture facilities. Size-by-size concentrations of influenza viruses will be measured using the improved sampler in a variety of swine and other animal agriculture facilities to demonstrate its utility and assess typical exposures to airborne influenza viruses among workers.

B.2. What did you accomplish under these goals?

Aim 1

The research team analyzed airborne virus samples collected during experimental measurements made with three sets of air samplers. All three sets included an Andersen Non-Viable Cascade Impactor (Tisch Environmental) and a Cyclonic Collector (Midwest Micro-Tek) for comparability across the sets. Set #1 focused on impingement and cyclonic samplers, utilizing a BioSampler (SKC), a Cyclone Bioaerosol Sampler (NIOSH), a VIVAS (University of Florida & Aerosol Dynamics), a SpinCon II (InnovaPrep), and a Bobcat (InnovaPrep) in addition to the Andersen impactor and the Cyclonic Collector. Focused on filtration and electrostatic collection, Set #2 included a Hi-Vol TSP sampler, a 47mm fiberglass filter sampler, a 47mm gelatin filter sampler, a PEMS $PM_{2.5}$ sampler (SKC), and an electrostatic sampler (University of North Carolina @ Chapel Hill). Set #3 focused on impaction. In addition to the Andersen impactor and the Cyclonic Collector, this set included a MOUDI impactor (TSI Inc.), a Series 230 High Volume Cascade Impactor (Tisch Environmental), and a Trichotomous Virtual Impactor Sampler (University of Minnesota). The tests were conducted in a room in the BSL-2 Veterinary Isolation Buildings at the University of Minnesota. For all three sets, we used the samplers to measure concentrations of three test viruses: MS2 bacteriophage, an H3N2 swine influenza virus (SIV), and an H9N9 avian influenza virus (AIV). Aliquots of stock viruses were thawed, and the suspensions were placed in a nebulizer, which was positioned directly

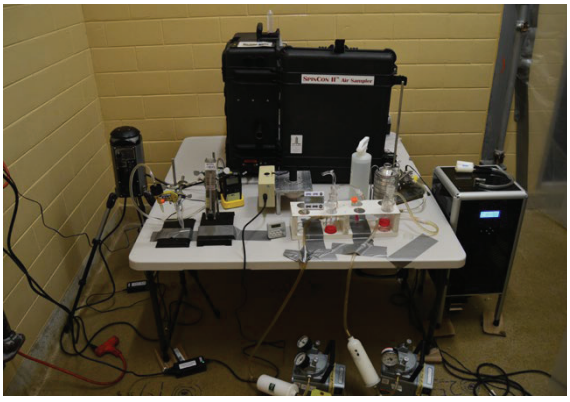


Figure 1. Sampling instruments arrayed in the isolation room for the first set of

in front of the opening of the supply plenum entering the room to promote mixing. Preliminary tests using an optical particle counter indicated that aerosol concentrations and size distributions were uniform and stable within a few minutes in the lower half of the room opposite from the supply plenum. Therefore, samplers were positioned there as shown for the first set of measurements in Figure 1. Inlets to the samplers were separated to the extent possible to avoid interferences. We performed three replicate tests for each virus in each set for a total of 27 tests. The tests yielded approximately 1,500 samples.

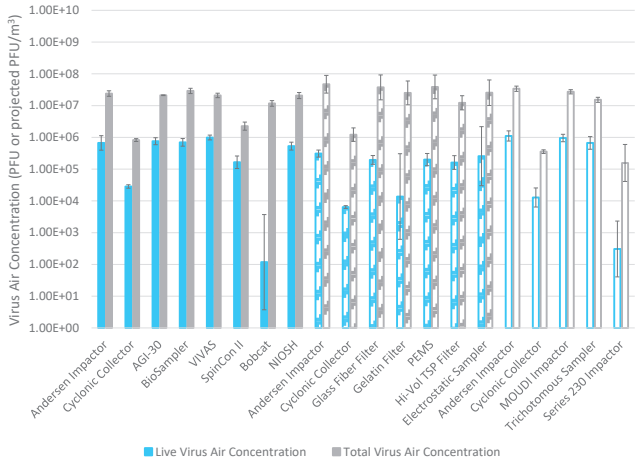


Figure 2. Infectious virus and viral RNA air concentrations measured by various samplers for MS2 bacteriophage. Bars represent geometric means and error bars represent ± one geometric standard deviation.

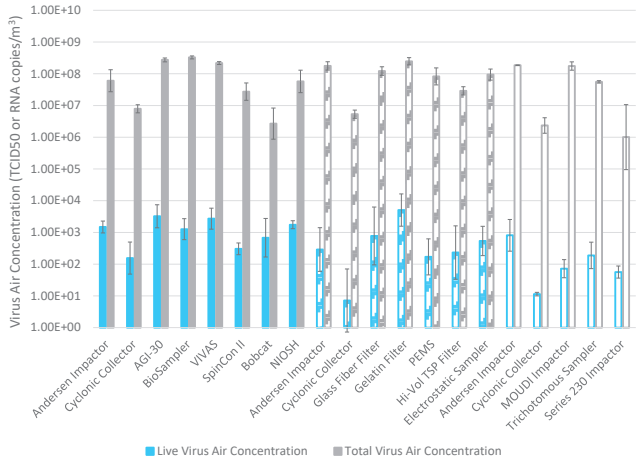


Figure 3. Infectious virus and viral RNA air concentrations measured by various samplers for H3N2 swine influenza virus. Bars represent geometric means and error bars represent ± one geometric standard deviation.

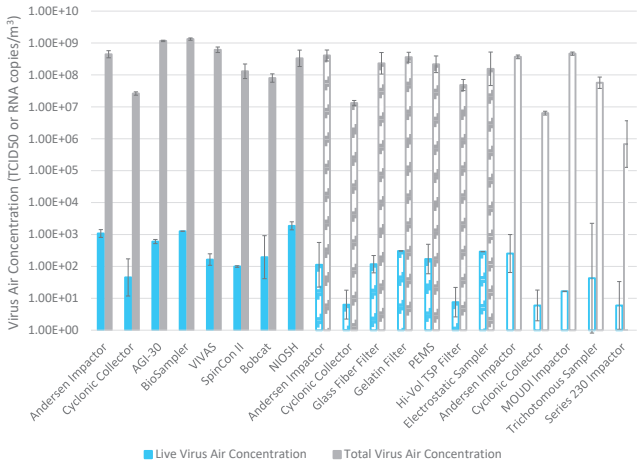


Figure 4. Infectious virus and viral RNA air concentrations measured by various samplers for H9N9 avian influenza virus. Bars represent geometric means and error bars represent ± one geometric standard deviation.

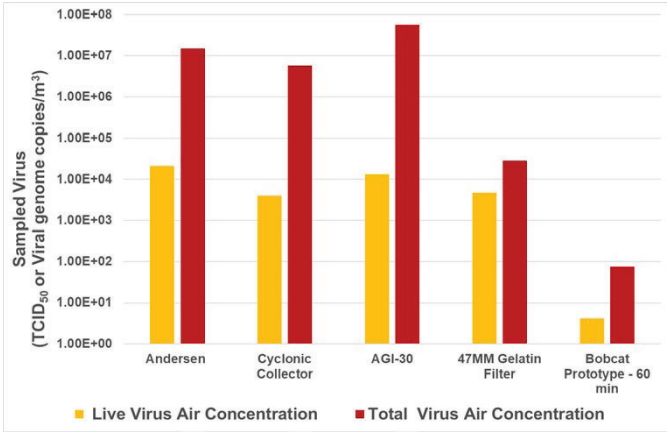


Figure 5. Live virus and viral RNA (total virus) air concentrations measured by samplers. Bars represent geometric means of three measurements.

Analyses included standard titration techniques for viable virus and molecular techniques to measure viral RNA (viable + inactivated virus). Viral RNA was extracted from samples and used for qRT-PCR (quantitative real time-PCR)

to provide cycle threshold (Ct) values. Standard curves for SIV and AIV were constructed using serial ten-fold dilutions of a matrix gene transcript RNA with known copy numbers for absolute quantification of the viral genome copy numbers in samples. For construction of an MS2 standard curve, serial ten-fold dilutions of MS2-RNA extracted from a virus stock with a known titer were used. The Ct values were then used along with the standard curves to calculate the absolute genome copy number of SIV or AIV, or MS2 genome copy number expressed as projected plaque forming units (PFU). SIV and AIV were titrated in Madin-Darby canine kidney (MDCK) cells to determine quantities of viable virus. After about 72-96 hours of incubation, the cells were observed for cytopathic effects, and viral titers quantified as 50% tissue culture infective dose ($TCID_{50}$) were calculated using the Karber method. Quantification of viable MS2 bacteriophage in samples was carried out using a double agar layer procedure, with results reported as PFU. Recovery of viable virus and viral RNA copies, in absolute terms, as well as air concentrations of viable virus and viral RNA were calculated and compared among tested samplers. Results were analyzed descriptively and statistically.

Figures 2-4 present the geometric means of the airborne concentrations of viable virus and viral RNA for each air sampler in each set of tests for MS2, SIV, and AIV, respectively. Error bars represent one geometric standard deviation from the geometric mean. Several conclusions were drawn from these measurements. While high flow rate samplers tended to yield higher titers and more RNA copies than low flow rate samplers, the highest measured concentrations shown in the figures were observed among lower flow rate samplers. One possible reason for this is that high flow samplers typically consolidate the sample more than low flow samplers, perhaps leading to high concentrations of salts and other components of the particles that create an environment that is harmful to the virus. Our findings also showed that impingement samplers tend to keep the viruses viable more effectively than other types of samplers. However, the high flow Cyclonic Collector, which uses both cyclonic motion and impingement, was the poorest performing sampler overall. This was an important finding by itself because University of Minnesota colleagues had frequently used this sampler previously in animal agriculture field studies. The Bobcat sampler was the easiest to use. While this is important, it should not be the main driver of decisions. Ultimately, a two-sampler strategy may have benefits during outbreak investigations. A high flow, non-sizing sampler could be used for detecting viruses while a lower flow, size-separating sampler could be used for concentration and particle size measurements.

The research team has published a journal article on the first set of tests in *PLOS One* (Raynor et al., 2021). A manuscript on the second set of tests is under review at the *Journal of Occupational and Environmental Hygiene.* A manuscript on the third set of tests is in preparation. We also anticipate submitting a manuscript summarizing results across all three sets of tests together.

Following the isolation room study, six samplers – the Andersen Non-Viable Cascade Impactor, the Cyclonic Collector, two of the Bobcats, the AGI-30 impinger, and the 47mm gelatin filter sampler – were used for a short field sampling campaign in March 2020. Unfortunately, this sampling campaign was cut short due to the COVID-19 pandemic. The samplers were arrayed side-by-side to sample for viruses in a swine production facility experiencing active influenza virus infections. The samplers were run for 30 minutes except for one of the Bobcats that operated for 60 minutes. Three replicate measurements were taken. The collected samples were stored on ice and transported to the laboratory where the aliquots were stored at -80°C until analysis. The $TCID_{50}$ method was used to titrate the samples in MDCK cells. Viral RNA was extracted from each sample and PCR primer and probes were used for the real-time RT-qPCR quantification. The viable virus and viral RNA copy concentrations were computed for each sample.

Results from these measurements are shown in Figure 5. The Andersen impactor and the AGI-30 impinger measured the highest air concentrations of both viable virus and viral RNA. The Cyclonic Collector and the gelatin filter measured lower concentrations. The recovery of viable virus and viral RNA concentrations measured by the Bobcat operated for 60 minutes were significantly lower than those of the other samplers. The Bobcat operated for 30 minutes did not detect either the viable virus or viral RNA in any of the three replicates. The lower flow rate AGI-30 impinger and Andersen Non-viable Cascade Impactor, measured higher airborne virus concentrations compared to the high-volume cyclonic sampler. The gelatin filter proved somewhat less effective during field sampling than in the tests in the isolation room. The viral particles were observed in particles larger than 3.3 µm in aerodynamic diameter by the Andersen impactor. The research team plans to submit a short communication regarding this field work to a peer-reviewed journal.

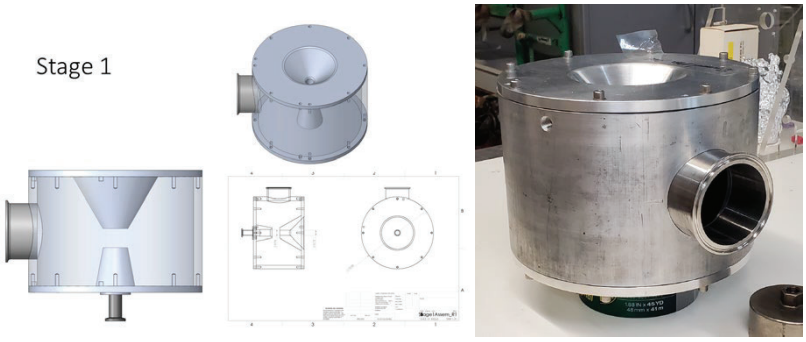
Aim 2

The research team has designed and fabricated a prototype for an improved sampler for airborne viruses. Size separation is achieved by virtual impaction. Most size-separated particles are collected using aerosol impingers to maintain viability of viruses. The smallest size interval will be captured using a filter because impingers can be ineffective at capturing very small particles. We refer to the sampler as a Bioaerosol Cascade Virtual Impactor (BCVI).

A virtual impactor consists of an acceleration inlet nozzle and two outlets: a collection probe which draws away a minor portion of the incoming flow – in our case 4-5% – and a bypass outlet which draws away the remaining major portion of the incoming flow. Airborne particles are accelerated through the inlet nozzle with the incoming air and directed towards the collection probe. Larger particles with sufficient inertia are separated in the probe and carried away with the minor flow while smaller particles follow the turning air and are carried away with the major flow. The BCVI is designed to separate particles into four aerodynamic size intervals (<1 μm, 1-4 μm, 4-10 μm, and >10 μm) using a series of virtual impactor stages with progressively more and smaller nozzles. These stages will process the same aerosol flow, with the particles separated by size into several samples that can be collected and analyzed individually. An advantage of using a virtual impactor over a conventional inertial impactor is that the virtual impactor keeps the size-separated virus-containing particles airborne so they can be collected by methods like impingement that maintain virus infectivity, as opposed to depositing them on a surface from which they must be removed and upon which the viruses can be inactivated. The BCVI will have an incoming flow of 300 L/min.

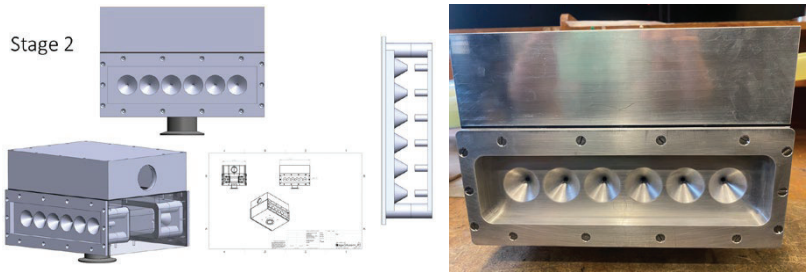
The BCVI was designed using Ansys computational fluid dynamics modeling (CFD) software. The steps needed to design the size-separating impactor sections were to (1) draw the geometry of each section in three dimensions, (2) lay out a three-dimensional mesh within the geometries, (3) model the airflow throughout the mesh, and (4) superimpose particle motion onto the airflow. Design parameters with initial values drawn from the scientific literature were adjusted to achieve the size separation aerodynamic diameters of 10 μm, 4.0 μm, and 1.0 μm. An attempt to add an additional separation at 0.5 μm was deemed to be impractical due to the requirement for a very large number of nozzles.

After the design was complete, the CFD geometries for the stages were imported into an engineering drawing program, from which diagrams were produced that allowed the University of Minnesota College of Science and Engineering Machine Shop to fabricate the three separation stages. The drawings and fabricated stages are shown in Figures 6-8.



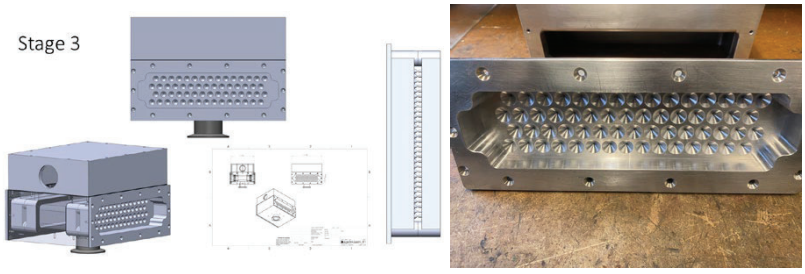
(a) (b)

Figure 6. (a) Engineering drawings for the first stage of the prototype Bioaerosol Cascade Virtual Impactor. (b) The first stage of Bioaerosol Cascade Virtual Impactor as fabricated.



(a) (b)

Figure 7. (a) Engineering drawings for the second stage of the prototype Bioaerosol Cascade Virtual Impactor. (b) The first stage of Bioaerosol Cascade Virtual Impactor as fabricated.



(a) (b)

Figure 8. (a) Engineering drawings for the third stage of the prototype Bioaerosol Cascade Virtual Impactor. (b) The first stage of Bioaerosol Cascade Virtual Impactor as fabricated.

The performance of each BCVI stage is being verified in laboratory tests. This involves measuring the separation of droplets or particles in each stage as a function of diameter. Testing the performance of each virtual impaction stage using both solid and liquid particles will allow us to evaluate its ability to accurately measure concentrations and sizes for virus-containing particles that are unlikely to be either fully solid or liquid. To measure size-dependent efficiency and wall losses, monodisperse (single-sized) liquid droplets are generated using a vibrating orifice aerosol generator. Oleic acid droplets dyed with fluorescein are used to measure liquid particle efficiency and wall losses whereas deionized water droplets with dissolved fluorescein are allowed to fully dry for measurements with solid particles. For each stage, we are generating monodisperse droplets or particles of 7 different sizes bracketing the anticipated 50% collection efficiency size. The droplets or particles are diluted and passed through a Krypton-85 charge neutralizer to remove excess electrostatic charges from them. The sizes of the monodisperse droplets and particles are assessed using an Aerodynamic Particle Sizer. Particles emerging from the major and minor flows are each captured on filters. In addition, the interior surfaces of the stage are rinsed to capture the droplets and particles lost to interior walls. The fluorescein in the droplets or particles captured on the filters are dissolved into liquids. The fluorescence of each sample is then measured using a spectrofluorometer. Through a calibration curve, we determine the amount of the incoming droplets passing into the major and minor flows as well as the amount deposited on the walls. This allows computation of efficiency and wall losses as fractions or percentages. We also measure pressure drops through each stage, which will help us determine specifications for the vacuum pump needed to pull air through the BCVI. We anticipate eventually submitting two manuscripts from this part of the research. One will focus on the CFD modeling by which the BCVI was designed. The other will report the results of the performance tests to verify the design of the sampler.

Aim 3

We did not complete Aim 3 during the funding period. We are carrying out this work with separate funding as it is part of the dissertation research for a doctoral student.

Following the BCVI performance verification in Aim 2, we expect to begin conducting tests with viable virus aerosols in either the University of Minnesota College of Veterinary Medicine Isolation Building or the University's Department of Mechanical Engineering BSL-2 wind tunnel to compare the new sampler to the best-performing samplers from our earlier tests: the AGI-30 impinger and Andersen Non-viable Cascade Impactor. Using experimental and analytical methods like those used for the Aim 1 measurements, the team will use SIV and MS2 bacteriophage as our test viruses, generated through nebulization. The primary outcome variables from these tests will be recovery of viable virus and viral RNA copies as both overall quantities captured and airborne concentrations. Results will be analyzed statistically to assess the influence of sampler and type of virus on viable virus and viral RNA recovery. Size distribution measurements will be compared among size-separating instruments. We expect to submit a manuscript about these tests.

Aim 4

We did not complete Aim 4 during the funding period. We will utilize the new sampler in future research projects, making comparisons to previously existing samplers.

Conclusions

The results of this project have led to a conclusion that was unanticipated at the start of the research: a two-sampler strategy may be optimal during zoonotic influenza outbreak investigations in animal agriculture facilities. At first, using a high-flow, non-sizing sampler may be optimal for detecting viruses at low concentrations. Then, if viruses are detected, using a lower-flow, size-separating sampler may be most suitable to accurately measure airborne virus concentrations and sizes.

While effective high-flow, non-sizing samplers are already available, we designed and fabricated an intermediate-flow, size-separating sampler to improve assessment of airborne viral particle concentrations and sizes. While the performance of the prototype Bioaerosol Cascade Virtual Impactor (BCVI) is still being verified, its design is based on physical principles which mean that we will be able to measure the concentrations and sizes of virus-containing particles at a flow rate ten times higher than we can with existing samplers, likely maintaining the viability of the virus better than existing samplers.

B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

PhD student Adepeju Adesina is working on this project as her dissertation research. She wrote a dissertation proposal related to Aims 3 and 4 of this project and submitted her first first-authored manuscript based on parts of Aim 1 of the project. A postdoc (Dr. Hamada Aboubakr) and a researcher (My Yang) participated extensively in the sampling and testing protocols for this project. This project provided them an opportunity to develop their skills in aerovirology.

B.5. How did you disseminate the results to communities of interest?

The research team published a paper in January of 2021 in the journal *PLoS ONE* related to the first set of tests for Aim 1:

Raynor PC, Adesina A, Aboubakr HA, Yang M, Torremorell M, Goyal SM (2021). Comparison of Samplers Collecting Airborne Influenza Viruses: 1. Primarily Impingers and Cyclones. PLoS ONE, 16(1):e0244977. DOI: 10.1371/journal.pone.0244977. PMCID: PMC7842955.

A manuscript on the second set of tests for Aim 1 is under review at the *Journal of Occupational and Environmental Hygiene*. We are currently working on an additional manuscript related to the third set of tests for Aim 1 that will be submitted to a research journal soon. We also plan a short communication from the field work for Aim 1 and another manuscript for the computational fluid dynamics modeling for the virtual impactor sampler design for Aim 2. Additional manuscripts will be submitted on the ongoing work that is addressing Aims 3 and 4.

PI Peter Raynor also presented to agriculture stakeholders (i.e producers and veterinarians) of the swine industry at the Allen D. Leman Conference on air sampling methods to detect and prevent the transmission of airborne viruses.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

N/A

C. PRODUCTS

C.1. Publications, conference papers, and presentations

Publications

Adesina, Adepeju, Aboubakr, Hamada A., Yang, My, Torremorell, Montserrat, Goyal, Sagar M., Raynor, Peter C. (2022). Comparison of samplers collecting airborne influenza viruses: 2. Primarily filters and an electrostatic precipitator, submitted to *Journal of Occupational and Environmental Hygiene*.(submitted)

Raynor, Peter C., Adesina, Adepeju, Aboubakr, Hamada A., Yang, My, Torremorell, Montserrat , Goyal, Sagar M. (2021). Comparison of samplers collecting airborne influenza viruses: 1. Primarily impingers and cyclones, PLoS ONE, 16(1):e0244977, https://doi.org/10.1371/journal.pone.0244977.

Presentations

Adesina, Adepeju; Raynor, Peter C.; Aboubakr, Hamada; Goyal, Sagar M.; Yang, My; Torremorell, Montse. Assessing Exposure to Airborne Swine Influenza A Virus (IAV) in a Minnesota Wean-to-Finish Facility. Poster presentation. American Industrial Hygiene Conference and Exposition. Virtual. May 24, 2021.

Raynor, Peter C. Assessing Airborne Hazards in Animal Agriculture. Oral presentation. College of Veterinary Medicine Research Seminar. St. Paul, MN. February 12, 2020.

Aboubakr, Hamada A. Comparison of Air Samplers for Efficient Recovery of Airborne Viruses from Bioaerosols. Oral presentation. 2020 American Society for Microbiology Biothreats Conference. Arlington, VA. January 28, 2020.

Aboubakr, Hamada; Adesina, Adepeju; Yang, My; Raynor, Peter C.; Torremorell, Montserrat; Goyal, Sagar M. Comparison of Air Samplers for Efficient Recovery of Airborne Viruses from Bioaerosols. Poster presentation. 2020 American Society for Microbiology Biothreats Conference. Arlington, VA. January 28, 2020.

Adesina, Adepeju; Raynor, Peter C.; Aboubakr, Hamada; Yang, My; Torremorell, Montse; Goyal, Sagar M. A Comparison of Sampling Methods for Detection and Measurement of Airborne Viral Particle Concentration. Oral presentation. American Industrial Hygiene Conference and Exposition. Minneapolis, MN. May 21, 2019.

Adesina, Adepeju; Raynor, Peter C.; Aboubakr, Hamada; Goyal, Sagar M.; Yang, My; Torremorell. A Comparison of Sampling Methods for Detection and Measurement of Airborne Viral Particle Concentrations. Poster presentation. American Industrial Hygiene Conference and Exposition. Minneapolis, MN. May 20, 2019.

Adesina, Adepeju; Raynor, Peter C.; Aboubakr, Hamada; Goyal, Sagar M.; Yang, My; Torremorell, Montse. Detection and Measurement of Airborne Viral Particle Concentration. Poster presentation. 2019 NORA Symposium. Minneapolis, MN. May 2, 2019.

Adesina, Adepeju; Raynor, Peter C.; Aboubakr, Hamada; Goyal, Sagar M.; Yang, My; Torremorell, Montse. Detection and Measurement of Airborne Viral Particle Concentration. Poster presentation. University of Minnesota School of Public Health Research Day, Minneapolis, MN. April 1, 2019.

Adesina, Adepeju; Raynor, Peter C.; Aboubakr, Hamada; Goyal, Sagar M.; Yang, My; Torremorell, Montse. A Comparison of Sampling Methods to Measure Concentrations and Sizes of Airborne Virus-Containing Particles. Biology/Chemistry Seminar at St. Catherine University. St. Paul, MN. September 18, 2018.

Raynor, Peter C.; Adesina, Adepeju; Aboubakr, Hamada; Yang, My; Torremorell, Montse; Goyal, Sagar M. Toward Identifying the Most Effective Samplers for Airborne Viruses. Allen D. Leman Swine Conference. St. Paul, MN. September 17, 2018.

Adesina, Adepeju; Raynor, Peter C.; Aboubakr, Hamada; Goyal, Sagar M.; Yang, My; Torremorell, Montse. A Comparison of Sampling Methods to Measure Concentrations and Sizes of Airborne Virus-Containing Particles. Leman Swine Conference. St. Paul, MN. September 16, 2018.

Peter C. Raynor. Factors Influencing Air Pollutant Levels in Swine Barns. Teleconference. August 2, 2018.

Adepeju Adesina, Peter C. Raynor, Hamada Aboubakr, Sagar M. Goyal, and Montse Torremorell. Evaluating Aerosol Samplers for Characteristics Improving Their Limits of Detection for Influenza Virus. 2018 American Industrial Hygiene Conference and Exposition. May 21-23, 2018. Philadelphia, PA.

Adesina A, Aboubakr H, Raynor PC, Goyal S, Torremorell M. Evaluating Aerosol Samplers for Characteristics Improving their Limits of Detection for Influenza Virus. 2018 NORA Symposium. May 3, 2018, Minneapolis, MN.

C.2. Website(s) or other Internet site(s) – include URL(s)

Nothing to report.

C.3. Technologies or techniques

The three stage Bioaerosol Cascade Virtual Impactor (BCVI) has been constructed as illustrated in section B.2. The performance of the BCVI is being assessed still in laboratory and field tests.

C.4. Inventions, patent applications, and/or licenses

The Bioaerosol Cascade Virtual Impactor is being assessed by the University of Minnesota Office of Technology Commercialization for patent potential.

C.5. Other products and resource sharing

Nothing to report.

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
PRAYNOR	Y	Raynor, P.		PI/PD	1.2	0.0	0.0			
GOYAL001	Y	Goyal, S.		Co-I	0.6	0.0	0.0			
MTORREMORELL	Y	Torremorell, M.		Co-I	0.6	0.0	0.0			
	N	Yang, M.		Laboratory Scientist	1.8	0.0	0.0			
	N	Adesina, A.(RA)		Grad RA	6.0	0.0	0.0			

D.2 Personnel updates

N/a

a. Level of Effort:

b. New Senior/Key Personnel:

c. Changes in Other Support:

d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

Research Assistant and PhD student Adepeju Adesina learned about culture-based and molecular analyses of viruses. Postdoctoral Associate Dr. Hamada Aboubakr learned about air sampling as part of this project, using and deploying a variety of air sampling instruments for the first time. Researcher My Yang expanded her expertise on air sampling methods using new samplers. MS student Charles Kreager is comparing viral aerosol size distributions measured by various impaction samplers for his Masters project, allowing him to complete his MS degree at the University of Minnesota School of Public Health. Mr. Kreager is a practicing industrial hygienist who works for the U.S. Department of Energy.

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

The research is helping to determine the best ways to sample airborne viruses, not only influenza viruses in animal agriculture operations but also other types of viruses in other settings. In particular, the methods being developed in this study will be applicable in non-agricultural spaces and with other viruses such as SARS-CoV-2. A key use of the sampler and sampling protocols developed in this study will be to more rapidly determine if a potential pandemic agent may be transmissible through aerosols. This will benefit not only workers in animal agriculture, but workers and the public everywhere. Additionally, knowing more about the concentrations and sizes of influenza viruses and other pathogens in animal agriculture operations and elsewhere will help researchers and practitioners determine the most appropriate control technologies to reduce exposure to viral aerosols.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

Nothing to report.

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

The COVID-19 pandemic delayed work from March 2020-August 2021. A planned field sampling campaign starting in March 2020 was cut short because travel was restricted by the University of Minnesota due to the pandemic. The research team set aside additional field sampling as a goal to focus on the development of the Bioaerosol Cascade Virtual Impactor (BCVI).

The team anticipated that the BCVI would be available much earlier than 2022 for performance verification and for isolation room and field measurements. Dr. Kim Anderson, formerly a faculty member at the University of Minnesota, conducted the computational fluid dynamics modeling to design the sampler in collaboration with the research team. However, Dr. Anderson left the University in July 2020 to work for NIOSH in Morgantown, WV, which significantly delayed the design of the BCVI.

BCVI fabrication activities required more time than expected at the University of Minnesota College of Science and Engineering Machine Shop. Due to retirement incentives, several staff members in the machine shop retired during the COVID-19 pandemic, setting back fabrication activities. While the sampler has been constructed, it has not been fully evaluated in laboratory and field tests, as planned in Aims 3 and 4 of the project.

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

N/A

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

N/a

G.2 Responsible Conduct of Research

N/a

G.3 Mentor's Research Report or Sponsor Comments

N/a

G.4 Human Subjects

G.4.a Does the project involve human subjects?

No

G.4.b Inclusion Enrollment Data

N/a

G.4.c ClinicalTrials.gov

N/a

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

No

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

No

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

No

G.8 Project/Performance Sites

See overall

G.9 Foreign Component

G.10 Estimated Unobligated Balance

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

No

G.11 Program Income

Is program income anticipated during the next budget period?

N/a

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?

No

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

This study indicates that a two-sampler strategy may be optimal during zoonotic influenza outbreak investigations in animal agriculture facilities. Using a high-flow, non-sizing sampler initially is the best option for detecting airborne viruses at low concentrations. Then, if viruses are detected, sampling with a lower-flow, size-separating sampler will provide the most accurate measurements of airborne virus concentrations and sizes. To meet this second need, we designed and fabricated an intermediate-flow, size-separating Bioaerosol Cascade Virtual Impactor (BCVI) to improve assessment of airborne viral particle concentrations and sizes. Its flow rate is ten times higher than existing size-separating samplers for viral aerosols, meaning that the sampler will be able to collect enough genetic material and viable viruses for analyses much more quickly than existing samplers. To publicize our research to the public health community and the public, this research was highlighted on the UMN News and School of Public Health news websites.

The methods developed in this study are already being applied in additional research. For example, our team has received donor funds to comprehensively assess concentrations, sizes, and viability of human-generated viruses in the air in high-risk workplaces and public spaces. A lack of real-world airborne virus concentration and particle size data is the biggest gap in the literature that we have identified in understanding the likelihood of aerosol transmission of potential pandemic pathogens. The sampling protocols established in the NIOSH-funded study are being applied in this additional research.

A. COVER PAGE

Project Title: Rural Firefighters Delivering Agricultural Safety and Health (RF-DASH)	
Grant Number: 5U54OH010170-10	**Project/Grant Period**: 09/30/2016 - 09/29/2022
Reporting Period: 09/30/2016 - 09/29/2022	**Date Submitted**:
Program Director/ Principal Investigator Casper Bendixsen, PhD	**Administrative Official Information** Kristina McReynolds 450 McNamara Alumni Center 200 Oak Street SE Minneapolis, MN 55455-2070
Change of Contact PD/PI: Not applicable	
Human Subjects: Project involves human subjects	**Vertebrate Animals:** Not applicable
hESC: Not applicable	**Inventions/Patents:** Not applicable

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

Firefighters are trusted leaders in rural and agricultural communities, and strong partnerships between firefighters and farmers can help make farms safer. The Rural Firefighters Delivering Agricultural Safety and Health (RF-DASH) project equips firefighters and Emergency Medical Services (EMS) personnel to share agricultural health and safety knowledge in their communities, with an overall goal to improve farmers' access to capable health and safety consultation. The specific aims of this project included:

Aim 1. Modify existing curricula to instruct rural emergency responders to effectively disseminate agricultural health and safety knowledge. The proposed curricula will enable firefighters to:

- Instruct farmers, farm families, and farm workers in Farm First Aid in order to raise injury awareness and disseminate prevention strategies.
- Perform agricultural safety consultations for farmers with the assistance of the Farm/Agriculture/Rural Management – Hazard Analysis Tool (FARM-Hazard Analysis Tool) in order to increase the number of competent agricultural safety consultants.
- Utilize Farm Mapping to Assist, Protect and Prepare Emergency Responders (Farm-MAPPER) in order to prevent injuries to firefighters during farm emergencies and expedite response times.

Aim 2. Utilize social network analysis and anthropologic data to describe and efficiently navigate the existing network of agricultural health and safety experts, fire training institutions, firefighters, insurance companies, and farmers.

Aim 3. Develop guidelines and technical assistance resources in order to promote sustainability, update curricula, and enable replication of the RFDASH model in new regions.

B.2. What did you accomplish under these goals?

Over the last six years, 7 of the master trainers have conducted 6 trainings, reaching and training 72 hazard analyst trainers in over ten US states and five provinces in Canada. Trainings were organized into a one-day, eight-hour course, equipping emergency responders with farm-specific first aid curriculum and safety consultation capabilities to assist farmers in mitigating hazards on their operations. The first four hours are held in a classroom setting, educating trainees on the five modules of the course. The modules include 1) Introduction to Ag Emergencies, 2) Preplanning and Mapping Farms with Farm MAPPER, 3) Farm Hazard Analysis with saferfarm.org, 4) Farm First Aid, and 5) Approaching the Farm Community. The second half of the training is focused on applying what they had learned at a local farm.

Overall, the project has relied upon applied cultural anthropology methods including open-ended, semi-structured interviews, social network analysis, and a plethora of feedback from the fire/EMS community. RF-DASH quickly surpassed its recruiting goals and expanded its reach well beyond the Midwest. The 72 trainers have gone on to educate many additional personnel, mentioning at least 478 unique contacts (235 Fire/EMS, 6 Ag Health & Safety (excluding RF-DASH personnel), 47 educators, 33 community members, and 37 farmers) as captured through the team's Social Network Analysis (SNA) methods. The media has picked up on the success of this program, with articles in key agricultural outlets and the fire/EMS industry. Trained trainers have effectively implemented RF-DASH prevention tools and methods in the field as evident by the rise in usage of the online tools www.saferfarm.org and www.farmmapper.org. SaferFarm.org, as of 2022, had 6,140 visitors, 338 verified user accounts, 429 defined farm sites with 600 individual survey's/inspections, and 1,172 site survey items scored across all sites. As of 2022, Farmmapper.org had 2,200 visitors and 994 registered users, consisting of 390 defined farm sites and 3,660 plotted items across the various farm sites.

The Social Network Analysis and semi-structured interviews with RF-DASH trainers revealed a need to brand and streamline the training materials. Broadhead, an external marketing company, helped the program to set itself apart and represent the many organizations that played a role in the success of RF-DASH through visually appealing logos and posters. This change has been well received by the RF-DASH community and is demonstrated by numerous

requests to receive updated materials. We also designed a training manual to serve as a guide to help trainers and provide in-depth instruction on the methodology for organizing trainings. The training manual delves into the five modules, information on how to conduct and organize trainings, media guidelines for emergency responders, and resources to further their knowledge in agricultural health and safety. The RF-DASH national training group expressed interest in communications and progress updates from other RF-DASH sites. The demand for a community network culminated in the development of a dedicated RF-DASH website, rfdash.org, allowing individuals to explore and utilize new and updated resources and materials to assist in adapting RF-DASH. The website will assist trainers by increasing their networking and collaboration amongst emergency responders and safety professionals in other regions, as well as having the capabilities to share updates, successes, and challenges to help others continue to build and train others within RF-DASH. The site also houses a related program that adopted RF-DASH into its curriculum, Agriculture Rescue Training. This curriculum includes techniques and methods to safely rescue individuals involved in an agriculture emergency. In addition, the community tab provides a social venue for all RF-DASH members to share updates with one another. This resource will allow us to maintain strong communication with trainees and assist them in promoting and growing RF-DASH in their regions.

Existing RF-DASH trainers and their local communities are building upon the program to better make both farmers and emergency responders safer. The RF-DASH team developed program resources and materials like the training manual and dedicated website to assist emergency responders in scaling up agricultural health and safety practices throughout their communities. In the final years of the research project, the program has taken a greater focus on creating various resources as part of the sustainability of the program and thinking beyond the life of the grant. Official RF-DASH firefighter patches have been created and development of a challenge coin is underway to increase buy-in and sense of community among firefighter audiences. Farm MAPPER is seeing continued enhancements with a complete re-design to take the program from a proto-type product and turn it into a more valuable and practical resource for emergency responders to pre-plan farm emergencies. The RF-DASH program is also seeking copyright and trademark protections for many of its growing resources and materials.

RF-DASH pursued collaborations with the Canadian Agricultural Safety Association (CASA) to support Canadian rural fire departments and their incorporation of the RF-DASH program into their departments' trainings. In-turn, RF-DASH Canada Master Trainers have now conducted additional trainings in their provinces with other emergency responders and are continuing to build the program within their regions.

RF-DASH has initiated conversations with organizations like the U.S. Department of Agriculture, Federal Emergency Management Agency (FEMA), and National Fire Protection Association (NFPA), pursuing the goal of integrating the programming into existing national response structures like FEMA's Regional Response Teams and NFPA's standards and codes for firefighter's to follow.

B.3. Competitive Revisions/Administrative Supplements

Not Applicable

B.4. What opportunities for training and professional development did the project provide?

RF-DASH has provided the following trainings for hazard analyst trainers, equipping emergency responders with farm-specific first aid curriculum and safety consultation capabilities to assist farmers in mitigating hazards on their operations:

- *RF-DASH Wausau Training,* Wausau, WI, In-person. November, 4, 2017.
- *RF-DASH Menomonie Training,* Menomonie, WI, In-person. April 21, 2018.
- *RF-DASH Elbridge Training,* Elbridge, NY, In-person. September 15, 2018.
- *RF-DASH National Training Pilot,* Minneapolis, MN, In-person. September 7, 2019.
- *RF-DASH Wisconsin EMS Association Training,* Wisconsin Dells, WI, In-person. November 14, 2019.
- *RF-DASH CASA Training, Winnipeg, MB, Canada, In-person. March 8th, 2022.*

B.5. How did you disseminate the results to communities of interest?

The RF-DASH program has had tremendous success nationally and internationally. The program has received feedback and requests to further support existing trainers and continue to expand the program beyond the life of the grant. RF-DASH has rebranded itself to have consistent, professional images, logos, and content that are recognizable by its target audiences.

The development of a training manual has supported existing trainers by supplying them with the resources and knowledge they need to successfully conduct their own version of trainings throughout their rural communities.

The program has continued to develop and refine its quarterly newsletters that highlight key updates and information regarding the RF-DASH program. In addition, the RF-DASH website has served trainers with the tools to effectively communicate throughout their networks and maintain program updates from the core RF-DASH team. The goal of the website is to continue to refine and develop materials and make it a 'one stop shop' for program resources, tools, and communications.

RF-DASH has gained attention from many organizations and media outlets that have recognized the uniqueness and benefits of the RF-DASH program, sharing them amongst their audiences. Training developments and discussions were had with the Georgia Farm Bureau and fire departments in Minnesota. Wisconsin Farm Bureau has also invited the program out to demonstrate Farm MAPPER and importance of pre-planning farm emergencies.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

In the next grant cycle for RF-DASH, we plan to accomplish the following:

- Enroll 15 RF-DASH sites: 5 Midwest, 5 nationally, and 5 in Canada. Each site will enroll five farms within their region into RF-DASH.
- Through interview, survey, and observational data generated from this grant cycle, there is a need for improved research on the dissemination and implementation of the RF-DASH program to further support fire/EMS personnel.
- Continued support and technical assistance of existing and new trainers
- Refine and expand upon the RF-DASH training manual
- Continue to refine and innovate the online tools to make it more practical and effective for emergency responders
- Expand the RF-DASH websites features, resources, and materials to make it a main hub for rural emergency responders on everything agricultural health and safety
- Support future sustainability of the program through more formal alignment with federal standards like those of NFPA and FEMA as well as by providing technical assistance to a growing and now international network. Activities include: virtual community development, continuing education, network meetings, module refinement and development, or other needs as presented by the participants.

C. PRODUCTS

- **C.1. Publications, conference papers, and presentations**
- **Publications**
- Bendixsen C, Keifer M, et al. Spheres of Influence: Mapping and Engaging the Institutions that can influence Agricultural Health and Safety. Grant No. UMASH P002283014, Minneapolis, MN: CDC/NIOSH; June 2014.
- Reyes I, Rollins T, Mahnke A, Kadolph C, Minor G, Keifer M. Farm Mapping to Assist, Protect, and Prepare Emergency Responders: Farm MAPPER. J Agromedicine 2014; 19(2):90-95.
- Bendixsen, Casper. (2017). Sorting through the Spheres of Influence Using Modified Pile Sorting to Describe Who Influences Dairy Farmers' Decision-Making About Safety. Journal of Agromedicine. http://dx.doi.org/10.1080/1059924X.2017.1353938"
- Weichelt, Bryan, Augmented Reality Farm MAPPER Development: Lessons Learned from an App Designed to Improve Rural Emergency Response, Journal of Agromedicine, 2018.

- Koshalek, K., Minor, G., Keifer, M., Murphy, D., Carrabba, J., Brown, S., Heiberger, S., Hill, D., Bendixsen, C. Rural Firefighters Delivering Agriculture Safety and Health Training Manual. 1st ed. (K. Koshalek, Ed.) Marshfield, WI. Published by the Upper Midwest Agricultural Safety and Health Center and the National Farm Medicine Center; 2022.
- **Media publications and coverage**
- Bendixen, Casper, Use Farm MAPPER to assist, protect, prepare emergency responders, *Progressive Dairyman*. October 19, 2017
- Bendixen, Casper, Rural firefighters delivering agricultural safety and health, *Progressive Dairyman*. September 19, 2017
- Bendixen, Casper, Step one in farm safety: Recognize and record the hazards*, Progressive Dairyman*. November 9, 2017.
- Bendixsen, Casper, Farm First Aid – Preparing for Tough Situations, *Progressive Dairyman*, 2018.
- Alfultis, M. Tracking Farm Hazards with Farm MAPPER. *Cornell Small Farms Program*. June 28, 2018.
- Baker, B. Rural Firefighters Delivering Ag Safety. *Dairy Radio Now*. August 21, 2018.
- Dairy Business News Team. Training for farm emergency response. *Dairy Business*. September 11, 2018.
- Steffes, J. Firefighters in Allenton hosting Agricultural Safety and Health (RF-DASH) seminar Dec. 8 – By Ron Naab. *Washington County Insider*. December 3, 2018.
- Loomis, S., Bendixsen, C. Map Farms to Save Lives, *AGRI-View*. February 24, 2019.
- Baker, B., Bendixsen, C. Improving Farm Safety, *Dairy Radio Now*. July 30, 2019.
- Simes, J., Koshalek, K. Online Tools help Analyze Hazards, *The Western Producer*. August 1, 2019.
- Baker, B., Bendixsen, C. Program Teaches Rural 9-1-1 Response. *Dairy Radio Now*. August 13, 2019.
- Heiberger, S. Rural firefighters promote farm safety. *Morning Ag Clips*. October 9, 2019.
- Heiberger, S. Rural firefighters promote farm safety through national program. *Wisconsin State Farmer*. October 8, 2019.
- Heiberger, S. Rural firefighters promote farm safety through national program. *Rural Radio Network*. October 8, 2019.
- Heiberger, S. Rural firefighters promote farm safety through national program. *KTIC Radio*. October 8, 2019.
- Heiberger, S. National program sees rural firefighters promote farm safety. *Vegetable Growers News*. October 8, 2019.
- Heiberger, S. Rural firefighters promote farm safety through national program. *Fruit Growers News*. October 8, 2019.
- Heiberger, S. Rural firefighters promote farm safety through national program that began in Wisconsin. *Daily Dispatch*. October 9, 2019.
- Heiberger, S. Stevens Point Journal. October, 2019.
- Heiberger, S. Rural firefighters promote farm safety through national program. *Montgomery Advertiser*. October 8, 2019.
- Heiberger, S. Rural firefighters promote farm safety through national program. *Silver City Sun News*. October 8, 2019.
- Heiberger, S. Rural firefighters promote farm safety through national program. *High Plains Journal*. October 14, 2019.
- Rusk, G., Bendixsen, C., Minor, G. Program Trains First Responders to Respond to Farm Accidents. *WMTV Channel 15*. Wisconsin Dells, WI. November 14, 2019.
- Program Trains Firefighters for Farm Accidents. *Firefighter Nation*. November 24, 2019.
- Brechwald, M., Bendixsen, C. Agricultural Health & Safety – Special Edition. *Off-Farm Income*. December 13, 2019.
- Contact First Responders Quickly. *Red River Farm Network*. March 8, 2020.
- Prater, L., Bendixsen, Casper, Firefighters and Farmers Tackle Safety Together, *Successful Farming*. May 1, 2020.
- Connatser, G. Weichelt, B., Minor, G. Wisconsin Farm-Related Fatality Report Resurrected, offers Data on Ag Deaths. *Wisconsin State Farmer*. August 12, 2020.

- Mayer, S., Minor, G., Biadasz, B., Grezenski, L. Farm Safety: Gas. *PDPW*. September 24, 2020.
- Mayer, S., Minor, G. Preventing Farm Fires. *PDPW*. October 22, 2020.
- Johnson, A. Barn Fires are a Winter Concern for Producers. *Minnesota Farm Guide*. January 29, 2021.
- Farmers partner with rural firefighters to reduce injuries, fatalities. *The Independent.* February 28, 2021.
- Wisconsin program trains firefighters on responding to farm emergencies. *Spectrum News 1*. June 2, 2021. https://spectrumnews1.com/wi/milwaukee/news/2021/05/31/wisconsin-program-trains-firefighters-on-responding-to-farm-emergencies?cid=id-app15_m-share_s-web_cmp-app_launch_august2020_c-producer_posts_po-organic
- Spotlight on Rural Firefighters Delivering Agriculture Safety and Health (RF-DASH). *Wisconsin Towns Association (WTA)*. October, 2021.
- Learning livestock behavior. *Dairy Star*. September 26, 2022. https://dairystar.com/Content/News/Daily-News/Article/Learning-livestock-behavior/1/256/18909
- **Presentations**
- Bendixsen CB, Barnes KL. *Rural Firefighters Delivering Agricultural Safety and Health (RFDASH)*. NORA Symposium. Minneapolis, MN. May 5, 2017.
- Bendixsen, Casper. *RFDASH Curriculum Round Table Discussion*. Marshfield, WI. June 7, 2017.
- Bendixsen, C., Barnes, K., Murphy, D., Hill, D., Keifer, M. *Rural Firefighters Delivering Agricultural Health and Safety.* International Society for Agricultural Safety and Health (ISASH). Logan, UT. June 25-28, 2017.
- Barnes, Kathrine. (2017). RF-DASH Curriculum Round Table Discussion. Marshfield WI.
- Bendixsen, Casper, Salzwedel, Marsha. *Sharing the News of RF-DASH. Pittsville Area Fire Fighting Training.* Pittsville, WI. September 25, 2017.
- Bendixsen, Casper. *Rural Firefighters Delivering Agricultural Safety and Health: An Example in Disseminating Through Technology.* Agricultural Safety and Health Council of America (ASHCA). Scottsdale, AZ. February 21-23, 2018.
- Bendixsen, C., Barnes, K. *Innovative Uses of Technology in Ag Health and Safety – the RF-DASH Project.* Agricultural Safety and Health Council of America. (ASHCA). Scottsdale, AZ. September 25-27, 2018.
- Zwaschka, J. *RF-DASH*. Southwest Regional Fire Department Association. Windom, MN. September 14, 2019.
- Zwaschka, James. (2020). EMS Panel. Panel discussion. 2020 Ag Symposium. Mankato, MN
- Bendixsen, C., Barnes, K., Koshalek, K. *An Eager Audience for Farm Safety: Updates from Rural Firefighters*. International Society for Agricultural Safety & Health (ISASH). Des Moines, IA. June 24-27, 2019.
- Bendixsen, C. Minor, G. *Rural Firefighters Delivering Agricultural Safety and Health*. Wisconsin Rural Partners. Virtual Presentation. June 18, 2020.
- Koshalek, K., Barnes, K., Bendixsen, C. *Rural Firefighters Delivering Agriculture Safety and Health (RF-DASH) – Expanding a Program beyond its Regional Boarders.* International Society for Agricultural Safety & Health (ISASH). Virtual Presentation. July 28, 2020.
- Swenson, A., Bendixsen, C., Barnes, K., Redmond, E., Koshalek, K., Pilz, M., Sauer, M. *Rural Firefighters Delivering Agricultural Safety and Health: Social Network Analysis*. International Society for Agricultural Safety & Health (ISASH).Virtual Presentation. July 26, 2020.
- Bendixsen, C., Barnes, K., Koshalek, K. *Flexing Trust: Firefighters and Farmers Tacking Farm Safety Together.* Wisconsin Towns Association (WTA). Virtual Presentation. October 14, 2020.
- Bendixsen, C. *Flexing Trust: Firefighters and Farmers Tacking Farm Safety Together.* Stand Up 4 Grain Safety Week: Emergency Action Plans. Virtual Presentation. April 2, 2021.
- Koshalek, K., Barnes, K., Swenson, A., Pilz, M., Sauer, M., Bendixsen, C. *America's Two Most Admired Professions. Separate No More.* ISASH. Virtual Presentation. June 22, 2021
- Bendixsen, C. Flexing Trust: Firefighters and Farmers Tackling Farm Safety Together. CASA. Virtual Presentation. August 12, 2021.
- Bendixsen, C. Flexing Trust: Firefighters and Farmers Tackling Farm Safety Together. NASAAEP. Virtual Presentation. August 11, 2021.
- Bendixsen, C. Flexing Trust: Firefighters and Farmers Tackling Farm Safety Together. CASA Conference. Virtual Presentation. October 21, 2021.

- Bendixsen, C. Prevention of Farm Incidents. Agriculture Rescue Training. Virtual Presentation. October 22-23, 2021.
- Koshalek, K. "Agriculture Rescue Training". NCRTA Trauma Conference. North Central Technical College, Wausau, WI. April 7th, 2022.
- Koshalek, K., Minor, G., Bendixsen, C. "Agricultural Rescue Training: Introduction to Farm Emergencies". Trauma Webinar Series. August 25, 2022.
- Koshalek, K. "Pre-Planning and Mapping Farms". Ag Incident Training. Stratford, WI. September 07, 2022.

C.2. Website(s) or other Internet site(s) – include URL(s)

- UMASH Rural Firefighters Delivering Agriculture Safety and Health (RF-DASH): http://umash.umn.edu/portfolio/rural-firefighters-delivering-agricultural-safety-and-health-rf-dash/
- RF-DASH Website: https://rfdash.org/
- Farm MAPPER: https://farmmapper.org/
- SaferFarm: https://saferfarm.org/

C.3. Technologies or techniques

Software: Digital tools on SaferFarm.org and farmmapper.org have been shared and continue to be refined.

C.4. Inventions, patent applications, and/or licenses

Not Applicable

C.5. Other products and resource sharing

Nothing to report

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
BENDIXC	Y	Bendixsen, Casper	PhD	PI	3.6					
	Y	Barnes, Kate	MS, MPH	Project Manager	1.68					
	N	Koshalek, Kyle	BS	Research Coordinator/Project Manager	8.3					
	N	Pilz, Matt	BS	Programmer	2.78					
	N	Keifer, Matt	MD, MPH	Master Trainer/ External Consultant	0.24					

D.2 Personnel updates

a. Level of Effort: No Changes in level of effort of project work

b. New Senior/Key Personnel: No new senior/key personnel added

c. Changes in Other Support: No changes in other support

d. New Other Significant Contributors: No new significant contributors

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

Not Applicable

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

Overall, this project has effectively and innovatively built a model to increase the number of local and trusted safety consultants available to assist farmers in improving the safety of their farms and has the momentum to become a national and international network. Fire/EMS have also shown increased desire for the RF-DASH program that covers pre-planning and emergency response similar to standards enforced in urban and industrial municipalities. The program is also in line with many National Fire Protection Association (NFPA) standards, which serve as guidelines and policies for emergency personnel to follow. We believe meeting NFPA standards will be an additional incentive for fire/EMS departments to train on RF-DASH.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

Not Applicable

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

No anticipated challenges or delays

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

No Change

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

Not Applicable

G.2 Responsible Conduct of Research

Not Applicable

G.3 Mentor's Research Report or Sponsor Comments

Not Applicable

G.4 Human Subjects

G.4.a Does the project involve human subjects?

Yes – research is also exempt from federal regulations (E4).

G.4.b Inclusion Enrollment Data

Not Applicable

G.4.c ClinicalTrials.gov

Not Applicable

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?

No

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

Not Applicable

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

No

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

Not Applicable

G.8 Project/Performance Sites

See overall

G.9 Foreign Component

The Canadian Agriculture Safety Association (CASA) requested the programs Master Trainers to come to Canada and train their organizations firefighters in RF-DASH. Current initiatives in assisting them with technical assistance and development of RF-DASH Canada is underway with translational materials into Canadian French, information dedicated towards Canadian producers/farmers, and Canadian study sites for the next grant cycle.

G.10 Estimated Unobligated Balance

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

Year 6 of the original grant cycle will have carryforward going into year one of the new grant. However, this amount will not be greater than 25% of the current year's approved budget.

G.11 Program Income

Is program income anticipated during the next budget period?

No

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?

Not Applicable

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

Over six years, six trainings have been conducted in both the U.S. and Canada, training 72 trainers who have gone out and trained dozens more. Trainers from 10 US states and five Canadian provinces have shown tremendous enthusiasm and buy-in to the RF-DASH program as they have gone on to train other fire/EMS departments, present at conferences and health organizations, and perform hazard analysis and preplanning with farmers and ranchers in their communities.

A key strength of RF-DASH has been its flexible program model. The RF-DASH team has received feedback from trainers regarding the programs adaptability to other regions emergency responders and forms of agriculture. Although, the program was originally designed for farms commonly seen in the Midwest, the model of connecting rural firefighters with farm/ranch producers has been widely seen by trainers across the U.S. and Canada, fitting their regions needs and preventing injuries and fatalities on farms and ranches.

First responder's receptivity to RF-DASH has been met with great enthusiasm. As one RF-DASH trainer said, *"I think that's the plus of the program, taking rural firefighters and engaging them with that population. It's a small enough community that everyone knows each other. There's already a relationship there so—it's not a government agency or an insurance company or something threatening, it's someone who knows them and says, 'Dude, I care about you, Let's work together to make it better.'"* This level of interest and eagerness to incorporate farms and ranches into their pre-planning emergency response, as well as preventing injuries and fatalities in agriculture has motivated them to train countless others. Specifically, some of the greatest champions within RF-DASH have what we call the triple threats. These individuals typically are or have extensive experience as fire/EMS, farming/ranching, and are an educator or trainer at their department or local technical colleges. Fire and EMS are naturally seen as trusted members within their communities and their networks reach many individuals. Through Social Network Analysis (SNA) interviews at least 478 unique contacts (235 Fire/EMS, 6 Ag Health & Safety (excluding RF-DASH personnel), 47 educators, 33 community members, and 37 farmers) as captured through the team's interviews with trainers. These individuals have made the biggest impacts in their rural communities and response from the farming community has well received.

One example of a positive community response can be seen from Fire Chief, Tim Carey of the Stratford Fire Department. Having attended a RF-DASH training at the Wisconsin EMS Association (WEMSA), less than a week later, Stratford Fire Department along with other departments supplying mutual aid responded to a fatal farm incident between a milk truck and a tractor. He effectively communicated with the local media about actions both farmers and the community could take to prevent an incident like this from re-occurring (Figure 3). "At this time of the year, everybody needs to slow down and be cautious of all the farm tractors out there. For all of the farmers out there, make sure you put new SMV signs, reflectors, and all of the flashing lights you can have because I don't want to come out to another one of these."

Chief Carey, both a farmer and a firefighter, knew how a tragic incident like this could affect the entire rural community. He stated, "To me when I see a victim of a farm accident, it's just like when it's someone from the fire service, even if I don't know them it feels like I do because they are like brothers to me."

Fire and EMS have continuously shown to be trusted by media and their communities as sources of farm safety information. “The feedback I have been getting about the interview in the Stratford community has been unbelievable, “Chief Carey recalled. “I was hauling corn into ProVision and even the person running the scale complimented me on the message from the interview. I told him if that short interview gets just one farmer to put some reflectors and a new SMV sign on his equipment and that prevents another accident, I will call it a win. “For further information on the agricultural incident and Fire Chief Tim Carey’s prevention message, visit: Tractor vs. Milk Truck Crash under Investigation (WSAW).

We reached out to three National Fire Protection Association (NFPA) committee members in the Midwest on whether the RF-DASH program could be incorporated into existing NFPA standards for rural fire/EMS departments. NFPA standards are considered to be the ‘bible’ of fire departments on processes and procedures to follow to mitigate risk of injury to the patient, reduce property damage, and keep fire/EMS personnel safe. We received positive feedback and pursued a pilot of a national training to evaluate if the project was generalizable to other regions. The RF-DASH training brought 18 individuals from nine states across the U.S. These individuals consisted of fire and EMS personnel partnered with their regions’ agriculture health and safety professional, as well as NFPA representatives from Wisconsin. After successful completion of the training, we were informed by the NFPA representatives that the RF-DASH program is in line with many of the current NFPA standards, specifically the 1300 standard regarding community risk analysis and reduction. This signifies that fire departments can remain compliant with NFPA standards through the RF-DASH program. Furthermore, a representative from the Federal Emergency Management Agency (FEMA) recognized RF-DASH as a program for national emergency response organizations such as FEMA, APHIS, and National Response Team’s emergency preparedness planning for incidents specifically involving agriculture. As stated by the FEMA representative, “In 2017, USDA reported the United States had just over 2 million farms accounting for 900.2 million acres of land in farms, or 40 percent of all U.S. land. The ability of the RF-DASH project to develop and incorporate planning and response guidance affecting these farms nationwide is immeasurable and will effectively bridge gaps in the existing planning efforts related to agriculture”. Further pursuits in implementing RF-DASH into NFPA standards and FEMA emergency response plans will be ongoing into the next grant cycle.

RF-DASH has continued to receive requests for trainings for fire/EMS departments from around the country, equipping them with the tools and resources to scale up agricultural health and safety knowledge among their communities. The requests for RF-DASH trainings not only tell us the success of the program’s model, but also the lack of training and knowledge that is available for first responders to prevent incidents in agriculture. We have received requests from Minnesota, Georgia, and North Carolina to name a few that have been seeking trainings and materials to equip their departments with. In addition to continuing in-person trainings for emergency responders, the RF-DASH team is looking into alternate methods to effectively train departments around the U.S. and Canada when time, staffing, or financial means are a challenge for departments.

As firefighters and EMS are naturally seen as trusted sources within their communities, media attention on the RF-DASH program has been positive and of great interest to reporters and their target audiences. The project has been mentioned in the media over 26 times in addition to 11 times from various media outlets on the RF-DASH national training. Coverage on the RF-DASH program has been seen on platforms such as Progressive Dairyman, Dairy Radio Ad Update, The Western Producer, Wisconsin Farmer, Rural Radio Network, Vegetable Growers News, Fruit Growers News, AgriView, Successful Farming, among many others.

RF-DASH has two separate tools, Farm MAPPER and Safer Farm that are a part of the program curriculum. Farm-MAPPER is a free interactive, secure, web based tool developed by the National Farm Medicine Center which provides emergency responders with a bird’s eye view of onsite information about hazards, resources, and physical layouts of agricultural operations. 8,200 views and 994 registered users indicates wide interest in Farm-MAPPER. The online tool has been enhanced to accept international farm addresses in an effort to accommodate future growth. This enhancement has long-term benefits as RF-DASH continues expanding its collaborative efforts with external safety organizations. The web-based application has been presented at virtual and in-person training workshops, including to agricultural-related academicians. A proof-of-concept mobile application was also developed and presented to emergency responders utilizing augmented reality to present the location and distances of important

elements on a mapped farm site. As of 2022, users have created 390 unique farm sites and mapped over 3,660 item markers.

SaferFarm is an ever-evolving online tool developed by the National Farm Medicine Center to make agricultural health and safety knowledge accessible and easy to use. This utility has been demonstrated at a national level, with approximately 429 inspection sites entered into the system by rural firefighters, educators, and students. Traffic has increased each year with a total of 21,112 page views from 2019-2022.

A. COVER PAGE

Project Title: Promoting Safety and Worker Health for Immigrant Dairy Workers	
Grant Number: 5U54OH010170-10	**Project/Grant Period**: 09/30/2016 - 09/29/2022
Reporting Period: 09/30/2016 - 09/29/2022	**Date Submitted**:
Program Director/ Principal Investigator JEFFREY B BENDER, DVM MS BS Phone number: 612-625-6203 Email: bende002@umn.edu	**Administrative Official Information** Kristina McReynolds 450 McNamara Alumni Center 200 Oak Street SE Minneapolis, MN 55455-2070
Change of Contact PD/PI:	
Human Subjects: Yes	**Vertebrate Animals:** N/A
hESC: N/A	**Inventions/Patents:** N/A

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The goal of this project is to improve immigrant dairy worker health and safety by applying an integrated One Health approach. This approach considers the health of people as a connected network linked to the health of animals and the environment. This involves engaging a multidisciplinary team of clinicians, veterinarians, producers, workers, occupational safety and health experts, immigrant health specialists and community health centers. The project aims are highlighted below.

Aim 1. Translate and apply evidence-based findings from a previous UMASH research project, Seguridad en Las Lecherías: Immigrant Dairy Worker Health and Safety through:

- Targeted, regionally focused needs assessment to obtain worker and local stakeholder input for successful implementation.
- Recruiting and engaging at least 30 dairy farms that employ at least 6 immigrant workers.
- Assisting producers in identifying hazards and abatement strategies through the introduction of available resources and mobile technology for hazard identification.
- Facilitating bilingual health and safety training courses for all immigrant workers on each farm and supporting the education of on-farm community health workers.

Aim 2. Expand and sustain an evidence-based worker health and safety intervention to include general worker health.

- Partner with community health centers to engage dairy farms through the use of mobile, on-farm preventative and general health care services for workers and farmers.
- Train and utilize University of Minnesota medical residents and academic health center students to assist health centers in providing care.

Aim 3. Train and engage veterinarians to be part of a One Health team for worker health and safety, especially as it pertains to safely working around dairy cattle.

- Assist with farm recruitment and reinforce worker health and safety strategies with producers and the health care team.
- Train and utilize veterinarians, University of Minnesota veterinary students, and veterinary public health residents to assess animal-related occupational hazards and understand the needs of immigrant dairy workers.
- Audit safe animal handling techniques to prevent work related injuries.

B.2. What did you accomplish under these goals?

Aim 1.

Phase I of this project was conducted in Wisconsin. A dairy worker needs assessment provided basic insights into the immigrant dairy worker population in the Upper Midwest. This served as a basis for outreach and education for Phase II of this project. All the farms enrolled in Phase II included standardized interviews with an owner or farm manager and 2 workers before beginning the 5-lesson training. The information obtained documented the scarcity of health and safety training for current dairy workers, provided information on on-the-job injuries, and their limited experience working on modern dairy farms.

Nineteen farms were enrolled in the project, with 360 workers receiving health and safety training as part of a 5-lesson of 1-hour each. Due to worker turnover not all workers completed all 5 lessons.

With the onset of COVID-19, our project suspended visits to dairy farms. We utilized this time to develop and provide educational and outreach materials on COVID in Spanish and English. This included assembling resources such as videos and fact sheets about COVID-19 and ways to protect the farm employees and farm family members. We also connected producers with local county health departments to provide free COVID testing and subsequent vaccination.

When permitted to return to conducting farm visits in the Spring of 2021, we resumed enrolling dairies with the on-farm health and safety training. This included reconnecting with initially enrolled farms. General demographics of participants include the following: 89% of the workers were male. 40% of dairy workers were between 25 and 34 years old, followed by 29% between 18 and 24 years old, 23% between 35 and 44 years old, 6% between 45 and 54 years old, and 1% of workers older than 55 years. Workers were from 6 different countries with the majority of 265 (74%) of the workers were from Mexico, 45 (12%) from Guatemala, 34 (9%) from Nicaragua, 10 (3%) from Honduras, and 3 (1%) from El Salvador. Those workers from Mexico came from 26 different regions in Mexico including Chiapas (n=18), Oaxaca (n=118), and Veracruz (n=28). The majority (94%) of the workers spoke Spanish, 5% spoke an indigenous Central American language, and 1% spoke English as their preferred language. The educational level of the dairy workers varied with 8% workers having no education to 5th grade education, 16% with a 6th to 8th grade education, 19% with a 9th to 11th grade education, 12% with a high school education, 6% with some or a post-secondary education. The question about educational level was added after the project started and 39% of the workers had already responded to a version of the survey without this question.

About 61% of workers had arrived in the U.S. in the previous 5 years and about 25% had arrived in the previous year. 71% of dairy workers have been working on dairy operations for 5 years or fewer, and 32% only been working on a dairy over the previous year. Pertaining to injuries acquired while working, 42% of the immigrant dairy workers reported having been injured on the job. 49% of workers had not received health and safety training prior to working.

Lesson assessments were conducted to understand work comprehension. Figure 1 and 2 provide some initial summary results of the improvement in worker knowledge after each Lesson.

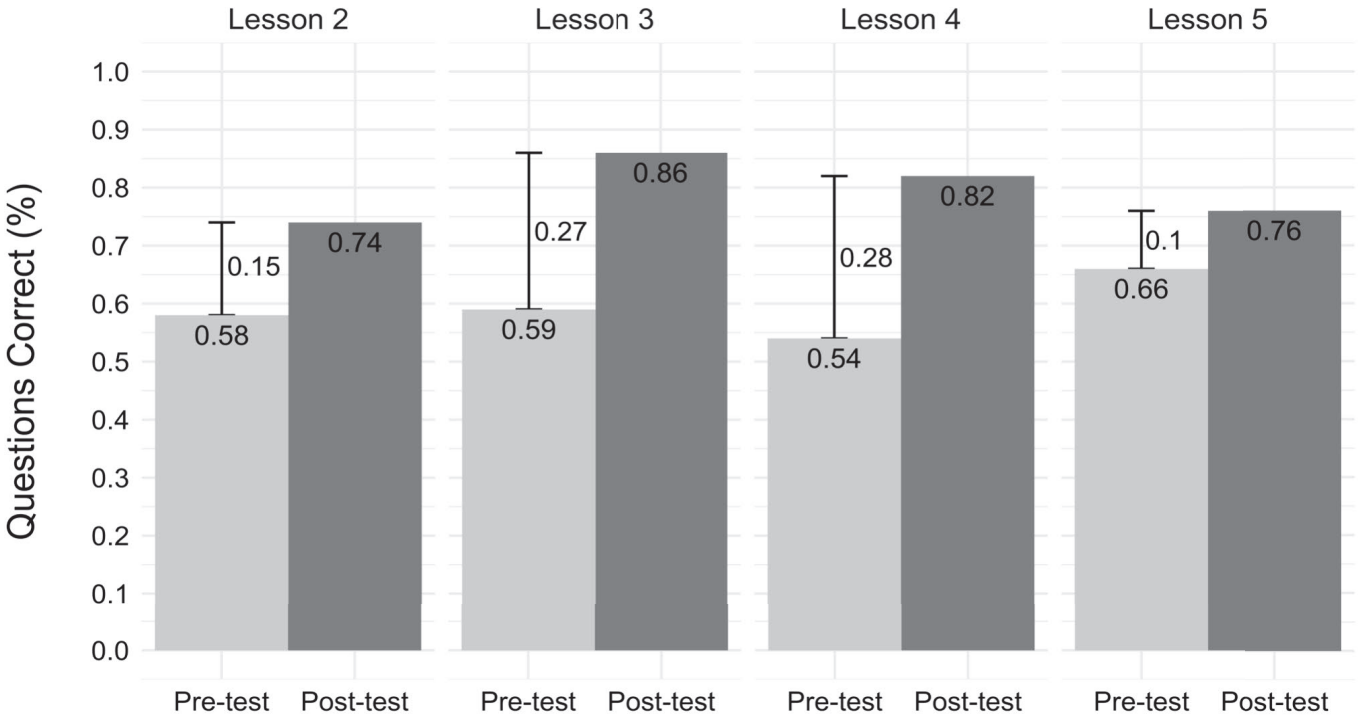


Figure 1. Change in worker knowledge after each lesson through pre- and post-testing

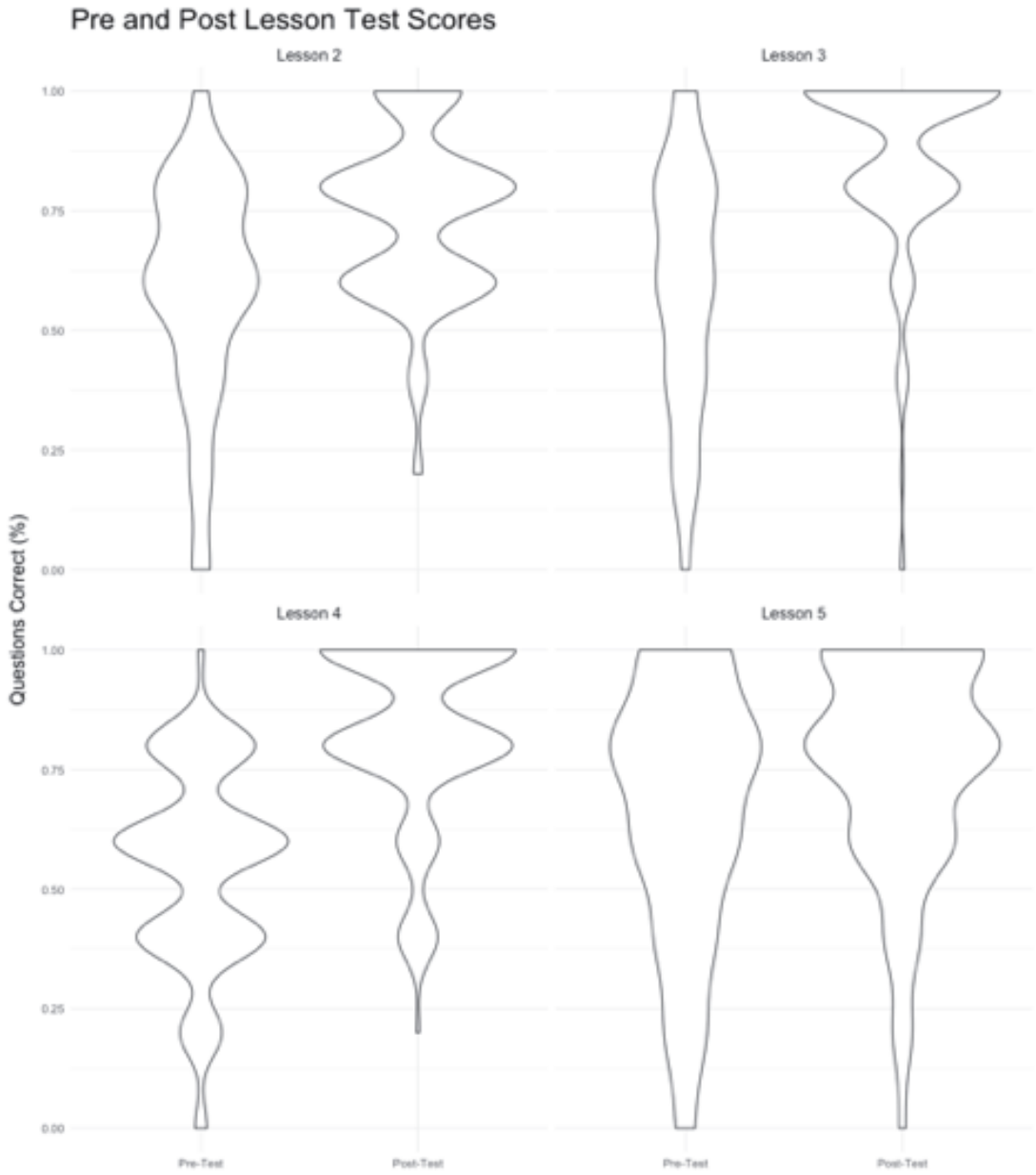


Figure 2. Plot documenting the individual kernel percentage distribution of increase in workers' knowledge increased after each training

In summary, there was a significant increase in knowledge between all pre- and post-assessments. This is evident in both Figure 1 and Figure 2. This improvement was statistically significant. The violin plot (Fig. 2) further demonstrates this significant increase in knowledge and most of the distribution of scores were at 75% or more after training. Furthermore, the violin plot shows that there were differences in the percentage distribution of scores between lessons which suggests that most of the workers understood the material. Even in Lesson 5 scores, where worker knowledge was good (75% and above) before the training (pre-lesson test scores), there is an expansion of the distribution further at the 75% percentile and above after training (post-lesson test scores). The percentage distribution greatly narrowed at the bottom for lessons 2 and 4 after the training, indicating that most workers had gained knowledge.

Aim 2.

Due to COVID many of the projected projects of medical outreach to farm workers were limited. This included our project partner Community Health Services Inc. that was to provide health screenings, health services, safety and

health information to dairy workers, farmers, and their families. They also were initiating a mobile clinic service for farms in southeastern Minnesota. In response to the pandemic, our community health partner, CHSI, offered telehealth appointments to the agricultural and rural community.

Our project physician (Dr. Jonathan Kirsch) at the University of Minnesota, School of Medicine was able to organize mobile clinics after the Spring of 2021. His team conducted health screenings in rural communities in south central Minnesota. These clinics provided primary health care, COVID testing, COVID vaccinations, vision screening and treatment, dental care and linkage to primary care.

Community and industry leaders (e.g.,the Minnesota Milk Producers Association, dairy cooperatives, dairy supply sales, extension educators, nutritionists, and dairy producers and managers) were engaged to raise awareness and support farm recruitment. When COVID-19 restricted on-farm access to dairy farms in Minnesota, regular communication and engagement with dairies continued. The project team focused efforts to support dairies with information and access to COVID-19 testing and vaccinations through their counties health departments, and our partner CHSI for dairies in south central Minnesota.

In 2021 we changed our engagement with producers and switched to consultative services with the dairy farms enrolled in our project on the best ways to vaccinate their workforce. Of the 13 dairies contacted, 10 responded and provided suggestions that included staggered vaccination in the event workers had a reaction to the vaccine and were unable to work, some preferred on-farm vaccination while other dairies suggested nearby clinics or community centers. The consultation was useful and of great help in facilitating access to the vaccine for workers.

As part of this pivot, we surveyed producers about their knowledge and response to the pandemic. This was done in collaboration with the University of Minnesota Medical School. Through a telephone and email survey of participating dairy farms from Wisconsin (Phase I) and Minnesota (Phase II) of the project 76 farms were contacted and 37 agreed to participate in the survey from June to July 2020. The results were published in the Journal of Agromedicine in July 2021 (Yung et al., 2021). We observed that dairies implemented or increased biosecurity measures and COVID-19 precautions during the pandemic. Dairies reported that they had adequate personal protective equipment for their workers, though face masks were not required on most dairies (n=32, 86%). Producers were concerned about the safety of their families, maintaining a healthy workforce, and keeping their farms profitable. Access to healthcare was not perceived to be an issue for their workers. One-quarter of dairies reported COVID-19 infections on their farms. Even though the majority had an isolation protocol in place if someone on the farm were to become ill, less than half of respondents felt their farm was protected against COVID-19. We concluded that farms would benefit from additional guidance and education on implementation of personal protective measures and disease prevention strategies to keep workers employed and safe.

In summary, we continued regular communication and engagement with farms on related health issues (i.e., mental health resources) which we were able to support by providing Spanish interpretation and facilitating access to healthcare in community clinics. With approval, in July 2021, we were able to resume health and safety trainings in Spanish for immigrant dairy workers in Minnesota, and we have expanded this research project to dairies in South Dakota. The Seguridad curriculum was updated, printed, and assembled for the implementation of the Community Health Workers Program on dairy farms.

Aim 3.

The focus of this aim was to assist producers in identifying hazards and abatement strategies through a One Health approach engaging different strategies from different disciplines. We were able to introduce new resources (print and video) to address topics of concern for producers. From the on-farm visits the trainer(s) were able to identify areas of concern by producers such as the use of bulls, disease concerns for employees working with calves, and “down animals”. Through these interactions, resources and mobile technology resources were made available for hazard identification and abatement strategies. A video on zoonotic disease risks of working with calves was developed and uploaded and a video on handling down animals is in process. These were done in conjunction with our veterinary partnerships.

Additionally, we planned to develop a safety audit tool for veterinarians to assess safe animal handling practices, infectious disease exposures on dairies, and worker safety. Ultimately, this tool is meant to be used to provide tangible farm assessments for producers in a simple, understandable format. These were meant to provide a tool for practicing veterinarians who could do on-farm veterinarian audits of animal-related hazards during their routine herd checks. In addition, we were working in collaboration with the School of Public Health Industrial Hygiene faculty and their graduate students and the University of Minnesota Veterinary Public Health and Preventive Medicine Residents to develop a useful safety audit tool. Due to COVID-19 we were unable to implement the pilot. However, we developed a template and piloted an initial tool. We plan to continue testing and refining this safety audit tool with farms that have requested an external safety walkthrough.

Through our veterinary partnerships, we have worked with Ag Safety and Health Alliance, partnering with them to develop educational materials for veterinary technicians (e.g., Emerging Issues Project). Also, as part of our partnership with the University of Minnesota, Veterinary Public Health Residents follow-ups to each of our participating farms including contacting the herd veterinarian about safety concerns they observed.

B.3. Competitive Revisions/Administrative Supplements

N/a

B.4. What opportunities for training and professional development did the project provide?

The project's safety trainers had the opportunity to improve their training skills and learn some of the tools used in the project, such as REDCap for data entry. There was also the opportunity for one safety trainer and a graduate student researcher to do data analysis and technical writing of manuscripts for publication. Additionally, the people involved in the project were able to talk about it in different professional spaces through workshops, posters, lightning talk, abstracts, providing opportunities to enhance professional development. Members of the project have been mentioned in newspaper articles relevant to dairies, and in television productions regarding the project. Likewise, relevant dairy news conducted interviews with members of the project team.

B.5. How did you disseminate the results to communities of interest?

The project produced fact sheets, posters, brochures, publications, news articles, and was featured on Twin Cities Public Television about the work of UMN School of Public Health on its 75th anniversary. In addition, the project is scheduled in a School of Public Health "Behind the Scenes" video production showcasing the work of UMASH. We also worked closely with our Advisory Board and partners to share the materials through media campaigns and routine email and social media.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

N/A

C. PRODUCTS

C.1. Publications, conference papers, and presentations

Publications:

- Yung, Mung Ting; Vázquez, Rosa I. (Chela); Liebman, Amy; Brihn, Auguste; Olson, Anna; Loken, Delaney; Contreras-Smith, Ana; Bender, Jeff; Kirsch, Jonathan D. (2021). "COVID-19 Awareness and Preparedness of Minnesota and Wisconsin Dairy Farms", Journal of Agromedicine, https://www.tandfonline.com/doi/full/10.1080/1059924X.2021.1927925

- Juárez-Carrillo, Patricia M.; Liebman, Amy K.; Reyes, Iris Anne C.; Sánchez, Yurany V. Ninco; Keifer, Matthew, C. (2019) Recognizing One of Our Own – Seguridad en las Lecherías: Immigrant Dairy Worker Health and Safety", UMASH, http://umash.umn.edu/seguridad-hpp-paper/
- Sharma, H., Kindell, E., Hane, J., & Kirsch, J. (2022). A Medical-Design Collaboration in the Age of COVID-19: Mobile Health for Rural Populations. *J Community Med Health Educ, 12*(9), 778. https://www.omicsonline.org/open-access/a-medicaldesign-collaboration-in-the-age-of-covid19-mobile-health-for-rural-populations.pdf
- Thomas, C. M., Searle, K., Galvan, A., Amy, L. K., Mann, E. M., Kirsch, J. D., & Stauffer, W. M. (2022). Healthcare Worker Perspectives on COVID-19 Vaccines: Implications for Increasing Vaccine Acceptance among Healthcare Workers and Patients. *Vaccine, 40*(18), 2612-2618. doi: 10.1016/j.vaccine.2022.03.011
- Katz, B. (Lead Author), Sevyrud, E., Garza, O., Silva, R., & Kirsch, J. D. (2022). Global Is Local: Interprofessional Experiential Learning for Migrant Farmworker Health Equity. *Journal of Health Equity, 6*(1), 159-166. doi: 10.1089/heq.2021.0114
- VanWormer, JJ. (2017). Socio-environmental risk factors for medically-attended agricultural injuries in Wisconsin dairy farmers. Injury. https://www.sciencedirect.com/science/article/pii/S0020138317303522
- Thomas, C. Liebman, A., Galván, A., Kirsch, J. D., & Stauffer, W. (2021). Ensuring COVID-19 Vaccines for Migrant and Immigrant Farmworkers. *American Journal of Tropical Medicine and Hygiene, 104*(6), 1963–1965. doi: doi:10.4269/ajtmh.21-0199
- Quadri, N. S., Brihn, A. A., Shah, J. A., & Kirsch, J. D. (2020). Bovine Tuberculosis: A Re-emerging Zoonotic Infection. *Journal of Agromedicine, 26*(3), 334-339. PMID: 32478614 doi: 10.1080/1059924X.2020.1771497
- Kirsch, J. D. (2021). *Guide: Mobile COVID-19 Vaccination Campaigns for Refugee, Immigrant and Migrant (RIM) Communities.*. National Resource Center for Refugees, Immigrants and Migrants. https://nrcrim.org/sites/nrcrim.umn.edu/files/2021-05/Guide%20for%20RIM%20Communities_%20Mobile%20COVID-19%20Vaccination%20Campaigns.pdf
- Kirsch, J. D. (2021). *Guide for Mobile COVID-19 Vaccination Campaigns for Immigrant Dairy Workers.*. National Resource Center for Refugees, Immigrants and Migrants. https://nrcrim.org/sites/nrcrim.umn.edu/files/2021-04/Mobile%20COVID-19%20Vaccination%20Campaigns%20for%20Immigrant%20Dairy%20Workers.pdf
- Kirsch, J. D. (2021). *Guide: Mobile COVID-19 Testing in Refugee, Immigrant, and Migrant (RIM) Communities.*. National Resource Center for Refugees, Immigrants and Migrants.

Presentations:

- Bender, Jeff. Dairy Work Group. Oral/podium presentation. Dairy Work Group. March, 2022.
- Bender, Jeff. Safety is a Team Sport. Oral/podium presentation. United States Animal Health Association. Annual Meeting. Virtual. October 2021.
- Bender, Jeff. COVID-19 Awareness and Preparedness of Minnesota and Wisconsin Dairy Farms. Oral/podium presentation. Legal Action of Wisconsin. August 2021.
- Vazquez, Chela; Bender, Jeff; Liebman, Amy; Kirsch, Jonathan. Immigrant Dairy Worker Health and Safety Trainings Wisconsin and Minnesota. 2021 Virtual Forum for Migrant and Community Health. Virtual. March 2021.
- Vazquez, Chela. Protecting the health of immigrant dairy workers. Oral/podium presentation (Lightning Talk). North American Agricultural Safety Summit. Virtual. March 2021.
- Vazquez, Chela; Bender, Jeff; Liebman, Amy; Kirsch, Jonathan. Protecting the health of immigrant dairy workers. Abstract. North American Agricultural Safety Summit. March 2021.
- Vazquez, Chela; Bender, Jeff; Liebman, Amy; Kirsch, Jonathan. Protecting the health of immigrant dairy workers. Poster. North American Agricultural Safety Summit. March 2021.
- Bender, Jeff. COVID-19 Preparedness for Ag Workers. Webinar. Minnesota Veterinary Medicine Association. Virtual. February 2021.
- Bender, Jeff. Safety Teams. Keynote speaker. UMASH Online Expo. Virtual. August 2020.
- Liebman, Amy. Agricultural Worker Health & COVID-19. Oral/podium presentation. UMASH Online Expo. Virtual. August 2020.

- Bender, Jeff. Agriculture is a team sport. Keynote speaker. Minnesota Dairy Initiative Coordinators Conference. St. Cloud, MN. March 2020.
- Liebman, Amy. The immigrant's journey to work and what this means for health. Webinar for a multi-disciplinary health sciences class. September 2019.
- Bender, Jeff, Liebman, Amy. How Safe Is Your Dairy Farm? Minnesota Milk Producers Association Dairy Webinar. September 25, 2018.
- Vazquez, Chela. Working Across Language and Cultural Barriers in Agriculture. 2018 North American Manure Expo, Brookings, SD. August 15, 2018.
- Bender, Jeff. One Health and the Immigrant Worker. Minneapolis, MN. July 20, 2018.
- Vazquez, Chela. Promoting Worker Health and Safety for Immigrant Dairy Workers. Agricultural Worker Project. Saint Peter, MN. April 20, 2018.
- Kampa D, Peterson C, Liebman A, Bender J, Alexander BH.,Dairy worker safety: moving from problem to solution. Poster Presentation. 2017 NORA Symposium. Minneapolis, MN.
- Liebman A, Reyes I, Juárez-Carrillo P, Ninco Sanchez Y, Keifer M.,Culturally appropriate health and safety intervention for immigrant dairy workers. Poster Presentation. 2017 NORA Symposium. Minneapolis, MN.

C.2. Website(s) or other Internet site(s) – include URL(s)

Promoting Safety and Worker Health for Immigrant Dairy Workers: http://umash.umn.edu/portfolio/promoting-safety-and-worker-health-for-immigrant-dairy-workers/

Our Invisible Guardians. Twin Cities PBS 4/26/20. https://www.tpt.org/our-invisible-guardians/

Caution with Calves - http://umash.umn.edu/caution-with-calves-stopping-the-spread-of-zoonotic-diseases/

C.3. Technologies or techniques

N/A

C.4. Inventions, patent applications, and/or licenses

N/A

C.5. Other products and resource sharing

COVID-19 Infection Prevention for Agricultural Employers and Employees

Prevención de infección contra el virus COVID-19 para los empleadores y trabajadores agrícolas

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
JBBENDER	Y	Bender, Jeffrey B.		PI/PD	0.84	0.0	0.0			
JDKIRSCH		Kirsch, Jonathan David		PI/PD	4.80	0.0	0.0			
	N	Peterson, C.		Outreach Coordinator	3.0	0.0	0.0			

	N	Vazquez, C.		Community Health Liaison	10.8	0.0	0.0			

D.2 Personnel updates

N/a

a. Level of Effort:

b. New Senior/Key Personnel:

c. Changes in Other Support:

d. New Other Significant Contributors:

E. IMPACT

E.1 – What is the impact on the development of human resources, if applicable?

N/A

E.2 – What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

Dairy workers routinely encounter physical, biological, and chemical hazards through the course of their employment. The risks from these hazards can be mitigated through appropriate prevention measures, however the dynamic nature of working in a dairy and the evolving make-up of the dairy workforce makes implementing prevention measures, including worker training, a complex problem. This project used evidence-based findings from a previous UMASH research project, Seguridad en Las Lecherías: Immigrant Dairy Worker Health and Safety, to guide the development of training that was appropriate for this essential workforce. The training methods and materials are available to producers to assist in creating a working environment that is better for both the workers and the cattle they care for. The impact of this project was enhanced through the use of a One Health model that incorporated the input from occupational health and safety professionals, producers, workers, veterinarians, and health care providers to consider the nature of health and wellbeing of workers from multiple angles.

Evidence of this impact is shown through our partners, additional requests have come on regional or industry specific educational and training opportunities. This includes outreach from Extension on possible zoonotic risks from using livestock manure on organic vegetable operations; dairy veterinarians requesting health and safety training for veterinary students; and producers concerned about dairy cattle welfare and worker safety in dealing with “down cattle”. Through these we have engaged other Ag Safety Centers in developing a plan and appropriate materials. Additional concerns have become evident with climate change (i.e., heat stress) for agricultural workers and the need to provide outreach materials. Also, in response to workers’ and farmers’’ concerns, we developed a fact sheet on musculoskeletal injuries due to repetitive motion.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

COVID had a significant impact on outreach and training to farms. We were limited for a 1 ½ year period to be able to step back onto farms. We were unable to reach our training goal of 30 farms but utilized this time to work alongside producers during the pandemic.

F.2 – Actual or anticipated challenges or delays and actions or plans to resolve them

We pivoted to provide resources about COVID testing and vaccination as well as mental health resources.

F.3 – Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

None

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

NA

G.2 Responsible Conduct of Research

NA

G.3 Mentor's Research Report or Sponsor Comments

NA

G.4 Human Subjects

G.4.a Does the project involve human subjects?

Yes, interviews of workers and producers. IRB permission received from University of Minnesota

G.4.b Inclusion Enrollment Data

360 Hispanic, adult dairy workers and producers (over the age of 18 years)

G.4.c ClinicalTrials.gov

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?

No

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

No

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

No

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

No

G.8 Project/Performance Sites

See overall

G.9 Foreign Component

N/A

G.10 Estimated Unobligated Balance

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

N/A

G.11 Program Income

Is program income anticipated during the next budget period?

No

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?

No

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

The outcomes of this dynamic project includes regular engagement with regional industry leaders, direct contact with workers, and adaptation to worker and producer needs during the pandemic. 360 immigrant workers were trained on health and safety at 19 dairies in Minnesota and South Dakota. This included five 1-hour lessons over a 6-month period. Results of these training demonstrated a statistical significant increase in knowledge after each Lesson training. This improved communication with workers and producers, where workers were more aware of the risks and could initiate conversation with owners/producers/farm managers.

In addition, new outreach and educational material was developed in conjunction with worker, producer, and industry input. This included updating the existing training material in English and Spanish and addressing new issues such as weather extremes (i.e., working in cold environments). During COVID-19 we produced and collected COVID educational materials in Spanish and English that provided information on workplace illness prevention and protection, which was posted on the UMASH website and distributed via email to dairies. This also translated into providing timely resources on access to COVID-19 testing and subsequent vaccination of dairy workers. In addition, our partners Community Health Services Inc. (CHSI) and the University of Minnesota, School of Medicine offered health screenings and telehealth appointments to workers and rural communities in south-central Minnesota. We are exploring ways to sustain this effort. This included ongoing discussion with legislators to support TeleHealth programs and broadband support to rural communities.

To better understand the impact of the COVID-19 pandemic on dairy farms in the region, we conducted telephone and email surveys on participating dairy farms in Wisconsin and Minnesota. The results were published in the Journal of Agromedicine in July 2021 (Yung et al., 2021) and provided insight in continuing support of dairy workers, producers, and their families. This outreach effort also led to opportunities to hear about mental health and childcare concerns from workers. This has led to submission of a mental health research program with the UMASH renewal.

In addition, as part of our One Health efforts we partnered with our Industrial Hygiene faculty and the College of Veterinary Medicine to develop a health and safety inspection tool. This was piloted in the summer of 2022. This tool is intended to provide an external safety assessment to dairies and deliver a 1-2 page report to dairies with recommendations on areas to focus on to improve health and safety on the farm. We hope through our renewal to continue to pilot this audit as part of our outreach efforts.

Novel outreach and educational materials have been developed and used in this program. This includes the training materials (i.e., PowerPoint copies of the 5 *Seguridad* lessons, a user-friendly train-the-trainer manual, COVID educational materials). From producer input, we developed a video on preventing zoonotic disease while working with dairy calves and are currently working on educational materials on handling “down cows”.

Our project has frequent requests to support media outlets. This includes 12 media contacts on platforms such as Hoard's Dairyman, Farm Journal Ag Web, The Farmer, Ag Update, Farmer's Hotline, Dairy Star, among others. Also, the dairy worker safety training has been cited as a resource several times, including by organizations like ASCHA, Ag Safety Info, Minnesota Milk Producers Association, Farm Answers, and extension offices. The project was also part of a Twin Cities Public Television program, *Our Invisible Guardians*, about the work of UMN School of Public Health on its 75th anniversary. There is also a project being developed to highlight the work of UMASH in a School of Public Health *“Behind the Scenes”* video production.

Project Title: Assessing and Preventing Occupational Injuries in Animal Agriculture	
Grant Number: 5U54OH010170-10	**Project/Grant Period**: 09/30/2016 - 09/29/2022
Reporting Period: 09/30/2016 - 09/29/2022	**Date Submitted**: See overall
Program Director/ Principal Investigator Dr. Bruce Alexander	**Administrative Official Information** Kristina McReynolds 450 McNamara Alumni Center 200 Oak Street SE Minneapolis, MN 55455-2070
Change of Contact PD/PI:	
Human Subjects:	**Vertebrate Animals:**
hESC:	**Inventions/Patents:**

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

Occupational injury in animal agriculture not only affects the health and well-being of workers but is a significant burden to the agriculture industry due to lost productivity and compensation costs. The safety environment of the workplace is complex in animal agriculture and the health and well-being of the animals must also be considered. There is significant interest in reducing the burden of injury, however the tools available for specific injury prevention activities are limited. The long-term objective of this research project was to provide injury prevention tools for producers, managers, and safety professionals to prevent and control injuries in animal agriculture, with the following specific aims:

Aim 1. Build on established partnerships with animal agriculture production operations and workers' compensation insurance carriers in the Upper Midwest and nationally.

Aim 2. Aggregate available data from multiple sources, including employer injury reports and workers' compensation claims data, to characterize injury risks and costs of injury.

Aim 3. Identify injury prevention priorities based on frequency, severity, and cost

Aim 4. Apply expertise in occupational safety and animal husbandry to develop specific loss prevention strategies that target specific injury risks using a Haddon Matrix approach.

Aim 5. Disseminate these prevention strategies and other UMASH derived products through partnership connections.

B.2. What did you accomplish under these goals?

Aim 1. Build on established partnerships with animal agriculture production operations and workers' compensation insurance carriers in the Upper Midwest and nationally.

This project has engaged key industry partners and experts in animal agriculture to characterize the burden of injury and identify opportunities for prevention. Data on injury occurrence was obtained from swine production companies, a worker compensation carrier, and the Minnesota Department of labor and industries. These continued partnerships with producers and producer groups, the Minnesota Department of Labor and Industry (MNDLI) and a local insurance carrier providing regional coverage to companies across the upper Midwest provided insights into the challenge of monitoring and prevention injuries.

Aim 2. Aggregate available data from multiple sources, including employer injury reports and workers' compensation claims data, to characterize injury risks and costs of injury.

To characterize injury burden, costs, and risks data from swine production companies, MNDLI, and worker compensation carriers were evaluated. The data from each source was reviewed to understand coverage, coding practices, data elements available, potential interpretation, and feasibility for use. No single data resource is available that will describe the occurrence and impact of injuries in animal agriculture. Each data source identified for this project captures a different part of the picture of occupational injuries in animal agriculture, and each source presents unique opportunities and challenges for characterizing injury burden.

Data from the companies had content and coverage based on the policies of the individual company. All companies were large multi-site operations that managed swine production through the entire process; breeding, farrowing, weaning, and finishing. The breeding, farrowing, and weaning were generally done at separate sites from finishing, so the workforce and management practice within the companies varied by site. The policies for data collection at each company, ranged from essential injury reporting for OSHA compliance purposes to comprehensive injury and incident reporting that was directly linked to worker compensation systems. Moreover, the actual operations were in multiple states so the requirements identifying lost-time injuries varied. An advantage of these data was the availability of specific information on job type and activity and details of the incident. Worker demographic information, including

duration of employment, were available from all companies. The available data had similar elements that described the nature and source of injury, injured body part, job titles and unit, and job activities varied somewhat across the companies and where standardized to allow the combining of the data. The text description of the injury event permitted a more detailed review of the circumstances of the injury which clarified some analyses. The burden of injury included reported days of lost work and days of restricted activity for all companies. Companies that tied reporting to worker compensation insurance data had information on the total paid in medical costs and lost wages. Denominator data were requested from the companies, but due to several reasons, each unique to each company, these data were ultimately not available.

Data acquired from the Minnesota Department of Labor and Industry captured all reported lost-time claims in the state of Minnesota for all agricultural sectors, as defined by North American Industry Classification System (NAICS), from 2003 – 2019. While the initial scope was injuries in dairy and swine production, we were able to capture and will continue to analyze data from additional agriculture sectors. Data was coded by MNDLI according to Occupational Injuries and Illnesses Classification System (OIICS). Data included information on employee age and tenure; injured body part, nature of injury, source of injury and injury event; days and costs of disability and lost work time; levels of permanent disability (if applicable); paid claim costs; and whether a vocational rehabilitation plan was put in place. The OIICS coding scheme changes in 2012 to include 'animals' as a distinct "source of injury" category, thus we focused our data analysis included all claims from 2012-2019. The MNDLI data was limited to lost-time injuries, which in Minnesota these include claims that result in more than three days of lost time. Any injury filed with worker compensation insurance claims with three or fewer days or that only resulted in medical treatment are not included in these data.

Additionally, data were acquired from a workers' compensation insurance carrier for claims related to animal agriculture. This carrier covers operations across the Upper Midwest. The dataset included similar data as the MN DLI dataset, however it also had information on medical-only (less severe claims) and a text field with details of the injury/illness claim. This text description provided additional granularity on circumstances surrounding injury which allowed ascertainment of certain high-risk situations and activities that would not be possible in the MN DLI data. The worker compensation claims data also included payroll data that can be used as a proxy for a denominator representing the population at risk.

Each data source had strengths and weaknesses. The company data provided a more comprehensive assessments of all injuries, and for some companies for injury events that did not result in treatment beyond first-aid or limited work time. The description of the injured worker could be characterized down to the type of work, and to some degree the task being performed. The text descriptions, though inconsistent, could be reviewed to clarify the causal mechanism of the injury. With data on time lost, limited work time, and medical costs paid to date, the burden of the injuries could be described. Limitations included not having information on both injured and non-injured workers. The lack of denominator data did not allow injury risk to be estimated. Additionally, the participating companies were larger producers and thus not representative of all workers in the industry. The MNDLI data had the advantage of capturing claims data for all operations with hired employees in the state of Minnesota. While these data do not include small family run producers that are not required to carry worker compensation insurance, they capture a wider range of operations and are more representative of the overall workforce. The MNDLI data also have standardized metrics for cost and burden of injury, including the degree of temporary or permanent disability and the need for vocational rehabilitation after the injury. MNDLI only records injuries that result in more than 3 days of lost work time, which underestimates the total burden of injury as most work-related injuries have fewer than three days of lost time or are only medically treated without lost work time. The data from the worker compensation carrier is limited to the clients insured by that company and therefore not representative of the entire workforce. The data from the carrier has a considerable amount of detail about the injury and costs for medical care and time-loss. Similar to the data reported from the companies, all injuries are included so the distinction between medical only and time loss can be evaluated, and robust text descriptions can help characterize the cause of the injury. Unlike the company data, there is less information on the job characteristics of the injured worker.

Combining the data from the different sources for analysis was determined to not be a useful exercise due to the described differences. Ultimately, the availability of data from multiple sources did allow us to view the injury burden picture from more than one perspective. The different aspects of the data resources also provided corroborating information on specific risks and potential avenues for prevention.

Aim 3. Identify injury prevention priorities based on frequency, severity, and cost

The essential results of the analysis of specific risk factors for the company acquired data are presented with animal interaction injuries and needlestick injuries as leading themes identified. The results based on the worker compensation claims data are corroborate some of these findings and present the results in a slightly different context. The results from the MNDLI are summarized to support the company and insurance claims data and contrast to injuries in the dairy industry.

Animal Interactions

Data provided by the companies were reviewed to identify injuries that resulted from a direct encounter with an animal. There was considerable heterogeneity in the available data from each company and this which presented challenges in standardizing across companies. Data on worker demographics (age, gender, date of hire, date of loss, job title, work experience, etc.), and injury information (nature, source, body part, etc) required extensive review to align the data. Variability was present both between and within companies. All data were reviewed and internally standardized based on specific codes and narrative descriptions of the injury event. Data were re-coded according to the Bureau of Labor Statistics' Occupational Injury and Illness Classification System (OIICS) to ensure consistent injury source and event terminology when characterizing the occupational injury incidents. In coding animal interaction injuries, the narrative was reviewed to correctly identify injuries that were true animal-interaction injuries- defined as injuries caused by or because of interaction with a live animal were identified.

Injuries were classified as report only, medical only, or indemnity. Report only injuries were any injury events that did not require mandatory reporting for OSHA purposes, including minor injuries that did not require medical care beyond first aid or a reassignment of job duties. Report only injuries were identifiable in only two of the systems. Medical only injuries included those that were reportable and required medical treatment but did not reach a threshold of time loss that triggered worker compensation for lost wages. The indemnity injuries were injuries that resulted in days away from work. Because state laws governing worker compensation determine the threshold for an indemnity claim this classification varies by state. A "lost time injury" for this analysis was defined as an injury that resulted in more than 3 days away from work. The injuries were summarized by the burden of injury in the context of lost workdays, limited duty days, and total costs due to medical treatment and indemnity costs for lost work time. We focused on the most severe injuries, where severity was defined as injuries resulting in combined medical and indemnity costs greater than $10,000 and/or greater than 3 days of work lost.

Animal-interaction injuries were the most common (32%) injury source among the pork production companies. Of the 1,014 animal interaction injuries 543 (53%) were report only with 280 (27.6) medical only and 191(19%) indemnity claims. Female workers accounted for 39% of the animal interaction injuries, but only 34% of all injuries and workers with less than one year of experience accounted for a slightly larger proportion of animal interaction injuries compared to all injuries (63% vs 57%). A preponderance of animal interaction injuries (49%) occurred while moving pigs compared to all injuries (23%). The burden of injury included 16,428 days of lost work (31.4% of total days lost for all injuries) and an additional 8,867 days on light duty (37.4% of total days light for all injuries). The average days on light duty or days lost varied considerably between companies. The three companies for which data were available accrued over $5.4 million in costs (36.8% of total injury costs). The average costs were skewed by a few very costly claims resulting in excessive medical or disability costs.

Knee injuries accounted for 28% of the animal interaction indemnity injuries and 20% of medical only injuries, costing $1,004,154.64 in total costs (mean $4,946.57), a total of 3,066 days lost, and a total of 1,803 days light. Hand injuries accounted for 12% of indemnity claims and 35% of medical only claims and cost = $273,751.36 in total costs (mean $1,875.01), a total of 1,568 days lost, and a total of 642 days light. Shoulder injuries accounted for 41% of indemnity claims and 25% of medical only claims accruing $1,114,664.29 in total costs (mean $17,693.08), a total of 3,952 days lost, and a total of 1,997 days light. Back injuries accounted for 25% of indemnity claims and 32% of medical claims and cost the companies $956,355.99 in total costs (mean $12,260.97), a total of 2,066 days lost, and a total of 1,118 days light.

Needlestick Injuries

Following the data review and standardization as described for animal interaction injuries the needlestick injuries (NSI) were classified based on coding and text descriptions. NSI not already categorized in the data were identified via a keyword search of injury descriptions using terms including “needle,” “injection,” and “puncture.” Injuries from needle-free injection systems were included in the analysis. We summarized the burden of NSI in the context of lost workdays, limited duty days, and total costs due to medical treatment and lost work. One company employed the use of both traditional needle injection as well as the use of needle-free injection systems, made it possible for us to perform a sub-analysis to evaluate costs of injuries caused by these different injection techniques. NSI within this company were further classified into traditional NSI or needle-free NSI through the use of search terms including “needleless,” “gun,”, and “pulse 500” among others. Traditional and needle-free NSI were then summarized and compared in the context of lost workdays, limited duty days, and total costs due to medical treatment and lost work.

NSI accounted for 6.1% (N=192) of all swine production injuries, 3.1% of total light duty days, 1.7% of total days of lost work, and 1% of total costs. Lost time injuries made up 18% of all NSI injuries, 44% of total NSI light duty days, 98% of total NSI days of work lost, and 79% of NSI total costs. All NSI occurred within six job tasks: 93% occurred when animal care, piglet management, and sow management related tasks were performed, while the other 7% of NSI occurred during maintenance or housekeeping tasks or while walking. Most of these injuries, 67%, were upper extremity injuries, while lower extremity injuries made up 22% of NSI and 9% of NSI were to the head or trunk.

Contrary to expectations, the needle-free injection system injuries resulted in higher median total costs and higher total and median days of work lost than traditional needle injection. Though based on small numbers, 77% of the needle free injuries occurred to workers with less than one year of experience, compared to 62% of traditional needle injection.

Worker Compensation Claims Data

From 2000-2017 a total of 417 claims were identified from pig related establishments. These establishments were included in the 0034 Insurance Class Code, which includes a range of types of farm production, including hogs, poultry, and eggs. All claims with this ICC were extracted and a keyword search to identify any claim that may be related to pigs, hogs, sows, pork, or swine for further review. Specific injury causes were identified through the text searches with a focus on animal related, needlestick, and power washing. Injury and employee characteristics were used to calculate frequencies and rates of injury per $1 million of payroll. Total incurred claims costs were adjusted with a 2% inflation factor.

The relative risk (RR) of incurring lost-time, as an indicator is increased injury severity, was calculated as a binary outcome using log binomial regression. Lost-time risk was calculated for animal-related (vs. all other), needlestick (vs. all other) and power-washer (vs. all other). Additionally, the distribution of claim costs commonly exhibit a significant right skew in workers’ compensation data, and the adjusted total incurred costs were transformed using natural log to more closely approximate a normal distribution and analyzed in linear regression models. Linear regression examined the relationship between animal-related injury costs

versus the costs of all other injuries as ratio of mean (RoM) for total incurred costs, lost-time costs, and medical-only costs.

The worker compensation claims insurance data identified animal interactions to be responsible for 53% of claims and NSI for 6% of claims, and power-washing for 13% of claims. The rate of injuries/million dollars in payroll were 6.02 for all injuries, 3.22 for animal interaction injuries, 0.39 for needlestick injuries, and 0.79 for power-washing injuries. Lost-time claims for animal interaction and power-washing injuries were more costly than other claims and the average cost of NSI claims were lower than all other claims combined. However, injuries due to power-washing and NSI were 14 and 86 percent more likely to result in a time-loss claim compared to all other injuries, however the small numbers in the analysis resulted in highly imprecise estimates. While the analysis of these data was limited it did corroborate the importance of these injury risks.

Minnesota Department of Labor and Industry Data

The worker compensation claims data reported to the Minnesota Department of Labor and Industry represented a wider range of producers, but only include injuries that result in more than three days of lost work time. All claims reported from 2012-2019 with a North American Industry Classification System (NAICS) code of 112120: Dairy Cattle and Milk Production (N=636) and 112210: Hog and Pig Farming (N=790) were included in the analysis. Like data from companies, these data only represent injured workers, so we can't compare to the overall workforce, however some notable findings emerged. Women accounted for 30.3% of claims in hog and pig production but only 19.8% in dairy. Injured workers with less than 1 year of time in that job accounted for 42% of the injuries. The body part injured differed by type of production where dairy workers were proportionally more likely to have an upper extremity injury and hog and pig workers were more likely to have lower extremity and back injuries. The nature of injury also varied with dairy workers more often reporting a fracture while hog and pig workers were more likely to have sprains, strains, and tears. Interaction with animals, followed by slips, trips, and falls, were the most common events leading to an injury. Most of the claims (57%) incurred some temporary total disability and 23% required modified or light duty accommodations to return to work. Permanent partial disability of some level occurred in 18.1% of dairy claims and in 12.2% of pig claims indicating the potential severity of these injuries.

Other

The data pointed to a few specific risk factors, but also considerable heterogeneity in severity of injury of multiple types and causes. In all injury categories and in all data the severity of injury ranged from very minor to extremely severe and costly. Based on these data and conversations with industry partners the management of the more severely injured worker presents a challenge. In addition to identifying avenues to prevent injuries, improving the management of injured workers to reduce the overall burden to workers and the industry is a priority.

Aim 4. Apply expertise in occupational safety and animal husbandry to develop specific loss prevention strategies that target specific injury risks using a Haddon Matrix approach.

The results of the analyses have identified several potential areas to explore with industry partners. In the coming months, we will organize a forum to explore these results with various partners. We will specifically reach out to members of our Advisory Board, the Minnesota Pork Producers Association, and the National Pork Board to identify individuals in the industry that can help describe best practices for injury prevention. We recognize that many producers have explored alternate approaches and convening a forum to share these ideas will benefit the industry as a whole and the workers they employ. We will use the Haddon Matrix structure to imagine ways to prevent injuries and reduce the burden of those that do occur.

Aim 5. Disseminate these prevention strategies and other UMASH derived products through partnership connections.

Risk factors and high-risk activates/situations resulting in injury were identified by the research and will be disseminated to stakeholder groups. We are preparing three publications on specific risk factors, one on contrasting risks in different animal agriculture sectors, and one that maps the utility and limitations of each data source for injuries in animal agriculture. We also anticipate a publication being developed from the forum. In addition to publications, we will share the results with regional pork and dairy producer organizations, worker compensation insurance companies, and other partners. This will be done through the UMASH network as well as professional meetings in the future. Additionally, the results of the best-practices discussion will provide avenues to tailor prevention activities to specific populations. dairy workers, thus dissemination will be tailored to each group.

B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

This project provided opportunities for graduate students and veterinary public health residents to become familiar with data resources for work related injuries including the policies and systems that drive the data collection. The students and residents participated in the data acquisition, reviewing, cleaning, and analyzing the data, and preparing manuscripts.

B.5. How did you disseminate the results to communities of interest?

We have presented the core concepts of the project to stakeholders through center meetings and several professional conferences. The manuscripts for the main results will be completed in the next year and shared with the various communities of interest. Additionally, the UMASH Outreach Core has translated findings into resources to share with stakeholders and audiences.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

In addition to completing the main publications, we will convene the forum of industry partners to review the findings and best practices for injury prevention. From this information will be shared with stakeholders through the UMASH channels.

C. PRODUCTS

C.1. Publications, conference papers, and presentations

Presentations:

- Schofield, Katie. Assessing lost-time work injuries in animal agriculture in Minnesota. June 12-16, 2022. ISASH- International Society for Agricultural Safety and Health Annual Conference, Fort Collins, CO
- Bender, Jeff. Needle Know How. November 28, 2018. National Hog Farmer Webinar
- Bender, Jeff, Alexander, Bruce. Injuries in Pork Production. March 2018. National Pork Board Safety Summit. Des Moines, IA.
- Green D, Evanson J Bender JB, Alexander BH. Missclassification of Animal Handling Injuries to Swine Workers. August 2017. 26th International Epidemiology in Occupational Health (EPICOH) Conference. Edinburgh, UK.
- Green D, Evanson J, Bender JB, Alexander BH. Injuries among swine workers related to swine-human interactions. May 2017. Poster Presentation. NORA Symposium. Minneapolis, MN.
- Bender J, Green DR, Evanson J, Alexander BH. Injuries among swine workers related to needlesticks. May 2017. Poster Presentation. NORA Symposium. Minneapolis, MN.
- Green DR, Evanson J, Bender J, Alexander BH. Misclassification of animal handling and the resultant burden on two swine farms. May 2017. Poster Presentation. NORA Symposium. Minneapolis, MN.

C.2. Website(s) or other Internet site(s) – include URL(s)
N/A

C.3. Technologies or techniques
N/A

C.4. Inventions, patent applications, and/or licenses
N/A

C.5. Other products and resource sharing
N/A

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
BHALEX	Y	Alexander, Bruce H.		PI/PD	1.8	0.0	0.0			
KSCHOFIELD	Y	Schofield, Katherine		Co-I	1.8	0.0	0.0			
JBBENDER	Y	Bender, Jeffrey B.		Co-I	0.6	0.0	0.0			
	Y	Godden, Sandra		Co-I	0.6	0.0	0.0			
	N	Peterson, Carol		Outreach Coordinator	1.2	0.0	0.0			
	N	Balius, Patrick		Grad RA	3.0	0.0	0.0			

D.2 Personnel updates
N/a

a. Level of Effort:
b. New Senior/Key Personnel:
c. Changes in Other Support:
d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?
The results of these analyses will emphasize the importance of training workers in this ever-evolving industry about the potential for injury and ways to mitigate risk.

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

This project highlights the continued challenge of injuries in the animal agriculture industry. The findings identify some examples of areas where practice can be improved to reduce injury burden. Not surprisingly a significant contributor to injury is the direct interaction with the animals. This points to the importance of workers understanding and practicing appropriate animal handling techniques, which, in turn, will improve the well-being of animals. The training of these practices needs to be considered in the context of the tasks involved and the changing nature of the workforce. It was evident that the risks differ between dairy and pork production, and likely vary within these sectors, though our data was limited in breadth and detail. A more specific risk of injury involves the use of injections for disease prevention and treatment and other animal husbandry needs. Appropriate use and practice in injections, whether traditional or needleless systems, is essential in preventing these injuries. These injuries represent not infrequent events, which are usually of minimal consequence, but have the potential to be quite serious. Best practices are available, but implementing these practices requires appropriate training and supervision. UMASH has developed specialized training materials for animal handling and needlestick injuries. These initial products are useful but can be refined for specific activities.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

N/A

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

The COVID pandemic had a significant impact on this project. Many of the partners in the pork and dairy production and worker compensation insurance who were initially engaged for this project were not able to continue due to other obligations and staffing shortages. While this did not change the overall approach, it did limit the volume of data we had anticipated working with, which resulted in a less robust analysis. We sought other avenues to characterize injury burden in the industry, which included pivoting to the MNDLI data. We also explored the potential for engaging smaller hold farmers who would not be represented in our injury reporting data, but a satisfactory mechanism to recruit these farmers was not identified.

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

N/A

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

G.2 Responsible Conduct of Research

N/A

G.3 Mentor's Research Report or Sponsor Comments

N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?

No. Data on injuries were provided in limited data sets.

G.4.b Inclusion Enrollment Data

G.4.c ClinicalTrials.gov

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
No

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?
No

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

No

G.7 Vertebrate Animals

Does this project involve vertebrate animals?
No

G.8 Project/Performance Sites

See overall

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

G.11 Program Income

Is program income anticipated during the next budget period?
No

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?

No

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

People who work in animal agriculture face several injury risks related to their employment. In addition to impacting the wellbeing of workers, these injuries result in financial burdens on producers. Data needed to understand these risks, develop ways to prevent injury, and reduce the costs of injury are limited. This project evaluated data from multiple sources on injuries occurring to workers in pork and dairy production to identify priorities to reduce the burden of injuries. Injuries are not random events. The data analyzed in this project pointed to patterns that should be considered for injury prevention efforts. Some injuries appeared to happen more often to newer workers, female workers, and workers conducting specific tasks. The patterns of injuries also differed between raising pigs and dairy cattle.

As might be expected, a common cause of injury when raising pigs is due to a direct interaction with an animal. These animal related incidents can result in a wide range of injuries; however, some patterns emerge. Workers in pork production are more likely to sustain injuries to the lower extremities, frequently knee injuries, as well as other sprains and strains. The activity more commonly associated with animal interaction injuries was moving pigs, which is done routinely in all areas of the pig raising process. A large proportion of the injured workers had been employed for less than a year, suggesting that experience may be an important factor. The combination of the risk of moving and handling pigs and lack of experience points to the importance of effective and routine training in animal handling procedures. A second area of focus was the risk of injuries from giving injections to keep animals healthy (needlestick injuries). The needlestick injuries frequently have minimal consequences but being injected with some of the medicines and vaccines can result in severe reactions in people. These reactions can accrue considerable medical bills and result in extensive lost work time. The use of needleless injection systems has been promoted as a more efficient and possibly safer method for injections. However, our analysis provided some evidence to suggest that accidental injections from these methods do occur and may be equally or more consequential.

This project acquired less data on injuries to dairy workers, but was able to characterize injuries that resulted in lost work time. Like workers raising pigs, a large proportion of injuries to dairy workers are the result of a direct animal-human interaction, however the types of injuries differ. Dairy workers are more likely to have an injury to an upper extremity and these injuries are more likely to be fractures. The actual mechanism of the injuries may not be clear, but again points to the importance of workers knowing how to work with animals and be able to anticipate situations where an animal may react.

The findings of this project prompted UMASH to contribute to the development of new resources for swine handling training and needlestick prevention materials. These products were developed in collaboration with the National Pork Board and followed previous efforts in dairy cattle handling training which have been well received by dairy producers and safety professionals. These findings and resources have been mentioned in the media more than 20 times, including by platforms like National Hog Farmer, Dairy Herd Management, Bovine Veterinarian, Midwest Marketer, Blenkharn Environmental, Farm Journal Report, UMN Extension Women in Ag Network, Tri County News, Journal Advocate, Farm Journal Pork, The Land Online, Iowa Farmer Today, AgriView, The Eagle, Nebraska Dairy Extension, and more. They have been cited as a resource more than 10 times, including by organizations like ASCHA, MDH, labor and industry organizations, and extension offices. Further, the resources have been used in other training contexts, including in a veterinarian's presentation about safe handling of pharmaceuticals on dairies, in an online module for animal caretakers at the University of Iowa, on farms to train workers, and to educate students. One testimonial

noted: “A well done resource for farm managers, for agribusinesses, veterinary services and healthcare clinicians to have on hand in their offices."