Final Progress Report

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Great Plains Center for Agricultural Health

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Abbreviations

Abbreviation	Definition, *specific project, were appropriate*
AFF	Agriculture, Forestry, and Fishing
AMCC	Agricultural Medicine Core Course, *Building Capacity project*
AP	Administration and Planning, *Admin core*
ASABE	American Society of Agricultural and Biological Systems Engineers, *Crash, MSD, and CAFO projects*
aOR	Adjusted odds ratio, *Crash project*
BC	Building Capacity
CI	Confidence interval, *Crash, MSD and Surveillance projects*
CFOI	Census of Fatal Occupational Injuries, *Surveillance project*
DOT	Department of Transportation, *Crash project*
EAC	External Advisory Committee of the GPCAH, comprised of national experts in agricultural safety and health topics relevant to protecting our region’s agricultural producers
EMG	Electromyography, *MSD project*
FACE	Fatality Assessment and Control Evaluation, *Admin Core and R2P project*
GPCAH	Great Plains Center for Agricultural Health, the NIOSH AFF Center funded at the University of Iowa
IAC	Internal Advisory Committee for the GPCAH, comprised of Center investigators and key staff who contribute to Center cores and projects
ISASH	International Society of Agricultural Safety and Health (Conference)
ISO	International Standards Organization, *MSD project*
MRASH	Midwest Rural Agricultural Safety and Health (Conference), *R2P project*
NIOSH	The National Institute for Occupational Safety and Health
NORA	National Occupational Research Agenda
OR	Odds ratio
R2P	Research to Practice, *R2P project*
RAC	Regional Advisory Committee, comprised of regional safety and health advocates and partners, committed to understanding risks and preventing injuries and illnesses among agricultural producers
RR	Risk Ratio
RMS	Root Mean Square, *MSD project*
% RVE	Percent of submaximal isometric reference concentration, *MSD project*
SDC	Shaker Dust Collector, *CAFO project*
STR	State Trauma Registry (Iowa), *Surveillance project*
TLV	Threshold Limit Value, as established by the American Governmental Industrial Hygiene Association, *MSD and CAFO projects*

Great Plains Center for Agricultural Health – Abstract

The Great Plains Center for Agricultural Health (GPCAH) is a nationally recognized public health resource that develops and implements programs of research, intervention, translation, education, and outreach with the long-term goal of preventing occupational injury and illness among agricultural workers and their families. The Center serves a nine-state region: Illinois, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin. In the 2011-2016 project period, the Center enhanced the skills of safety and health advocates by providing 40-hour education to 470 trainees, improving the knowledge and skills of healthcare providers, veterinarians, medical students, and health and safety professionals as well as farmers throughout the region and country (Building Capacity). Research findings and best-practices were developed and disseminated, with input and guidance from regional advisors, using multiple outlets (Research to Practice) including web delivery, newsletters, educational posters, and monthly Safety Watch articles written for agricultural newspapers. Twenty-three investigators and community advocate organizations received pilot grant training funds, which increased the expertise and skills of both grant recipients and the agricultural workers with whom they engaged. Research projects identified important risk factors of hazards associated with traumatic injuries and chronic health effects important to the region. The frequency of farm crashes on GPCAH roadways can be reduced by improving lighting and marking and improving education, including emphasizing high-risk factors including proximity to town centers, roadway traffic volume, high speed limits, and straight road segments, all which increase the risk of farm vehicle crashes. Musculoskeletal symptoms of the low back are highly associated with whole body vibration, which is substantially lower in combines but significant in all other on-farm vehicles; outreach materials to explain this risk factor to farmers and advocates have been developed. An intervention project identified two methods to improve the air quality in swine production buildings: replace traditional heaters to reduce up to 1000 ppm carbon dioxide in farrowing rooms and deploy a recirculating ventilation system with air filtration to significantly reduce indoor dust concentrations in winter. Our surveillance team identified that standard news clipping services yields underestimates of on-farm fatalities. However, when on-farm status is included as a data field, state-wide trauma registries provide robust data to assess risk factors associated with severe injuries. The Iowa State Trauma Registry identified that only 51.7% of traumatic injuries on the farm were a result of farm work, indicating the need for a total health approach to protect rural populations from on-farm injuries. In addition, the time to receive care from an on-farm injury was substantially greater than that for other rural injuries, indicating a need for improved emergency action planning for farmers. New knowledge from all Center projects and pilot-grant projects have been incorporated into Building Capacity educational programs and Research to Practice translational materials to disseminate findings and best-practice recommendations for prevention. Relationships with new regional partners have been formed to maximize the impact of both new knowledge and the prevention of persistent hazards on the reduction of injury and illness among the region's farming population.

GPCAH Administration and Planning Core

GPCAH Administration and Planning Core

PI: T. Renée Anthony (renee-anthony@uiowa.edu)

Description

The Center Administration and Planning (AP) team provided programmatic and financial infrastructure needed for efficient Center operation. This team provided the expertise and resources necessary for (i) planning, coordinating, and monitoring of GPCAH activities, (ii) integration of GPCAH expertise across disciplines, (iii) management of GPCAH resources, (iv) optimal use of GPCAH advisory committee personnel, (v) ensuring appropriate facilities for GPCAH activities, (vi) required recordkeeping, and (vii) preparation of reports and summary information necessary to meet reporting obligations. Four personnel were involved in the overall Center administration: Director (Anthony), Deputy Director (Gerr), Center Coordinator (Gibbs), and Fiscal Administrator (Sickles). These individuals constituted administrative infrastructure, providing financial and programmatic oversight and leadership. The Director, Deputy Director, and Center Coordinator provided ongoing leadership in programming and reporting, essential to the success of meeting the overall goals of the GPCAH. The AP team formally met weekly to discuss Center planning and administration, including reviews of Center progress, reporting obligations, budgets, web maintenance, community requests for assistance, outreach opportunities, and upcoming meetings and events. A summary of key Center-level activities and events, including key personnel turnover, are detailed in Table 1.

Center planning activities were coordinated through weekly meetings with the AP Core personnel. The main communication with the project investigators occurred through monthly Internal Advisory Committee (IAC) meetings. External input into the activities and direction of the Center were obtained via quarterly Regional Advisory Committee (RAC) meetings and annual External Advisory Committee (EAC) meetings. The AP Core personnel communicated findings to all GPCAH project teams through the monthly IAC meetings.

Planning & Evaluation Core: Center AP Core personnel met weekly to manage ongoing Center activities: Director (Gerr 2011-15; Anthony 2015-17), Deputy Director (Gerr 2015-17), Center Coordinator (Haywood 2010-13; Gillette 2014-5; Gibbs 2015-17), Evaluator (Yang 2011-12; Cheyney 2013-17). These meetings ensured that progress was made on both timely activities (*e.g.*, pilot grant announcements and reviews, coordination of meetings such as MRASH and ISASH, annual and progress report generation) and ongoing opportunities for the Center (emerging issues discussions, scheduling outreach opportunities, web maintenance). While Center administration turnover occurred during this project period, activities and progress toward Center goals were maintained throughout.

Internal Advisory Committee (IAC) Monthly Meetings: The GPCAH investigators and staff IAC meet monthly (third Wednesdays) to discuss a range of Center-related activities. Standard topics included reporting on AP Core activities, evaluation progress (monthly reporting reminders, upcoming focus group activities), project progress reports, and new business. In new business, discussions on potential emerging issues were included (*e.g.*, effect of drought on stress in 2013) and opportunities to collaborate with the Iowa FACE and ICASH teams to generate monthly safety articles for the weekly Iowa / Illinois / Missouri Farmer Today (2014 began scheduling). Discussions of upcoming meetings (AFF Program Director visit; EAC meetings at ISASH events) were included. Also included in these meetings were efforts to update the GPCAH web (2013-2014) and discussions of journals to target GPCAH publications. In years 1-2 of the project, investigators provided short technical presentations on their studies to inform all Center personnel of the projects and to foster integration of activities and expertise among all safety and health disciplines in the Center. Additional IAC meetings were scheduled throughout the year to (1) score pilot project proposals, (2) build project staff and investigator expertise to provide web content, and (3) conduct focus groups for Center/Administration Evaluation.

Regional Advisory Committee (RAC) Quarterly Meetings: RAC activities were coordinated through the Research to Practice (R2P) with Community Partners translation project, but with involvement of AP personnel. Calls were coordinated quarterly with the 12-17 members of the RAC and with AP Core personnel. Topics for discussion included one main topic for the quarter (pilot/feasibility projects in spring; outreach plans in summer) with ongoing discussions on: emerging issues within each RAC member's community and reports on activities from each participant on the call.

Periodically, RAC members were provided with materials generated from GPCAH projects, and RAC members provided input on potential collaborations based on their current activities, *e.g.*, GPCAH Rural Roadway Crash Study worked with (a) ICASH (a state-funded center for agricultural safety) efforts with Nationwide insurance and (b) the National Education Center for Agricultural Safety (NECAS) to incorporate findings into its drivers training program (2012).

During the fall, the RAC met face-to-face at a regional agricultural health and safety meeting (MRASH, co-sponsored by the GPCAH), with a conference call established for those not able to travel. This meeting has been used to not only build relations between RAC members but to solicit specific feedback on ways to improve what GPCAH does. In 2013, RAC members were led through a brainstorming activity to identify ways to (1) improve the website, (2) improve solicitations and quality of pilot grants, (3) prioritize webinar training topics, and (4) rank print material resource formats that are used for outreach events. In 2014, RAC members reviewed results from the three needs assessment surveys (farmers, RAC, IAC) and provided discussion and recommendations to GPCAH on action plans for new research and outreach activities. In 2015, RAC members reviewed key findings from GPCAH research and intervention projects and brainstormed new ways to disseminate and new partners to collaborate with to maximize the Center's reach.

External Advisory Committee (EAC) Annual Meetings: The EAC has met

Table 1: Timeline of significant GPCAH events

Yr	Date	Event / Activity
Year 1	**Sept 30, 2011**	**Y1 BEGINS**
	Oct 2, 2011	E Heywood (coordinator) starts
		Investigator indicators form developed and piloted
		Center form created (documents progress and impact of Center activities – IAC annually)
		Focus Group Guide developed (IAC, EAC)
	July 1, 2012	G Yang (evaluator) leaves
Year 2	Sept 30, 2012	**Y2 BEGINS**
	Sept 30,	Administrative supplement funded for Y2
	Feb 19, 2013	M Cheyney (evaluator) starts
	March	PI interviews conducted to assess evaluation needs
	April	Investigator indicators and Center forms revised (reduce duplication/increase reporting efficiency and quality of data collected)
	May 1	Aaron Kline (R2P coordinator) leaves
	June	Access database created to store evaluation data and allow for easy retrieval
	July	Farm Communication Study conducted (admin. supplement project) at 3 county fairs
	Aug	Farm Communication Study intercept interviews conducted
	Sept	IAC focus group conducted
Year 3	**Sept 30, 2013**	**Y3 BEGINS**
	Sept 30	L Graft (R2P staff) leaves
	Oct 1	K Donham (Dep. Director; PI of R2P and BC programs) retires; Rohlman assumes PI role for BC; Gerr for R2P
	Oct 4	E Heywood (coordinator) retires
	Oct 29	RAC Y3 survey completed
		Leadership evaluation developed
	Dec	GPCAH all-staff leadership survey conducted
	Feb 3, 2014	P Gillette (coordinator) starts
	Aug-Sept	Farm Health and Safety Concerns (needs assessment) survey conducted
Year 4	**Sept 30, 2014**	**Y4 BEGINS**
	Nov 2014	RAC in-depth telephone interviews conducted
	Feb 6, 2015	New website goes live Google analytics goes down
	April	REDCap data collection system implemented to replace hand-written investigator indicators form (collects project outputs and outreach done by project teams)
	May 1	P Gillette (coordinator) retires
	July 1	**Leadership transition -** Anthony takes over as director
	July 7	J Gibbs (coordinator) starts
	Aug-Oct	PPE use project (outreach based on needs assessment) conducted
Year 5	**Sept 30, 2015**	**Y5 BEGINS**
	Feb 1, 2016	Google analytics resumes
	Feb	EAC survey
	March/April	IAC in-depth interviews conducted
		RAC Y5 survey conducted
		Increased social media (facebook)
		Collaborative outreach with regional AFF centers (RAC input driven)
NCE	**Sept 30, 2016**	**No Cost Extension (NCE) BEGINS**
	Sept 30	J Venske (R2P) leaves
	Mar 31, 2017	***Project Period Activity ENDS***

annually, either via teleconference or face-to-face at the Center or at national meetings (ISASH), to discuss the Center progress and to recommend specific actions to improve the Center. Recommendations included where to publish, how to get farmers involved, and partnering opportunities with other Ag Centers. The 2015 meeting confirmed the need to transform some components of the Agricultural Medicine Core Course into distance learning, with substantial discussions focused improving everyone's understanding of farming operations (large operations, small farms, and beginning farmers). From these discussions, the Center has reached out to producer groups who, by 2015, were invited and actively participating in both RAC and EAC activities, and directly to farmers (on-the-go programs in R2P project, starting 2015) to focus on opening stronger lines of communication with farmers and their producer organizations.

Aim 1: Ensure efficient management of Center resources - Activities

The Center AP core personnel oversaw the Center budget. The Financial Manager (Sickles) prepared monthly account summaries for project investigators, available for review in monthly Internal Advisory Committee (IAC) meetings. Project budget updates were provided to primary investigators monthly, via email, throughout the project period to track expenditures. The Center Director received and reviewed all Center budgets at the same time, allowing for identifying additional resource and activity needs throughout the project period. A line item on the monthly IAC agenda was dedicated to project updates, where issues pertinent to project budgets were solicited. The Center AP personnel examined budget issues throughout the project period and identified and discussed issues (*e.g.*, unspent funds near end of project year, needed additional resources to respond to emerging issues) with investigators when items emerged to identify resource allocations. Continued budget discussions identified actions to reduce the possibility of project failure due to poor allocation of limited funds.

Aim 2: Implement effective review and oversight of Center projects for early identification and resolution of unanticipated threats to project completion - Activities

All proposed Center projects included process evaluation procedures, designed to ensure completion of project aims. The best safeguard against deviation from project aims was ongoing implementation of process evaluation, which was monitored through the progress reports presented by all Center investigators at the monthly IAC meetings. Review of problems with project implementation were a priority at these meetings so that effective and sometimes creative solutions could be identified. Specific plans and timelines for resolution of problems were established and reviews of their effectiveness were included on the agenda of subsequent meetings. Threats and opportunities were identified in these meetings, with examples of input from the IAC, including: identification of new partners (Farm Crash project, R2P project), recommendation for additional subject matter experts (Building Capacity), recommendations for new approaches (Safety Watch for R2P, leadership feedback survey for Evaluation), and input and review of new content development (for Web, interactive activities with farming community for R2P, outreach material infographics, NIOSH PPOPs).

Aim 3: Facilitate communication (a) among Center personnel and (b) between Center personnel and appropriate community, public health, academic and government stakeholders - Activities

An essential component of Center effectiveness was timely and effective communication both among Center personnel and between Center personnel and our stakeholders. The monthly meeting of the IAC was an important mechanism of within-Center interaction. Quarterly meetings with the Regional Advisory Committee (RAC) was coordinated through the R2P project, with Center administrative personnel assisting in the coordination of topics and information needs. In addition to this regional external group, a national advisory group (External Advisory Committee) was established, with annual meetings, to provide oversite of Center projects, identify threats, gaps, and opportunities to all Center activities, as previously detailed.

Communication with stakeholders were facilitated through multiple channels. First, a redesigned GPCAH web site was created and rolled out to address distinct needs of various stakeholders, particularly agricultural workers, community agricultural health and safety partners, and researchers. In addition, formalized relationships with important community partners were developed, with resources and AP Core personnel, particularly through the R2P translational/educational project. The administration and planning team met with project investigators to identify relevant topics to include in translation efforts to meet needs of community partners and coordinated exchange of information between research investigators and partners.

Finally, all Center specialists provided informal consultation with community members and agricultural health organizations active in the nine-state region. Communication between the GPCAH and other NIOSH-funded Agricultural Health and Safety Centers was facilitated by AP Core participation in monthly Center Director Conference Calls, annual Center Director Meetings, and semi-monthly calls with and project activities in working groups within the NIOSH AFF Center Evaluation, Coordinators and Outreach (ECO) group. See "Outputs" lists for details of these educational and outreach efforts, beginning page 7.

Aim 4: Identify current and anticipate future agricultural health and safety needs and implement appropriate programmatic responses - Activities

A structure was in place to provide ongoing mechanism to identify threats to farm workers throughout the region. The AP Core conducted formalized strategic planning for growth and development of the Center. In 2013-4, a comprehensive needs assessment was performed to solicit feedback from farmers and their advocates. The AP Core evaluated surveillance trends and findings (Evaluation Core), particularly during press-clipping surveillance activities, and communicated with state FACE investigators (Iowa Department of Public Health and UI Researchers) to identify emerging hazards in nearly real time. In addition to quantitative input from these activities, AP Core personnel formalized data collection from stakeholders on both persistent and emergent agricultural health and safety issues relevant to the region, collaborating among Center experts, regional advisors, public health officials, community partners, and External Advisory Committee members. This effort was central to prioritizing the development of outreach materials for the Education/Translation Core projects (R2P and Building Capacity) and for prioritizing funding expenditures in the Pilot/Feasibility and Emerging Issues Program, which focused on generating new knowledge and translational materials to address the identified needs. External funding opportunities from regional grants were obtained from John Deere (gas monitor survey with field demonstrations, 2015-16), with partnership with the Air Quality Improvements in CAFOs team to conduct bench testing and develop communication with equipment manufacturers to evaluate low cost hydrogen sulfide monitors (combined with R2P outreach in 2016). Other sources of successful new funding for agricultural health and safety studies, from Center investigators, are also identified in Outputs.

Administrative Supplement (2012-13) - Activities

In year 2 of the project, an administrative supplement was funded to identify communication channels used and trusted by farmers and agricultural producers. In 2013, a survey of 195 agricultural producers was conducted, collecting demographic information and feedback on the frequency of use and level of farmer trust of 14 sources of agricultural health and safety information. Surveys identified that both use and trust were high for traditional (print) media sources across all age groups and that information from both medical clinics and academia (university and community colleges) was highly trusted but under used. In addition to sharing these findings in scientific literature (Chiu *et al.,* 2015), this finding was incorporated into the Center translation activities by developing relationships with weekly agricultural newspapers to deliver monthly safety and health articles (Safety Watch, R2P) and to develop and deliver educational posters to farmers via medical providers (*e.g.*, sun safety and hearing protection educational posters).

Outputs and Outcomes

The structure of the GPCAH was designed to provide evidence-based recommendations and intervention guidance throughout the region for both persistent hazards (*e.g.*, noise, heat stress, tractor safety) and new information resulting from investigator-driven research projects (*e.g.*, roadway safety, whole body vibration, air quality in livestock production). The AP Core was structured to provide administrative support to Center activities, including the coordination and communication of Center activities and outputs with: regional stakeholders, advisory committee members, with national agricultural health and safety experts, and directors of other NIOSH-funded AFF Centers. In addition, the AP Core has tracked emerging issues relevant to protecting agricultural worker health and safety throughout the region, by soliciting input from content experts and by providing resources to address key hazards.

The following outputs and outcomes is a compilation of efforts across the Center that were not directly aligned with individual project objectives but which contributed to the outputs and impact of the GPCAH. Outputs directly from supplemental administrative funds are reported here, designated with §.

Publications-Peer Reviewed

1. Chiu S, Cheyney M, Ramirez M, Gerr F: [2015] Where do agricultural producers get safety and health information? *Journal of Agromedicine*. 20(3): 265-72*. [PMID: 26237716]§*

Presentations - Abstracts and Conference Presentations, not aligned with projects

1. Peek-Asa, C: [2016] Agriculture and Rural Roadway Safety: A Global Challenge. Plenary Talk, World Health Organization World Safety Congress, September 2016. Tampere, Finland.
2. O'Brien K, Chimenti M, Farnell M, Tabler T, Bair T, Bray J, Nonnenmann MW: [2016] Evaluation of Personal Exposure to Inhalable Dust, Endotoxin and Bioaerosols among Poultry Workers. Nordic Meeting 2016: Agricultural Occupational Health and Safety, Aug 24-26, Billund, Denmark.
3. O'Brien K, Nonnenmann MW: [2016] Evaluation of Occupational Exposure to Gases in a Turkey Infected with the Highly Pathogenic Avian Influenza A H5N2 virus in Iowa, USA. Nordic Meeting 2016: Agricultural Occupational Health and Safety, Aug 24-26, Billund, Denmark.
4. O'Brien K, Nonnenmann MW: [2016] Airborne Influenza A is detected in the Personal Breathing Zone of Swine Veterinarians. Nordic Meeting 2016: Agricultural Occupational Health and Safety, Aug 24-26, Billund, Denmark.
5. Williams SA, Farnell M, Tabler T, Nonnenmann MW: [2016] The Effects of a Sprinkler Cooling System on Dust Concentrations in Broiler Chicken Production. Nordic Meeting 2016: Agricultural Occupational Health and Safety, Aug 24-26, Billund, Denmark.
6. Anthony, TR: [2016] Closing the gap in worker protection: Interventions for manure gas exposures. International Society for Agricultural Safety and Health, June, 2016, Lexington, KY.
7. O'Brien K, Chimenti MS, Farnell M, Tabler T, Bair T, Bray JL, Nonnenmann MW: [2016] Evaluation of Poultry Dust Composition using Whole-Genome Shotgun Sequencing. International Society for Agricultural Safety and Health, June, 2016, Lexington, KY.
8. O'Brien K, Nonnenmann MW: [2016] Evaluation of Occupational Exposure to Gases in a Turkey Infected with the Highly Pathogenic Avian Influenza A (H5N2) virus in Iowa, USA. International Society for Agricultural Safety and Health, June 2016, Lexington, KY.
9. Anthony, TR: [2016] Notable confined space events and issues: Confined spaces in agriculture. American Industrial Hygiene Conference and Exposition, May 26, 2016, Baltimore, MD.
10. Boles C, O'Brien K, Nonnenmann MW: [2016] The Development and Optimization of a DNA Extraction Method for Aerosol Samples Collected using Polyvinylchloride Filter Media. American Industrial Hygiene Conference and Exposition, May 21-26, 2016, Baltimore, MD.
11. Williams SA, O'Brien K, Farnell M, Tabler T, Nonnenmann MW: [2016] Production Practices Associated with Personal Exposure to Inhalable Aerosols during Work in Broiler Chicken Production. American Industrial Hygiene Conference and Exposition, May 21-26, 2016, Baltimore, MD.
12. Ramaswamy, M, Fethke N: [2016] Methods for Estimating Health Outcomes among Beginning Farmers. Building Capacity Networking Reception/ OEH Conference /University of Iowa Public Health Research Week, Iowa City, IA.
13. Ranapurwala S, Young T, Ramirez M: [2016] Predictors of Injury in a Farm Vehicle Crash: Modifiable and Non-modifiable factors. Building Capacity Networking Reception/ OEH Conference /University of Iowa Public Health Research Week, Iowa City, IA.
14. Gibbs JL: [2016] Occupational Health and Impacts on Iowa Agriculture. Iowa Governor's Conference on Public Health, April 12th, 2016. Des Moines, IA.
15. Ismail A, Abdel Rasoul G, Bonner MR, Hendy O, Mara K, Wang K, Olson JR, Rohlman DS: [2016] Organophosphorous Pesticide Exposure And Neurobehavioral Performance Among Adolescents In Egypt: A Ten-month Prospective Study. Society of Toxiology 55th Annual Meeting, March 13–17, 2016, New Orleans, LA.

16. Rohlman DS, Ismail A, Rasoul G, Bonner MR, Hendy O, Ortega L, Wang K, Olson RJ: [2016] Occupational Pesticide Exposure and Parental Report of Attention Deficit Hyperactivity Disorder in Adolescent Pesticide Applicators in Egypt. Society of Toxiology 55th Annual Meeting, March 13–17, 2016, New Orleans, LA.
17. Anthony, TR [2015] Improving air quality in swine barns: Results of intervention study. Midwest Rural Agricultural Safety and Health Conference, Nov 16-17, 2015, Decorah, IA.
18. Rohlman DS, Campo S, Morrison L: [2015] Enhancing Supervisor's Skills and Employer Policies to Promote and Protect the Health of Young Agricultural Workers. Midwest Rural and Agricultural Safety and Health Conference. Nov 15-17, 2015, Decorah, IA.
19. Gibbs JL: [2015] Future of Occupational Health: Impacts on Agriculture. Midwest Rural Agricultural Safety and Health Conference, Nov 16-17, 2015, Decorah, IA.
20. Leonard, S: [2015] Lessons Learned from a Successful Farm Safety Workshop for Journalists held in Cedar Rapids, IA. Midwest Rural Agricultural Safety and Health Conference, Nov 16-17, 2015, Decorah, IA.
21. Leonard, S: [2015] An Iowa FACE Program Case Study: Carbon Monoxide from a Smoldering Grain fire Killed Two Employees Who Entered a Grain Storage Bin. Midwest Rural Agricultural Safety and Health Conference, Nov 16-17, 2015, Decorah, IA.
22. O'Brien K, Nonnenmann MW: [2015] Airborne Influenza A is detected in the Personal Breathing Zone of Swine Veterinarians. Midwest Rural and Agricultural Safety and Health Conference. Nov 15-17, 2015
23. Williams SA, Farnell M, Tabler T, Nonnenmann MW: [2015] The Effects of a Sprinkler Cooling System on Dust Concentrations in Broiler Chicken Production. Midwest Rural and Agricultural Safety and Health Conference. Nov 15-17, 2015, Decorah, IA.
24. Williams S, Farnell M, Tabler T, Nonnenmann M: [2015] The Effects of a Sprinkler Cooling System on Dust Concentrations in Broiler Chicken Production. International Society of Agricultural Safety and Health. Normal, IL [June 21-24, 2015]
25. Olson JR, Abdel Rasoul G, Ismail AA, Hendy O, Hamad L, Singleton ST, Bonner MR, Khan K, Rohlman DS: [2015] Longitudinal Assessment of Exposures to Chlorpyrifos and Profenofos in Adolescent Egyptian Agricultural Workers. Society of Toxicology 54nd Annual Meeting, San Diego, CA [March 25, 2015]
26. TePoel M, Shaw M, Huszar S, Rohlman DS: [2014] Correlates of Mental Health in Seasonal Farmworkers. 13th Annual Midwest Rural Agricultural Safety & Health Conference, Ankeny IA [November, 2014]
27. Young T, Ranapurwala SI, Ramirez MR: [2014] Epidemiology of farm equipment crashes in nine Midwestern states. 40th Annual International Traffic Records Forum [Oral]; St. Louis, MO [October, 2014]
28. Butler-Dawson J, Thorne PS, Rohlman DS: [2014] Estimate pesticide exposure among children in agricultural communities and examine the impact on neurobehavioral function in children. 13th Annual Midwest Rural Agricultural Safety & Health Conference, Ankeny IA. [November 2014]
29. Cassidy A & Cheyney M: [2014] U.S. Agricultural Safety and Health Centers YouTube Channel. 13th Annual Midwest Rural Agricultural Safety & Health Conference in conjunction with the Iowa Rural Health Association's Fall Meeting, Ankeny, IA [November 19, 2014]
30. Douphrate, Fethke, Hagevort, Nonnenmann, Gimeno, Mixco, Marshall, Reynolds: [2014] Task-specific and full-shift sampling of upper extremity muscle activity among US large-herd dairy parlor workers. 7th International Symposium: Safety & Health in Agricultural & Rural Populations: Global Perspectives. Saskatoon, SK, Canada. [October 19-22, 2014]
31. Rohlman DS, Abdel Rasoul G, Ismail AA, Bonner M, Hendy O, Khan K, Olson JR: [2014] Exposures, Symptoms, and Neurobehavioral Performance: A Longitudinal Study of Adolescent Pesticide Applicators. 7th International Symposium: Safety & Health in Agricultural & Rural Populations: Global Perspectives, Saskatoon, SK, Canada [October 2014]
32. Rohlman DS, Shaw M, TePoel M, Huszar S: [2014] Occupational and Environmental Stress in Latino Agricultural Workers. 7th International Symposium: Safety & Health in Agricultural & Rural Populations: Global Perspectives, Saskatoon, SK, Canada [October 2014]
33. Schall, Chen, Merlino, Gerr, Fethke: [2014] A prospective study of musculoskeletal symptoms among agricultural workers in the Midwest region of the United States. 7th International Symposium: Safety & Health in Agricultural & Rural Populations: Global Perspectives. Saskatoon, SK, Canada [October 19-22, 2014]

34. Denning G, Harland KK, Jennissen C: [2014] Too many tragedies: national pediatric all-terrain vehicle fatalities. International Society of Agricultural Safety and Health [ISASH], Omaha NE, June 2014.
35. Rohlman D, Abdel Rasoul G, Ismail A, Bonner M, Hendy O, Hamad L, Khan K, Al-Batanony M, Olson J: [2014] Building Research Capacity in Egypt through Education and Training. 10th Anniversary Symposium for Brain Directors for the Brain Disorders in the Developing World: Research across the Life Span [BRAIN], Bethesda, Maryland.
36. Cheyney M, Gerr, F, Ramirez, M: [2013] Where do farmers get health and safety information? Midwest Rural Agricultural Safety and Health Conference, Ames, IA. Nov 19-20, 2013. [§]
37. Leonard S, Anthony TR: [2013] Agricultural Fatality Case Studies. Midwest Rural Agricultural Safety and Health Conference, Ames, IA. Nov 19-20, 2013.
38. Manz N, Silver K, Fethke N, Hoffman K, Loury S, Florence J: [2012] Building a consensus for tomato grower ergonomics: a community-based expert panel study. American Public Health Association 104th Annual Meeting and Exposition. October 27-31, 2012, San Francisco, CA.
39. Fisher E: [2013] Motivating Families to Create Safe Play Areas on Farms: Intervention Results. International Society Agricultural Safety and Health 2013 Annual Meeting. June 23-27, 2013, Sandusky, OH.
40. Ramirez M, Fisher E, Ellis T, Rautiainen R, Lee B: [2013] Motivating families to create safe play areas on farms; a randomized trial. National Meeting of the Safe States Alliance and the Society for Advancement of Violence and Injury Research. June 3-7, 2013, Baltimore, MD.
41. Madsen M, Donham KJ: [2013] Farm and Ag injuries in press clips. 2013 Upper Midwest Agricultural Safety and Health Annual Forum. April 17, 2013, St. Paul, MN.
42. Kline A: [2012]: Building Capacity of Agricultural Medicine **–** The Academy of Instructors. Midwest Rural Agricultural Safety & Health Conference. November 16-17, 2011, Johnston, IA.
43. Rohlman D, Shaw M, Huszar: [2013] Workplace demands and stress in hispanic farmworkers. Midwest Rural Agricultural Safety and Health Conference, Ames, IA. Nov 19-20, 2013.
44. Ramirez M, Fisher E, Ellis T, Rautiainen R, Lee B: [2012] A Process Evaluation of Safe Play Areas on Farms. Midwest Rural Agricultural Safety & Health Conference. November 13-15, 2012, Cedar Rapids, IA.
45. Sullivan R, Ramirez, M, Kraemer J, Peek-Asa, C, Gergelt R: [2012] Toxicology testing in fatally injured workers. National Occupational Injury Research Symposium [NOIRS] October 18-20, 2011, Morgantown, WV.
46. Gerr F: [2012] Neurobehavioral effects of solvent exposure among agricultural works. International Society Agricultural Safety and Health 2012 Annual Meeting. June 24-28, 2012, Burlington, VT.
47. Ramirez M, Anthony TR, Gerr F: [2012] Agriculture injury surveillance: collaborations between academia and government. Council of Territorial and State Epidemiologists National Meeting. June 3, 2012, Omaha, NE.
48. Badtke L, Kelly KM, Wang K, Merchant J, Ludewig G: [2012] Influence of paraoxonase 1 Q192R and lifestyle factors on PON1 activity over time in an agricultural population. Society of Toxicology Meeting, March 2012, San Francisco, CA.

Academic Lectures, Workshops or Seminars that Incorporated Findings from GPCAH Activities

Agricultural safety and health best-practices were incorporated into classroom curriculum at the University of Iowa (UI) and other universities. Topics were covered in six reoccurring UI courses (Occupational Health; Occupational Safety; Agricultural Safety and Health; Rural Health and Agricultural Medicine; Introduction to Injury and Violence Prevention; OEH Seminar). Additional courses where materials have been integrated include:

1. Fethke N: [2015] “Musculoskeletal pain among agricultural workers. lessons from an ongoing prospective study” Seminar delivered to graduate students (n=15) and faculty affiliated with the Southwest Center for Occupational and Environmental Health, University of Texas, School of Public Health, Houston/San Antonio, TX. October 2, 2015
2. Leonard S: [2015] “Ag Fatalities and Injuries” to 25 students at Kirkwood Community College.
3. Anthony TR: [2014] Agricultural Safety and Health lectures to 30 Agribusiness students at Kirkwood Community College (2 lectures)

4. Peek-Asa C: [2014] “Time to Definitive Trauma Care for Farmers” at the “I Love Science: Medical Science Training Program”, UI Carver College of Medicine.
5. Peek-Asa C: [2014] “Time to Definitive Trauma Care for Farmers” at the Biomedical Health Science Research Week.
6. Donham K: [2013] Lecture: “Occupational and Community Health Concerns of Large Scale Swine Production” delivered to 150 college students, faculty, and community members at Grinnell College, Grinnell, IA.
7. Donham K: [2012, 2013] Lecture: “Agricultural Health and Safety for Agricultural Producers: Swine Production” delivered to 55 students and 2 faculty in the Agriculture 450 course at Iowa State University, Ames, IA.

Community Lectures, Workshops or Seminars that Incorporated Findings from GPCAH Activities

1. Anthony TR: [2016] “Pit Foam & Producer Safety. Hazards and Prevention of Airborne Exposures and Risks” to 50 agricultural producers and workers (Iowa Pork Congress, January 27, 2016)
2. Anthony TR: [2016] “GPCAH Updates to Iowa Extension Field Specialists” to 14 ISU Extension agents at their fall regional meeting. (September 28, 2016)
3. Fethke N: [2015] “The right tool for the job... and you.” Presented to 30 community members in Ames, IA (2 contact hours).
4. Nonnenman M: [2015. “Occupational Hygiene in Agriculture.” Coordinated round table at AIHce (#235) in Salt Lake City, UT (June 3, 2015). Estimated 50 attendees in 3.5 hour session.
5. Nonnenman M: [2015] “Occupational Hygiene in Animal Production Agriculture: New Approaches.” Coordinated round table (#247) at AIHce, Salt Lake City, UT (June 4, 2015). Esimated 50 attendees, 3.5 hour session.
6. Peek-Asa C: [2015] “Trends in Non-Fatal Agricultural Injuries in Iowa.” Presented to 20 Community members in Grinnell, IA (1.5 contact hours)
7. Peek-Asa C: [2014] Participatory Research: How to keep the honeymoon going” to the NIOSH Science Forum in Washington DC.
8. Donham K: [2013]: Presentation: “Confined space and grain safety” delivered to Agricultural Safety & Health Council of America, Minneapolis, MN.
9. Donham K: [2013] Presentation: “Iowa's Center for Agricultural Safety and Health” delivered to Public Health, Extension, and Department of Agriculture personnel and farmers, Ames, IA.
10. Peek-Asa C: [2013] Lecture: “Rural Driving Interventions: from the street to the driver” delivered to Ohio State University College of Medicine Speaker Series attendees.
11. Ramirez M: [2013] Lecture: “Safe Driving Interventions for Rural Teens on Rural Roads” delivered to Nationwide Children’s Hospital Lecture Series.
12. Donham K: [2012] Lecture: “Farm Safety Day” Rural Health Clinic of Greater Johnson CO. Delivered to farm families from Johnson, Iowa, Keokuk, and Washington Counties, Iowa City, IA.
13. Gerr F: [2012] Keynote presentation at 2012 Midwest Regional Agricultural Safety and Health Conference, Cedar Rapids, IA.
14. Merchant J: [2012] Rapporteur: UNC and UI CAFO Research Workshop, Chapel Hill, NC
15. Merchant J: [2012] Commissioner and discussant: National Commission on Industrial Farm Animal Production Workshop—Update and Review. Center for a Livable Future, Johns Hopkins Bloomberg School of Public Health, September 30 - October 2, Baltimore, MD
16. Ramirez M: [2012] Lecture: “Fatality Assessment and Case Evaluation: Toxicology Testing in Fatally Injured Workers” delivered at the Iowa State Medical Examiners Meeting, Des Moines, IA.

Consultation or Information Exchange

Information exchanges were documented with 68 community members over the project period. Highlights are provided here:

1. Gibbs JL: [2016] Provided technical assistance to the Iowa Department of Agriculture and Land Stewardship Pesticide Bureau about pesticide drift and air monitoring in Iowa. (Aug 2016)
2. Anthony TR: [2016] Provided technical assistance to OSHA about manure gases.
3. Leonard S: [2015] Information Exchange: “Agritourism Safety” with 10 producers in Donnellson, IA.

4. Anthony TR, Gibbs J: [2015] Provided information to producers during Amana Farms Open House, specifically addressing instrumentation to provide hydrogen sulfide alerts from manure pit gases. (August, 8, 2015)
5. Peek-Asa C: [2013] Consultation: Advocacy & Testimony for Graduated Driver's Licensure.
6. Nonnenmann M: [2013] Consultation: Grain bin safety resources with a Washington County Public Health nurse.
7. Anthony TR: [2013] Consultation: Provided information on CO/CO_2 sensors for grain bins, via email with farmer/producer.
8. Gerr F: [2013] Provided mentoring to (1) Director of the Rural Health Clinic of Greater Johnson County and (2) staff at Farm Safety For Just Kids on preparing pilot grant applications.
9. Ramirez M: [2013] Consultation: Safe Play on Farms (in collaboration with Marshfield Clinic and CS-CASH) with American Family Insurance.
10. Anthony TR: [2011-12] Consultation: building air quality walk through and discussion (3 producers)
11. Anthony TR: [2012] Information exchange: provided guidance to the Rural Health and Safety Clinic of Greater Johnson County about noise in rural settings.

Information Given to Policy Makers

1. Gerr F: [2016] NIOSH AFF activities to protect farmers and farm workers in the nine-state region. Discussed GPCAH activities with federal representatives from the nine-state region. February 3.
2. Anthony TR, Rohlman D: [2015] NIOSH AFF activities to protect Iowa Farmers. Discussions with Iowa representatives sharing GPCAH activities to support Iowa farmers. September 23 and 24.
3. Jennissen C: [2015] Recreational Off-Highway Vehicle Exposure, Safety Behaviors, and Crash-Related Injuries: Testimony on behalf of the American Academy of Pediatrics. Oral Presentations Regarding the Recreational Off-Highway Vehicles Notice of Proposed Rulemaking. US Consumer Product Safety Commission Public Meeting. Bethesda, MD.
4. Peek-Asa C: [2014] Rural Agricultural Injury data presented to Sen. Harkin and staff, Sen. Grassley and staff, and Rep. Loebsack and staff.
5. Ramirez M: [2014] Road characteristics and incidence of farm vehicle crashes. Given to 30 members of the State Traffic Records coordinating committee
6. Ramirez M: [2014] Farm vehicle-related crash study in nine states: 2005 – 2010. Given to 18 Representatives of Departments of Transportation (DOT) of Iowa, Kansas, North Dakota, Nebraska, Minnesota, and Missouri.
7. Ramirez M: [2014] Epidemiology of farm equipment crashes in nine Midwestern states. Given to 18 Representatives of Departments of Transportation (DOT) of Iowa, Kansas, North Dakota, Nebraska, Minnesota, and Missouri.
8. Ramirez M: [2014] Characteristics of farm equipment crashes involving youth occupants: One pager. Given to 18 Representatives of Departments of Transportation (DOT) of Iowa, Kansas, North Dakota, Nebraska, Minnesota, and Missouri.
9. Ramirez M: [2014]. Lighting and marking legislation to prevent farm equipment crashes on the road: one pager. Given to 18 Representatives of Departments of Transportation (DOT) of Iowa, Kansas, North Dakota, Nebraska, Minnesota, and Missouri.
10. Ramirez M: [2014] Prevalence of Alcohol Testing and Impairment in On-road Farm Equipment-Related Crashes: One pager. Given to 18 Representatives of Departments of Transportation (DOT) of Iowa, Kansas, North Dakota, Nebraska, Minnesota, and Missouri.
11. Ramirez M: [2014] Not just a rural occurrence: Farm Equipment-related Crashes: One pager. Given to 18 Representatives of Departments of Transportation (DOT) of Iowa, Kansas, North Dakota, Nebraska, Minnesota, and Missouri.
12. Ramirez M: [2014] Effect of road segment characteristics on the incidence of farm vehicle-related cashes: One pager. Given to 18 Representatives of Departments of Transportation (DOT) of Iowa, Kansas, North Dakota, Nebraska, Minnesota, and Missouri.
13. Ramirez M: [2014] ATV data presented to an audience of 500 members of the Iowa legislature and County Supervisors (for all 99 IA counties).

14. Ramirez M: [2014] Farm Crash data presented to the members of the Iowa congressional delegation.
15. Anthony TR: [2013] Swine Barn Explosion information provided to NIOSH/OSHA Liaison at information exchange meeting at request of Brad Husberg, Director NIOSH Office of Agriculture, Forestry, and Fishing.
16. Donham K: [2013] Rural Health/Agricultural Safety & Health information provided at the Legislative Breakfast -- Iowa Legislation with Center for Rural Health.
17. Donham K: [2013] Proposed Legislation for Roadway Use for ATVs provided to ICASH Board and Advisory Committee.
18. Donham K: [2013] Grain Safety & Primary Care, a white paper review with the National Grain Safety Coalition.
19. Donham K: [2012] Child Labor Law information provided to Senator Harkin's Staff.
20. Peek-Asa C: [2013] Farm Equipment on Rural Roadways information provided to federal legislators. Washington, DC.
21. Ramirez M: [2013] Farm Equipment on Rural Roadways information provided to federal legislators. Washington, DC.
22. Gerr F: [2012] Impact of the Great Plains Center for Agricultural Health provided to the AFF Review Panel of the National Academy of Sciences, May 31.
23. Gerr F: [2012] National Academies of Science. Re-review of NIOSH Agricultural Forestry and Fishing Program. Washington, DC.

Press Releases and Media Stories

Outside of articles authored by the GPCAH as part of R2P project activities (*e.g.*, monthly Safety Watch articles and the *Farm Family Alive and Well* newsletter), the GPCAH provided content to 20 news stories, either in response to formal press releases or with direct contact with reporters working on hazard or prevention articles addressing agricultural health and safety hazards. High-impact stories, not referenced in project specific summaries, are given here:

1. Hakes D: [2015] "Pediatric ER doc patiently pushes ATV safety." Iowa City Press Citizen. Sept 4, 2015. http://www.press-citizen.com/story/news/2015/09/03/pediatric-er-doc-patiently-pushes-atv-safety/71646520/
2. Ramirez M, Ellis T: [2015] "Safety Watch: Help farm kids play it safe." Missouri Farmer Today, May 26, 2015. http://www.iowafarmertoday.com/news/safety-watch-help-farm-kids-play-it-safe/article_0515386c-ff15-11e4-8e63-0b1fe13d1ba9.html
3. Rohlman D: [2015] "ATV safety simulator renews push for increased safety." (June 8, 2015) KWWL, Channel 7. http://www.kwwl.com/story/29270854/2015/06/08/atv-simulator-renews-push-for-increased-safety
4. Gerr F: [2014] "Common sense, patience vital to ranch safety". Progressive Cattleman, May 15, 2014.
5. Rohlman D: [2014] "Grain Silo Safety" on the Devine Intervention show, AM 1400 KBFT, Fort Dodge, IA. June 11, 2014.
6. Anthony TR: [2013] "Farmers slow to adopt technology that monitors grain bins remotely", Des Moines Register, July 25, 2013.
7. Donham K: [2013] "Confined Space Hazards in Agriculture" Iowa Pork Producers magazine.
8. Donham K: [2012] "Rural Roadway Safety," *Successful Farming Radio*.
9. Ramirez M: [2011] "Iowa FACE program warns of grain entrapment risk," University of Iowa news release, October 19.
10. Ramirez M: [October 2011] "Prevent fatalities from grain entrapment," Iowa FACE Hazard Alert.

Grant Proposals Submitted or Funded with GPCAH Support

1. Anthony TR. Design, Evaluation, and Validation of a Next-generation Inhalable Aerosol Sampler. (Funded 2012-2017; CDC/NIOSH R01 OH010295; tested in agricultural environments).
2. Rohlman D. Identifying Occupational Safety and Health among Tea Workers and Stakeholders. College of Public Health Global Health grant. (Funded 2015, University of Iowa College of Public Health)
3. Rohlman D, Campo S. Developing online training for supervisors of young agriculture workers. (Funded 2014-19; U54 OH009568, Marshfield Clinic Research Foundation)

4. Rohlman D. Workplace stress in farmworkers and their families. (Funded 2012-17; U50 OH007544, CDC/NIOSH via Pacific Northwest Agricultural Safety and Health Center)Workplace stress in farmworkers and their families. (Funded 2012-17; U50 OH007544, CDC/NIOSH via Pacific Northwest Agricultural Safety and Health Center)

Cumulative Enrollment

Cumulative Enrollment Table

This enrollment covers the Administrative Supplement Survey (project year 2)

PHS Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

OMB Number: 0925-0001 and 0925-0002
Expiration Date: 10/31/2018

***Study Title (must be unique):** GPCAH Administrative Core: Identify communication channels for information used by farmers and agricultural producers

* Delayed Onset Study? ☐ Yes ☒ No

If study is not delayed onset, the following selections are required:

Enrollment Type ☐ Planned ☒ Cumulative (Actual)

Using an Existing Dataset or Resource ☒ Yes ☐ No

Enrollment Location ☒ Domestic ☐ Foreign

Clinical Trial ☐ Yes ☒ No **NIH-Defined Phase III Clinical Trial** ☐ Yes ☐ No

Comments: GPCAH Administrative Supplemental, 2012-13 (7548-12)

Racial Categories	Ethnic Categories									
	Not Hispanic or Latino			Hispanic or Latino			Unknown/Not Reported Ethnicity			Total
	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	
American Indian/ Alaska Native	0	0	0	0	0	0	0	0	0	0
Asian	0	0	0	0	0	0	0	0	0	0
Native Hawaiian or Other Pacific Islander	0	0	0	0	0	0	0	0	0	0
Black or African American	0	0	0	0	0	0	0	0	0	0
White	50	129	1	0	0	0	0	0	0	180
More than One Race	0	0	0	0	0	0	0	0	0	0
Unknown or Not Reported	0	0	0	0	0	0	0	0	15	15
Total	50	129	1	0	0	0	0	0	15	195

Inclusion of Gender and Minority Study Subjects:

Women and those of minority racial/ethnicity were not excluded from participating in the research project. The proportions of women (25%) and those of minority status (<1%) among the study sample reflected the an increased representation of gender and minority make-up of the population of farm owner/operators in the Midwest region of US, which is predominantly male and Caucasian based on US Census of Agriculture.

Inclusion of Children:

No children were included as study subjects in this project

Materials Available for Other Investigators

Digital versions of all materials generated as outputs from this project are available to all at the GPCAH website (www.gpcah.org).

GPCAH Pilot/Feasibility Projects and Emerging Issues Program

Pilot/Feasibility Projects and Emerging Issues Program

PI: Fredric Gerr, fred-gerr@uiowa.edu

Abstract

This program maximized the Center's ability to reduce injuries and illnesses in our region by awarding 23 pilot projects throughout the region. To address the need to build both scientific and community outreach throughout our region, two tracks were designated. Over the project period, 67 pilot grant proposals were received and reviewed, and 12 community grants and 11 research/scientific grants were awarded. Although one-quarter of pilot project activities were performed in the state of Iowa, three quarters of pilot project activities were conducted in Illinois, Missouri, Nebraska, North Dakota, South Dakota, Minnesota, Wisconsin, and Kansas. Grant recipients were selected by considering both peer-review panel scores and assessments of the likelihood of projects to address relevant hazards in the region. The five topics receiving the most pilot grant funding were: grain handling, farm safety/safety culture, children safety, emergency response, and ATV/UTV safety. This pilot/feasibility program has supported the careers of 14 researchers and professionals with five or fewer years of experience in agricultural safety and health, increasing the expertise throughout the region.

Background and Aims

The Pilot/Feasibility Project and Emerging Issues Program served as an incubator for new research and prevention activities to advance knowledge, investigate new hazards and health effects, assess interventions, and promote the development of agricultural health expertise in the region. A novel feature of the program was the creation of separate pilot grant applications for academic projects and community-based outreach projects. The specific aims of the Pilot/Feasibility Projects and Emerging Issues Program were to:

1. Maximize the Great Plains Center for Agricultural Health's impact on agricultural safety and health within our entire region by funding four pilot/feasibility and emerging issues projects per year.
2. Develop and review annually a compilation of persistent and emergent agricultural safety and health priorities, to be used in the evaluation of Pilot/Feasibility and Emerging Issues Program and Outreach Program Applications (in collaboration with the Internal, Regional, and External Advisory Committees).
3. Improve the quality of pilot/feasibility project applications by providing academic and technical consultation and assistance to Pilot/Feasibility and Emerging Issues applicants.

Methods

Applications for pilot/feasibility grants were solicited annually, with late-summer due dates. Announcements were revised substantially in years 2 and 3 to improve the application quality, providing separate guidance for research/scientific and outreach/community grants. *Research/scientific* projects were those submitted by investigators at academic/research institutions (both student/new investigators and established investigators new to agricultural health and safety), with the goals of (i) creating new agricultural safety and health knowledge, (ii) promoting best-practices in agricultural safety and health, and (iii) developing the agricultural safety and health research workforce. The review process for these applications focused on the scientific merit of the proposal using established NIH-style criteria. *Community outreach/education grants* were awarded to projects submitted by personnel of non-academic entities and focused on delivering and evaluating health and safety interventions and educational programs to agricultural workers. These projects were evaluated on the feasibility, impact, innovation of outreach methods, and ability to impact new and vulnerable populations. Selected applicants with both high scores and relevant topics were contacted, communicating requests for clarification and necessary human subjects actions prior to awarding funding. Unsuccessful applicants were contacted and provided with reviewer feedback to improve future grant applications. A second request for proposals was issued if additional funding was available to award pilot grants, with unsuccessful applicants contacted to recommend resubmission.

Awardees received funds only once human subjects approvals were assured. If a community awardee had no formal mechanism, the Center prepared and submitted the project through the University of Iowa human subjects review mechanism, with coordination of materials by the awardee. The Center Coordinator also assisted investigators with preparing applications, promotional activities for community events, recruitment of research participants, and generation of media articles and social media messaging to promote project successes. Projects were completed in a 12-month period, with a mid-year progress report and a final progress report submitted to the Center Coordinator. Pilot grant investigators were encouraged to present at the GPCAH-sponsored Midwest Regional Agricultural Safety and Health (MRASH) conference and were contacted within two years following the grant closure to track any additional outputs that have been generated from their pilot project. The impact of this project was evaluated by assessing the relevance of pilot project topics to the regional needs and vulnerable populations; quantifying publications and media reach of project results; and quantifying the extent of impact of pilot grant on researchers or organizations for those new to the agricultural safety and health field.

Findings

The GPCAH received 67 pilot grant applications and awarded 23 pilot project grants. Twelve *community outreach/education* grants and 11 *research/scientific* grants were awarded, although one project included both community and scholarly components. The program fostered new collaborations across groups of researchers and agricultural safety and health practitioners across the entire nine state region. Overall, 30% of pilot project investigators were affiliated with non-profit organizations or health care/local industries, 26% were investigators and researchers at Universities other than the University of Iowa (*e.g.*, University of Missouri, University of Illinois, University of Nebraska), 22% of the Center's pilot project investigators were University of Iowa investigators (Pulmonary Medicine, Emergency Medicine, Occupational and Environmental Health, Audiology), and 30% were University of Iowa graduate students. Greater than half of the projects (57%) were collaborative, involving multiple partners.

Maximize the Impact of the GPCAH: The program provided resources to address important topics not included among Center-based research projects but that were important to the safety and health of agricultural workers in the region. Examples included grain bin safety, hearing conservation, biological pathogens, safety behaviors among young farmers, machine safety (tractor rollover prevention), first aid/traumatic injury response, and ATV/UTV safety. The community outreach/education grants have provided a unique mechanism for the Center to engage difficult to access vulnerable populations across the region, including Anabaptists (Hutterites), middle and high school farm youth, migrant and seasonal farmworkers, and geographically isolated rural farm families.

The academic/scholarly pilot grant projects funded by the GPCAH have resulted in publishable manuscripts and additional funding from both government agencies and private entities. Table 2 summarizes outputs from these pilot grants. The community-based outreach grants had an especially large impact because of the number of persons who participated in them. Twelve community grants resulted in the training of 4,600 individuals. The most common categories of persons trained were farm family members (32%), adult farmers (25%), and adolescent farmers and agriculture students (26%). The most frequent training topics included grain handling safety, hearing conservation, ATV/UTV safety, general awareness of farm hazards/machine safety, and emergency response/first aid.

The pilot projects have resulted in 98 media stories, both nationally and in all nine states of the GPCAH region. In the final year, the Center Coordinator also began collaborate with pilot project grant recipients to promote pilot project events, trainings, and initial findings on social media. As a result of this effort, GPCAH Facebook promotions that focused on pilot projects reached 2968 individuals and engaged 348 individuals, who either commented, viewed a link, liked, or shared the content. This was an engagement rate of 8.5% (GPCAH considers an engagement rate of 10% to be indicate favorable performance).

Overall, 14 of the 23 GPCAH pilot grants were awarded to new or beginning researchers/professionals, defined has having five or fewer years of experience in agricultural safety and health. Of these individuals, six are now employed as an agricultural safety and health professional or are engaged in agricultural health research studies, and five are working in a public health field. In addition, two pilot grant-funded early career professionals have started annual Agricultural Safety and Health Awareness programs at their local medical clinics, now securing funding and support from their medical organization. GPCAH pilot grant projects have also supported 11 master's thesis or doctoral dissertations in the field of Agricultural Safety and Health (Table 2).

Table 2: Pilot/Feasibility project outputs by year

Output	2011-12	2012-13	2013-14	2014-15	2015-16	Total
Publications	-	5	2	-	2*	9*
Abstracts & Conference Presentations	9	7	8	9	10*	43
Trainings & Workshops (# Participants)	11 (860)	12 (1600)†	7 (1135)†	7 (556)	9 (654)	46 (3365)*
Technical Reports		2	-	2	1[2]	5*
Press Releases, Media Stories, Radio	27	48	12	6	5	98
Educational Tools and Curriculum	2	1	2	3	5	13
Websites or Online Materials	2	1	-	1	1*	5*
Additional Funding Received	5	1	-	2	1*	9*
Master's Thesis or Doctoral Dissertations	-	1	3	3	4	11
Social Media Reach (Engagement)	--	--	--	--	2,968 (348)§	2,968 (348)§

†Numbers of participants include demonstrations and training at farm shows and state fairs.
*These data may be incomplete as several publications are in progress following the results of the pilot project.
§ GPCAH engaged in social media promotions of pilot grant events and research findings beginning in 2015-16.

Persistent and Emergent Priorities: A running list of persistent and emerging hazards was generated by Center administration from monthly internal advisory committee meetings, quarterly regional advisory committee meetings, and annual external advisory committee meetings. In addition, priorities were identified in a Center needs assessment that included ~200 agricultural producers in Minnesota, South Dakota, and Nebraska. Funding decisions for pilot grants most often reflected the scientific merit evaluations rather than priority areas, and all pilot grants that were funded addressed relevant hazards within the region, well justified in the significance section of funded proposals. The six priority areas with the highest cumulative pilot grant funding this period were: grain handling, farm safety/safety culture, children safety, emergency response, ATV/UTV, and hearing protection.

Improve the Quality of Applications: The quality of Pilot/Feasibility Projects was significantly improved by providing technical assistance with grant applications. Separate pilot grant application processes and reviews were completed for academic and community-based outreach projects. The Coordinator provided technical assistance to several applicants during the development and formulation of ideas for the grant application as well as throughout the grant writing process. This greatly improved the quality of the grants--all but one of the grant applicants that received GPCAH technical assistance was funded. Applicants were coached on the NIH-style scoring procedures used by reviewers. The Coordinator also assisted investigators with promotional activities of community events, recruitment of research participants, and construction of media articles/social media messaging to promote project successes. In addition, the Coordinator provided six pilot project awardees with IRB Human Subjects application assistance through the UI human subjects research office.

Conclusions and Impact

To date, 6 of 12 academic projects have resulted in 9 scientific publications, with anticipation of more from recently ending projects (see Outputs: *Publications under review* and *Dissertations and Thesis*). Overall, 10 of 23 projects have received additional funding from government agencies or private institutions. This program has supported the careers of 14 new and beginning researchers, professionals, or organizers in the field of agricultural safety and health. Of these individuals, 11 are now employed as an agricultural safety and health profession or working in a similar public health field. Principal investigators were encouraged to publically present their findings and educational resources at annual agricultural safety and health conferences. From 2011-2016, pilot project investors contributed 13 abstracts/presentations at the Midwest Rural Agricultural Safety & Health Conference and 14 abstracts/presentations at the International Society for Agricultural Safety and Health Conference. Many pilot grant awardees are actively engaged in outreach and research in agricultural safety, many on the front lines where local interventions can contribute to preventing farmer injuries and illnesses throughout the region. Descriptions of each funded pilot project begins on page 22.

Outputs and Outcomes

Publications- Peer Reviewed

1. Kahn K: [2017] Efficacy of technology-based interventions to increase the use of hearing protections among adolescent farmworkers. International Journal of Audiology, in press.
2. Kates A, Dalman M, Roner J, Smith T: [2017] A cross-sectional study of *Staphylococcus aureus* colonization and the nasal and oropharyngeal microbiomes. *J Occup Med and Tox.* In press, https://doi.org/10.1101/145540
3. Schneberger D, DeVasure JM, Bailey KL, Romberger DJ, Wyatt, TA: [2017] Effect of low-level CO2 on innate inflammatory protiene response to organic dust from swine confinement barns. *J Occup Med and Tox.* 12:9, 10.1186/s12995-017-0155-8 [PMCID: PMC5366145]
4. Jennissen CA, Harland KK, Denning GM: [2016] Characteristics of side-by-side vehicle crashes and related injuries as determined using newspaper reports from nine US states. *Safety*. 2(10): 1-12.
5. Liu B, and Koc AB: [2015]. Field tests of a tractor rollover detection and emergency notification system. *J Agric Saf Health* 21(2):113-127. [PMCID: PMC26204787]
6. Schneberger D, DeVasure JM, Bailey KL, Romberger DJ, Wyatt, TA: [2015]. Effect Of Workplace Co2 Exposure Limit Levels On Innate Immune Response To Hog Barn Dust Exposure. *Am J Respir Crit Care Med.* 191; 2015:A1720 N/A
7. Jennissen CA, Harland KK, Wetjen K, Peck J, Hoogerwerf P, Denning GM: [2014]. A school-based study of adolescent all-terrain vehicle exposure, safety behaviors, and crash experience. *Annals of Family Medicine.* Jul; 12(4):310-6. [PMCID: PMC4096467]
8. Liu B, and Koc AB: [2013]. SafeDriving: A mobile application for tractor rollover detection and emergency reporting. *Computers and Electronics in Agriculture*. 98:117-120.
9. Jennissen CA, Denning GM, Sweat S, Harland, KK, Buresh C: [2012]. All-Terrain Vehicle injury prevention: healthcare providers' knowledge, attitudes, and the anticipatory guidance they provide. *J Community Health*. 37:968–975. [PMCID: PMC3717765]

Publications- Peer Reviewed, under review

1. Anthony TR, De Vito C, Gibbs JL: [2017] Hearing protection fit assessment using personal attenuation rating measures for agricultural and manufacturing workers. Under review, *J Occ Env Hygiene*.

Presentations (Abstracts and Conference Presentations)

1. Rudolphi J, Rohlman D: [2017]: Family vs. Non-Family Farms: A Comparison of Organization Factors and Safety Policies. ISASH, Logan, UT.
2. Jennissen C, Denning G, Thorton K: [2017] Rural Occupational and Recreational Side-by-side Vehicle Crashes: An Emerging Health and Safety Concern. ISASH, Logan, UT.
3. Gibbs JL, Cheyney M, Menscher R, Klemuk S: [2017] A Noise Induced Hearing Loss (NIHL) Simulation Tool for Educating Young Farmers. National Hearing Conservation Association Conference, San Antonino, TX.
4. DeVito C, Gibbs JL, Anthony TR: [2016] Personal Attenuation Ratings of Farmers: How Well do Earplugs Really Fit? MRASH, Sioux Center, IA.
5. Gibbs JL, Cheyney M, Menscher R, Klemuk S: [2016] A Noise Induced Hearing Loss (NIHL) Simulation Tool for Educating Young Farmers. ISASH, Lexington, KY.
6. Gibbs JL, Cheyney M, Menscher R, Klemuk S: [2016] A Noise Induced Hearing Loss (NIHL) Simulation Tool for Educating Young Farmers. Iowa Speech, Language and Hearing Association Conference, Iowa City, IA.
7. Johannes A: [2016] Health of Migrant and Seasonal Farmworkers in Iowa. ISASH, Lexington, KY.
8. Ramaswamy M, Fethke NB: [2016]. Methods for Estimating Health Outcomes among Beginning Farmers. Annual Occupational Safety and Health Symposium, Iowa City, IA.
9. Ramaswamy M, Fethke NB: [2016]. Health Outcomes among Beginning Farmers. MRASH, Sioux Center, IA.
10. Rudolphi JM, Rohlman DS: [2016] Track with your App: Developing a Safety Intervention Using the Social Cognitive Theory and Smartphone Technology. MRASH, Sioux Center, IA.

11. Denning G, Jennissen C, Harland K: [2015] ATV-related fatalities on paves and unpaved roads: implications for public policy. ISASH, Normal, IL.
12. Hill D, Aherin R: [2015] Lifeline Training in Grain Bin Entry. Grain Operations Conference and Entrapment Prevention Symposium, Bloomington, IL.
13. Hill D, Aherin R: [2015] Promoting Harness and Lifeline Use in Grain Bin Entry for Farm and Elevator Workers through Development, Training, and Distribution of Specific Lifeline Installation/Procedures/Use Training Curriculum. American Society of Safety Engineers Convention, Dallas, TX.
14. Hill D, Aherin R: [2015] Lifeline Training in Grain Bin Entry. ISASH, Normal, IL.
15. Jennissen C, Harland K, Winborn A, Denning G: [2015] ATV and UTV Safety Training for Agricultural Workers: A Safety Workshop Piloted with Iowa Farmers. National Occupational Injury Research Symposium. Advancing Occupational Injury Research through Integration and Partnership. Kingwood, WV.
16. Jennissen C, Harland K, Winborn A, Denning G: [2015] Safety Training for Agricultural ATV and UTV Use. 2015 ISASH, Normal, IL.
17. Jennissen C, Harland K, Winborn A, Denning G: [2015]) ATV and UTV Safety Training for Agricultural Workers: Short Term Results of a Workshop Piloted with Iowa Farmers. Great Plains Society of Academic Emergency Medicine Meeting, Minneapolis, MN.
18. Jennissen C, Harland K, Winborn A, Denning G: [2015]) Pilot Study of an ATV and Side-by-Side Safety Workshop for Iowa Farmers: Final Results. MRASH, Decorah, IA.
19. Rudolphi JM, Rohlman DS: [2015] Iowa's Future Farmers: Current Work Practices and Barriers to Adopting Safe Behaviors Knowledge Measures. ISASH, Normal, IL.
20. Aherin R: [2014] Procedure for Establishing a Lifeline in a Grain Bin. ISASH, Omaha, NE.
21. Adkisson J, Adherin R: [2014] Grain Handling Safety Coalition Community Based-Partnerships. ISASH, Omaha, NE.
22. Adkisson J, Adherin R: [2014] Grain Handling Safety Coalition Community Based-Partnerships. MRASH, Ankeny, IA.
23. Adkisson J, Adherin R: [2014] Grain Handling Safety Coalition Community Based-Partnerships. GEAPS Safety Conference, Kansas City, KS.
24. Harland K: [2014] Taking Risks: All-Terrain Vehicle Safety Among Agricultural Communities. ISASH, Omaha, NE.
25. Jennissen C, Harland K, Winborn A, Denning G: [2014] ATV and UTV Safety for Agricultural Workers and their Families: A Safety Workshop Piloted with Iowa Farmers. MRASH, Ankeny, IA.
26. Schneberger D, DeVasure JM, Bailey KL, Romberger DJ, Wyatt, TA: [2014] Effect Of Workplace CO_2 Exposure Limit Levels On Innate Immune Response To Hog Barn Dust Exposure. American Thoracic Society Conference, San Diego, CA.
27. Schneberger D: [2014]. Effects of elevated carbon dioxide on innate immune response in the Lung. ISASH, Omaha, NE.
28. Adkisson J, Adherin R: [2013] Grain Handling Safety Coalition Community Based-Partnerships. ISASH, Sandusky, OH.
29. Adkisson J, Adherin R. [2013] Grain Handling Safety Coalition Community Based-Partnerships. MRASH, Ames, IA.
30. Adkisson J, Adherin R: [2013] Grain Handling Safety Coalition Community Based-Partnerships. American Society of Agricultural and Biological Engineers (ASABE) Annual Conference, Kansas City, MO.
31. Adkisson J, Adherin R: [2013] Grain Handling Safety Coalition Community Based-Partnerships. North American Agriculture Summit, Minneapolis, MN.
32. Adkisson J, Adherin R: [2013] Grain Handling Safety Coalition Community Based-Partnerships. American Farm Bureau Federation Safety Conference, Washington, DC.
33. Hill D, Aherin R: [2013] Promoting Harness and Lifeline Use in Grain Bin Entry for Farm and Elevator Workers through Development, Training, and Distribution of Specific Lifeline Installation/Procedures/Use Training Curriculum. North American Agricultural Safety Summit, Minneapolis, MN.

34. Liu B, Koc AB: [2013] A Vehicle Rollover/Accident Prevention, Education, Training and Emergency Reporting System. ISASH, Sandusky, OH.
35. Aherin R Hill D: [2012] Hazards, issues and injury experience regarding agricultural confined spaces with emphasis on grain safety. MRASH, Cedar Rapids, IA.
36. Adkisson J, Adherin R: [2012] Grain Handling Safety Coalition Community Based-Partnerships. ISASH, Burlington, VT.
37. Adkisson J, Adherin R: [2012] Grain Handling Safety Coalition Community Based-Partnerships. MRASH, Cedar Rapids, IA.
38. Adkisson J, Adherin R: [2012] Grain Handling Safety Coalition Community Based-Partnerships. American Society of Agricultural and Biological Engineers (ASABE) Annual Conference, Dallas, TX.
39. Adkisson J: [2012] Grain Safety Confined Spaces: Difference Perspectives and Initiatives (Panel). MRASH, Cedar Rapids, IA.
40. Burgus S, Funkenbusch K, Schlater T: [2012] Web-based interaction encouraging safe and healthy rural-related behaviors. ISASH, Burlington, VT.
41. Burgus S, Funkenbusch K: [2012] The Next Generation: Farm Safety and Health. MRASH, Cedar Rapids, IA.
42. Denning G: [2012] Newspaper press clipping surveillance of utility vehicle-related injuries and deaths. MRASH, Cedar Rapids, IA.
43. Jennissen C: [2012] A population based study of all-terrain vehicle use in a rural county. MRASH, Cedar Rapids, IA.

Information Given to Policy Makers – by pilot grant recipients

1. Jennissen C: [2015] Recreational Off-Highway Vehicle Exposure, Safety Behaviors, and Crash-Related Injuries: Testimony on behalf of the American Academy of Pediatrics. Oral Presentations Regarding the Recreational Off-Highway Vehicles Notice of Proposed Rulemaking. U.S. Consumer Product Safety Commission Public Meeting. Bethesda, MD.
2. Jennissen C: [2015] ROV/UTV Exposure, Safety Behaviors, and Crash-Related Injuries in the U.S. Heartland. ANB45 (1) Rollover Subcommittee Meeting, Sponsored by ANB45 Committee on Occupant Protection. Academy of Sciences Transportation Board Annual Meeting. Washington, D.C.

Dissertations/Thesis – of pilot grant recipients

1. Rudolphi J: [2017] Safety and Health of Young Adult Agricultural Workers. PhD Thesis, University of Iowa Department of Occupational and Environmental Health. University of Iowa College of Public Health, Iowa City, IA. http://ir.uiowa.edu/etd/5617/
2. DeVito C: [2017] Comparison of Personal Attenuation Ratings of Hearing Protectors for Agricultural and Industrial Workers. Master's Thesis, University of Iowa Department of Occupational and Environmental Health. University of Iowa College of Public Health, Iowa City, IA. http://ir.uiowa.edu/etd/5457/
3. Johannes A: [2016] Health of Migrant and Seasonal Farmworkers in Iowa. Master's Thesis, University of Iowa Department of Occupational and Environmental Health. University of Iowa College of Public Health, Iowa City, IA.
4. Kates A: [2016] The human nasal and oropharyngeal microbiomes and Staphylococcus aureus colonization. PhD Thesis, University of Iowa Department of Epidemiology. University of Iowa College of Public Health, Iowa City, IA. http://ir.uiowa.edu/etd/2229/

Cumulative Enrollment

Cumulative Enrollment Table

PHS Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

OMB Number: 0925-0001 and 0925-0002
Expiration Date: 10/31/2018

***Study Title (must be unique):** GPCAH Pilot/Feasibility Grant and Emerging Issues Program

* Delayed Onset Study? ☐ Yes ☒ No

If study is not delayed onset, the following selections are required:

Enrollment Type	☐ Planned	☒ Cumulative (Actual)
Using an Existing Dataset or Resource	☒ Yes	☐ No
Enrollment Location	☒ Domestic	☐ Foreign
Clinical Trial	☐ Yes	☒ No

NIH-Defined Phase III Clinical Trial ☐ Yes ☐ No

Comments: This inclusion enrollment report covers pilot grants from 2011-2016 based on enrollment numbers from individual project investigator's final reports.

Racial Categories	**Ethnic Categories**									
	Not Hispanic or Latino			Hispanic or Latino			Unknown/Not Reported Ethnicity			**Total**
	Female	**Male**	**Unknown/ Not Reported**	**Female**	**Male**	**Unknown/ Not Reported**	**Female**	**Male**	**Unknown/ Not Reported**	
American Indian/ Alaska Native	0	0	0	0	0	0	0	1	0	1
Asian	0	0	0	0	0	0	0	1	0	1
Native Hawaiian or Other Pacific Islander	0	0	0	0	0	0	0	0	0	0
Black or African American	0	0	0	0	0	0	0	2	0	2
White	0	0	0	0	0	0	171	647	0	818
More than One Race	0	0	0	0	0	0	1	2	0	3
Unknown or Not Reported	0	0	0	0	0	0	201	455	1,724	2,380
Total	0	0	0	0	0	0	373	1,108	1,724	3,205

Inclusion of Gender and Minority Study Subjects:

373 (12%) females enrolled and 1,108 (36%) males, with 54% not reported

Inclusion of Children:

Overall, six pilot projects included individuals under 21 years of age. In chronological order: the *Evaluation of Technology-based Interventions to Increase the Use of Hearing Protection among Adolescent Farmworkers in Iowa* (2013) included 26 children; *Identifying agricultural behaviors of Iowa's young farmers* (2014) included 25 children; *Family ATV Safety Training* (2014) included 56 children; *Safe Farming, Safe Living: Educational Outreach to the Leut* (2014) included 114 children; *Noise Induced Hearing Loss (NIHL) Simulation and Hearing Protection Device Fit Testing* (2015) included 29 children; and Safe Farming, Safe Living: CPR Outreach to the Leut (2015) included 205 children.

Descriptions of Individual Pilot/Feasibility Projects and Impacts

Individual projects are described below, in chronological order.

Year 1 (2011 –2012) - 4 submitted, 3 funded

1. *Web-based interaction encouraging safe and healthy rural-related behavior* (S Burgus, Farm Safety 4 Just Kids, Urbandale, IA; K Funkenbusch, University of Missouri, Columbia, MO). Project personnel conducted a pre- and post-survey of farming youth who participated in an agricultural safety and health blog. Users reported that the blog was a useful tool for discussing health and safety topics with other young farmers. Participants included farm youth in all nine GPCAH states. The blog had more than 2,700 views and 141 Facebook shares during a one-year period.

2. *Using community-based partnerships for grain safety awareness and prevention training across the grain handling spectrum* (J Adkisson, Grain and Feed Association of Illinois, Springfield, IL; R Aherin, University of Illinois, Champaign-Urbana, IL; P Rhomba, Illinois Farm Bureau, Bloomington-Normal, IL). The project developed and disseminated grain handling safety messages and trainings (printed, PSAs, wallet cards and decals), and supported the original construction of the Grain Handling Safety Coalition website (now one of the most popular grain safety information sources available on the web with sustained funding from over 15 organizational members). Public Service Announcements were aired on 70 Farm Bureau affiliate radio stations and were also disseminated through OSHA QuickTakes. Interviews of participants were incorporated into NPRs grain bin fatality story (Howard Berkes, Buried in Grain, 3/24/2013, see http://www.npr.org/2013/03/26/174828849/fines-slashed-in-grain-bin-entrapment-deaths). Community trainings reached 517 people (students, farmers, elevator employees, others). In 2015, the number of confirm grain bin fatalities fell to its lowest level nationwide in a decade (14 fatalities) and the Coalition is thriving independently.

3. *Prevention of injury, illness, and fatality due to grain entrapment and exposure* (D Neenan, National Education Center for Agricultural Safety, Peosta, IA). This project addressed the ongoing burden of grain entrapment deaths within the region by providing four interactive grain safety and rescue training events to over 350 farmers, grain industry employees, and rural volunteer rescue personnel. As a result of this program, there were 9 successful grain bin rescues performed by volunteer emergency response personal who had attended these trainings.

Year 2 (2012 –2013) – 20 submitted, 4 funded

4. *Using technology to enhance the flexibility, adaptability of training tools for community based training in grain handling safet*y (J Adkisson, Grain and Feed Association of Illinois, Springfield, IL; R Aherin, University of Illinois, Champaign-Urbana, IL; P Rhomba, Illinois Farm Bureau, Bloomington-Normal, IL). This project built on community partnerships with the development of training tools to promote grain handling safety. Special emphasis was given to designing a visual learning assessment tool to address low literacy participants (*e.g.*, photos and videos). The materials were assessed by experienced trainers and are now available to the public at www.grainsafety.org. The YouTube training videos created with funds allocated to this project have been viewed more than 21,000 times.

5. *Determining the mechanisms and outcomes of ATV crashes among high-risk groups in the Great Plains Region* (C Jennissen, G Denning, K Harland, University of Iowa, Dept. of Emergency Medicine, Iowa City, IA). This project compiled 1996-2012 Iowa FACE data and nine state press clipping data to identify factors associated with agricultural ATV/UTV crashes. Data were compiled for two academic publications, and results have led to further funding from the Kohls Foundation (*Kohls Cares)* for community ATV/UTV safety outreach activities.

6. *Genetic variation in endotoxin receptors and their association with COPD phenotypes* (T LeVan, J Merchant, & K Kelly, University of Iowa, Dept. of Occupational and Environmental Health, Iowa City, IA). Using stored blood samples of Keokuk County Rural Health Cohort participants, a nested case-control study examined the relationship between COPD and specific single nucleotide polymorphisms. A previously unknown association between COPD and HHIP polymorphisms rs13118928 and rs1542725 was observed. The results have been published in the academic literature.

7. *A tractor rollover detection and emergency reporting system* (A Bulent Koc, W Downs, University of Missouri, Columbia, MO). Project investigators developed the first rollover detection sensor system with a Bluetooth connection to iPhone/iPad. This technology was shared with the ASABE and resulted in two scholarly publications. Researchers provided demonstrations to more than 1600 individuals at events sponsored by ASABE, the Cattlemen's Association, Pork Producers Association, and the Missouri State Fair. More than 50 media stories covered these events. One of two academic papers resulting from this project also was awarded "Best Paper" recognition at the 2013 International Society for Agricultural Safety and Health Conference.

<u>Year 3 (2013 –2014) – 14 submitted, 4 funded</u>

8. *Piloting an occupational ATV/UTV safety workshop for Iowa farmers* (C Jennissen, G Denning, K Harland, University of Iowa, Department of Emergency Medicine, Iowa City, IA; A Winborn, Greater Johnson County Rural Health and Safety Clinic). This team developed and delivered a workshop on the safe use of ATVs/UTVs in agriculture, translating their findings from their 2012 pilot study to a local community. Post-workshop surveys found that 44% of attendees stated they were more likely to wear a helmet when using an ATV after attending the workshop.

9. *Promoting harness and lifeline use in grain bin entry for farm and elevator workers through development, training, and distribution of specific lifeline installation/procedures/use training curriculum* (R Aherin, University of Illinois, Champaign-Urbana, IL; D Hill, Emergency Services Rescue Training Inc., Penn State University, State College, PA). The investigators developed a safety harness and lifeline use curriculum for grain bin entry and pilot tested it among 25 farmers. Project investigators partnered with grain bin manufacturers and a farmer's cooperative to retrofit older grain bins. This collaboration has strongly influenced the new ASABE x624 Grain Bin Entry Design Standard.

10. *Evaluation of technology-based interventions to increase the use of hearing protection among adolescent farmworkers in Iowa (*K Khan, University of Iowa, Dept. of Occupational and Environmental Health, Iowa City, IA; A Winborn, Greater Johnson County Rural Health and Safety Clinic). Project investigators developed and delivered hearing protection (HP) training to 70 adolescent farmers and evaluated the impact of training mode (classroom, smartphone, computer-based) on prevention effectiveness. Knowledge and frequency of HP use increased across all three groups with greatest effects observed among the computer training groups. Future Farmers of America advisors continue to use this training.

11. *Effect of elevated carbon dioxide on lung inflammation in barn dust instilled mice* (D Schneberger, University of Nebraska Medical Center, Omaha, NE). The investigators tested co-exposures of mice to both barn dust extracts and an atmosphere with 5000 ppm CO_2. Although no changes were noted with CO_2 exposure in the absence of barn dust, the addition of CO_2 to barn dust was associated with an increase in inflammatory markers in comparison to barn dust alone. These results provide evidence that controlling CO_2 concentrations in swine barns may prevent respiratory inflammation among swine workers. These results led to an American Thoracic Society presentation, additional funding, and a peer-reviewed publication. The findings from this study were critical to communicating the need to protect swine producers from CO_2 in the Center's Intervention project that investigated controls to reduce exposures in swine production buildings.

Year 4 (2014 –2015) – 12 submitted, 4 funded

12. *Identifying agricultural behaviors of Iowa's young farmers* (J Rudolphi, University of Iowa, Dept of Occupational and Environmental Health – graduate student). An online survey was completed by 222 young farmers and showed that young female farmers reported safer work practices than young male farmers. In addition, the study found a strong link between workplace policies and safer work practices. This project supported J Rudolphi's PhD dissertation, and a manuscript is in development.

13. *Metagenomics and Staphylococcus aureus colonization in livestock workers* (Kates, A. University of Iowa, Dept. of Epidemiology, Iowa City, IA – graduate student). Study investigators are examining the nasal microbiome of 33 non-livestock and 26 livestock workers in order to compare those with *S. aureus* colonization to those without *S. aureus* colonization to identify risk factors for this outcome. All RNA sequencing and spa typing has been completed. Results showed that colonized livestock workers had significantly more Porphyomonas (P = 0.03) than non-colonized livestock workers, meaning that they are at increased risk for carriage of *S. aureus*. Interventions such as improving oral hygiene may lead to decreased carriage by reducing other bacterial species such as Porphyomonas. This project supported A Kates's PhD dissertation, and the findings have been published and are available for viewing on BioRxIV (DOI: https://doi.org/10.1101/145540).

14. *Family ATV safety training* (J Mortensen, North Dakota Farm Bureau, Bismark, ND). Two ATV safety classes were provided in rural North Dakota to 56 farm youth and one or both parents. During the training, parent focus groups identified several solutions for reducing ATV injuries among farm youth. Notable solutions included monitoring the ATV keys and keeping them out of children's reach, performing frequent safety checks, and purchasing helmets. The project also led to a radio PSA on ATV Safety Awareness (https://www.ndfb.org/news/atv-safety-awareness/).

15. *Safe Farming, Safe Living: Educational outreach to the Leut* (M Gale, K Lutjens, Avera St. Benedict Health Center, Parkston, SD). To address the large number of agriculture-related injuries in rural South Dakota, Avera St. Benedict Health Center personnel provided culturally appropriate agricultural safety and health training to ~500 residents of the Dakota Hutterite Colonies. Topics included eye protection, heat/cold illnesses, sun and water safety, large animal safety, PTO/Rollover prevention, and ATV safety. The investigators observed a 51% reduction in agriculture trauma-related incidents after the training, and the Hutterite community requested additional future safety trainings. The GPCAH Coordinator (Gibbs) and the Principal Investigator (Gale) co-authored an article titled "Safe Farming, Safe Living: Outreach to Hutterites in South Dakota" that was featured in the University of Iowa's *Insight Magazine* in the *Rural Health Information Hub*. In addition, the article was featured on the GPCAH website and was one of the most visited pages in 2016.

Year 5 (2015 –2017) – 17 submitted, 7 funded

16. *Occupational safety and health protection among migrant and seasonal farmworkers in Iowa (*A Johannes, University of Iowa, Dept. of Occupational and Environmental Health – graduate student). In collaboration with Proteus, Inc. (a nonprofit organization that provides healthcare to migrant farmworkers), study investigators examined injuries and illnesses, healthcare-seeking behavior, and use of prevention measures among 70 migrant and seasonal farmworkers. Less than 40% of survey respondents reported receiving information on any common health problem from their doctor, employer, or elsewhere. Participants requested more information on prevention, management, and treatment of these health concerns. These results have been shared with employers and Proteus staff. This project supported A Johannes's master's thesis.

17. *Grain bin safety and emergency prevention among farm families* (D Neenan, B Kruse, National Education Center for Agricultural Safety [NECAS], Peosta, IA; A Becker, University of Missouri, Columbia, MO). NECAS customized existing grain bin engulfment rescue training designed originally for emergency responders for delivery directly to farmers and farm families. The new training incorporated best practices and a unique hands-on engulfment and retrieval simulator. The training was delivered to more than 200 attendees at 12 locations in four states. The principal investigator, D Neenan, a was the recipient of the 2016 Agricultural Safety and Health Hall of Fame Award for his work, (which included

two GPCAH Pilot Grants) preventing injury and fatalities due to grain entrapments. Neenan was recognized during the Midwest Regional Agricultural Safety and Health Conference in Sioux Center, IA, and had a special feature in the GPCAH *Alive and Well* Newsletter.

18. *Noise induced hearing loss (NIHL) simulation and hearing protection device fit testing* (J Gibbs, M Cheyney, University of Iowa, Dept. of Occupational and Environmental Health, R Meschner, S Klemuk, University of Iowa, Dept. of Communication Sciences and Disorders/Audiology). This team (a) designed a NIHL simulator for use at outreach events and (b) examined how well hearing protection fits farmers (E-A-R fit™ validation test). Fit test data show most farmers achieved better personal attenuation using 'Push-In' style ear plugs than with formable foam style ear plugs despite the higher manufacturer-reported Noise Reduction Ratings for formable foam plugs. This study has led to two scientific publications— (one article on personal attenuation results has been submitted to the Journal of Occupational and Environmental Hygiene and another article evaluating the E-A-R fit™ validation test as an outreach method is currently being drafted), as well as recommendations for changes to hearing conservation recommendations among agricultural workers. Two posters for dissemination of agricultural safety and health information were developed with assistance from the University of Iowa Audiology Department and GPCAH Regional Advisory Committee members. These posters were shared with more than 110 agricultural educators across the region and are now available on the GPCAH website: http://www.public-health.uiowa.edu/gpcah/ag-educators-posters/. In order to better reach vulnerable populations, these posters have recently been translated into Spanish.

19. *Identifying job demands and health outcomes among Iowa beginning farmers* (M Ramaswamy, University of Iowa, Dept of Occupational and Environmental Health – graduate student). Study personnel estimated associations between (a) physical and psychosocial demands and (b) general and musculoskeletal health status and acute injury occurrences among 98 beginning farmers. Women and men differed significantly with respect to exposure to certain physical demands. Men reported higher exposure to holding powered equipment with hands (median [IQR]: 3.0[1.9-3.6], men; 2.0 [1.0-3.0], women) as well as using manual tools (median [IQR]: 3.6[3.0-5.0], men; 2.5 [1.0-3.2], women).Participants reported occurrence of musculoskeletal pain over the past 12 months, with 62% reporting pain in the neck/shoulder region, 45% in the elbow/hand/wrist region, and 69% in the low back region. The GPCAH Coordinator (Gibbs) and the Principal Investigator (Ramaswamy) co-authored an article titled "Pilot study looks at musculoskeletal symptoms among beginning farmers" that was featured in the GPCAH *Alive and Well* Newsletter.

20. *Increasing the use of hearing protection among young adult swine confinement workers*. (J Rudolphi, University of Iowa, Department of Occupational and Environmental Health – graduate student).This project examined safe behavior (hearing protection use) and differences between 72 young study adult swine production workers who used smart-phone tracking with and without daily goals for hearing protection use. After completing the baseline survey, all participants were mailed hearing protection kits. Instructions for downloading and using a smartphone app to log behaviors was sent to participants in the two intervention groups. The greatest increase in reported hearing protection use was in the intervention *with* goal group, who reported a mean use increase of 47%. The intervention *without* goal group reported a mean increase of 42% and the control group reported a mean increase of 32%. This project supported J Rudolphi's PhD dissertation, and a manuscript is in development.

21. *Characterization of occupational inhalation exposure among poultry workers during the highly pathogenic avian influenza (H5N2) outbreak in the Midwest.* (K O'Brien, University of Iowa, Department of Occupational and Environmental Health, post-doc). The emerging H5N2 highly pathogenic avian influenza A (HPAI) outbreak in the United States has caused severe economic loss among turkey and laying hen farmers in the Midwest. Previous HPAI epidemics, the Hong Kong/1997H5N1 HPAI and The Netherlands/2003 H7N7 HPAI, reported human infections were the most prevalent among workers performing culling and disposing of infected birds. However, the route of zoonotic transmission is not well understood. This pilot project initially aimed to characterize the inhalation exposure of aerosolized HPAI, ammonia, and organic poultry dust among turkey workers handling the aftermath of the HPAI outbreak. However, during the project, recruitment efforts by investigators to obtain turkey farmer

participants through AgriSafe Network, the Iowa Turkey Federation, and the Minnesota Turkey Growers Association were unsuccessful. Therefore, the project was ended and the budget was re-applied to other pilot grant applicants in 2016-2017.

22. *Safe Farming, Safe Living: CPR outreach to the Leut* (M Gale, Avera St. Benedict Health Center, Parkston, SD). This program presented certification-level educational information and outreach to eight Hutterite colonies (400 individuals) in South Dakota in order to improve health outcomes of farm-related injuries. Content focused on preparing for emergencies (*e.g.*, calls to responders), cardiopulmonary resuscitation (CPR), automated external defibrillator (AED) use, and basic first aid. One hundred twenty six individuals were officially trained in Adult First Aid/CPR/AED (US Red Cross). Farm youth were also trained on how to perform basic first aid and to contact local emergency response personnel. Overall, post survey data demonstrated that colony members felt confident that they could perform CPR, use an AED, and perform first aid in the field. A YouTube training video describing contents of a farm emergency response kit has also been generated.

23. *Gove County farm safety and health fairs: ATV safety, emergency response, and educational displays to prevent agricultural injury and fatality in Northwest Kansas* (C Nelson, Gove County Medical Center, KS). Study personnel collaborated with multiple stakeholders to design a Farm Safety and Health Fair for farm families in Gove County, Kansas, a rural agricultural community. More than 40 farm children and 35 adults attended the event. The project increased safety awareness about ATV use, handling grain and farm chemicals, and dangers associated with common harvesting activities. Fifteen children were awarded ATV helmets for participating in training activities. The fair also focused on knowledge of basic first aid/emergency response to help farm families respond quickly and effectively to reduce fatality rates. This training is particularly responsive to the community since, in Western Kansas, a large proportion of farmers live 30 or more miles from a Critical Access Hospital.

GPCAH Research Core

Farm Equipment Crash Study (Project A)

Musculoskeletal Disorders among Farmers (Project B)

GPCAH Research Core

PIs: Marizen Ramirez (mramirez@umn.edu), Nathan Fethke (Nathan-fethke@uiowa.edu)

Description

The GPCAH Research Core consisted of two projects: the Farm Equipment Crash Study (Project A) and the Musculoskeletal Disorders among Farmers (Project B). These research projects were hypothesis driven and focused on improving our understanding of agricultural health and safety, specifically to identify risk factors associated with farm equipment crashes on roadways and ergonomic risk factors associated with both farming tasks and demographic factors. These projects provided information necessary to develop effective interventions to prevent traumatic injuries from crashes and acute and chronic health conditions associated with musculoskeletal disorders (MSDs) of the low back, neck/shoulder, and upper extremities. The scope of these projects identifies risk factors of critical exposures to GPCAH agricultural workers, where similarities in tractor use for both commodity crops and livestock dominate the rural roadways and where farming tools, equipment, and practices for producing the region's main commodities may be similar throughout the nine state region. The impact of the findings of these projects are relevant nationally, where findings may also drive interventions across a broader population who use similar equipment to that used in our region.

Farm Equipment Crash Study - Activities

The Farm Equipment Crash study involved analysis of public roadway crash data from 2005-2010 from nine Departments of Transportation, road segment data available from the Environmental Health Sciences Research Institute, and regulatory statutes on lighting and marking of farm equipment on public roads from legislative databases and LexisNexis. In 2014, a cross-sectional survey was conducted with a stratified random sample of farm operators from the nine-state region in collaboration with the US Department of Agriculture's National Agricultural Statistical Service. The survey collected data on lighting and marking behaviors, miles driven, near misses, and crashes. Geographic Information Systems was used to map the location of crashes onto roadway segments across the region. Multiple statistical approaches were used to identify potential risk factors and to evaluate the impact of lighting and marking policies.

Significant findings from this study, along with activities associated with each conclusion, are summarized by the following:

Key Finding 1: Lighting and marking policies are associated with reduced farm equipment roadway crashes (Ramirez et al., 2016). To evaluate the effectiveness of laws regulating lighting and marking of farm equipment operated on public roadways in the nine GPCAH states, we conducted an ecologic study to assess the relationship between the comprehensiveness of the regulatory statutes/administrative codes and state farm vehicle crash rates. Each state policy was coded according to guidelines offered by the American Society of Agricultural and Biological Engineers (ASABE) for a lighting score, marking score and combined lighting/marking score. The higher the score, the more compliant the state policy is with ASABE guidelines. Crash data involving farm equipment were collected from nine State Departments of Transportation. We identified that as the state lighting and marking score increased by 5 units, crash rates reduced by 17%.

Key Finding 2: Crashes with agricultural equipment are unexpectedly common in urban areas and near towns and cities (Harland, et al., 2014). We examined differences between agricultural equipment-related crashes by their urban–rural location and distance from a town center. Agricultural equipment crashes were collected from nine Midwest Departments of Transportation (2005–2008). Of 4444 crashes involving agricultural equipment, 30% crashes occurred in urban zip codes. Urban crashes were more likely to be non-collisions, involve 2 or more vehicles, and occur in a town or within one mile of a town compared with rural crashes. Small rural crashes, compared to isolated rural crashes, were twice as likely to be non-collisions. In urban settings, crashes occurred, on average, approximately two miles from a town; in small, large and isolated rural settings, crashes occurred slighted further from a town center (average ranged from 2.37 to 2.85 miles).

Key Finding 3: Roadways with higher traffic volume, higher posted speed limits, narrower roads, decreased sinuosity, and decreased gradient have ***increased*** *crash risk (Greenan et al., 2016; Ranapurwala et al.,* *2016).* Using Geographic Information Systems, we geocoded the location of crashes and characterized the roadway characteristics where these crashes occurred. In an analysis of Iowa crash data, we found that increased traffic volume, posted speed limits, and smaller roadway widths were all significantly associated with the occurrence of farm equipment crashes. In an analysis expanded to all nine states, increased roadway sinuosity (curvature) and increased gradients (hills) were interestingly associated with *reduced crash rates*.

Key Finding 4: About 6% of farm equipment crashes involve youth, and their injury and crash patterns can inform intervention efforts (Touissant, et al. 2017). Six percent of farm crashes in the Midwest involve a youth occupant or operator. Sixty-six percent of these crashes had a child driver only, while 30% had an adult driver with a child occupant. Youth *passengers* had a 4.1 higher odds of injury than youth *operators*. Occupants who used restraints had significantly lower odds of injury than those who did not. Injuries to youth occupants were more likely in non-collision crashes.

Musculoskeletal Disorders among Farmers - Activities

The MSD study included recruiting 518 farmers throughout all nine states served by the GPCAH. Participants completed questionnaires at baseline and every six months for up to 3.5 years. The questionnaires collected information about demographic factors, farm operation characteristics, occupational psychosocial stress, and musculoskeletal symptom status during each of the prior two seasons. Participants also reported, for each of the two seasons prior to receiving each survey, the average number of weekly hours engaged in a set of common agricultural activities. On-farm measurements of exposure to physical risk factors were obtained among a subsample (n=55) of participants. Measured exposure data were combined with self-reported average weekly hours data to construct, for the full cohort, seasonal time-weighted averages of exposure. Descriptive statistics included the prevalence of musculoskeletal symptoms by season across the full study duration and distributions of measured exposure data by agricultural activity. Generalized linear models were used to estimate associations between seasonal time-weighted average exposures and the prevalence of musculoskeletal symptoms while controlling for confounding.

Significant findings from this study are summarized below. Many findings are important not only to MSD studies but to the broader understanding of work patterns of farmers throughout the GPCAH region.

Key Finding 1: The seasonal prevalence of MSD symptoms were identified as:

- Low back: 26.6% to 48%, with a significant decrease in winter
- Neck/Shoulder: 23.1% to 32.8%, with an increased prevalence in the summer compared to winter
- Distal upper extremity: 17.1% to 24.8%, with no seasonal differences.

Key Finding 2: Differences in the number of hours engaged per week in common agricultural activities was fairly consistent across seasons, with the exception of *field work with a vehicle*, *handling/storing harvested crop,* and *feeding animals*. When examining the total number of hours per week engaged in any agricultural activity, multivariable models identified small but statistically significant associations between the *total weekly hours* spent engaged in agricultural activities and *low back symptoms* (OR 1.004, 95% CI 1.002-1.007), *neck/shoulder symptoms* (OR 1.004, 95% CI 1.002-1.007), and *distal upper extremity symptoms* (OR 1.005, 95% CI 1.002-1.008). The odds ratio (using the low back model as an example) is interpreted as a 0.4% increase in the odds of reporting symptoms *for each one-hour increase in the total weekly hours engaged in agricultural activities*. This finding may be useful to provide recommendations to administratively control exposures (*e.g.*, work-rest recommendations) that can be useful for rural medical provider interventions.

Key Finding 3: Whole body vibration levels varied by equipment type, with combines significantly lower than all other vehicle types. The association between the total frequency-weighted acceleration (our primary metric of whole-body vibration exposure) and low back symptoms was statistically significant (OR 1.08, 95% CI 1.03-1.14). The odds ratio is interpreted as an 8% increase in the odds of reporting low back symptoms for each one unit increase in total frequency-weighted acceleration (in m/s^2). Aside from combine seats, the seats in many agricultural vehicles performed poorly with respect to reducing exposure to whole-body vibration. Operators are encouraged to understand the functionality of available seat suspension systems to ensure proper adjustment, to regularly inspect the seat suspension system for defects, and to repair/replace defective seat suspension components.

Outputs and Outcomes

The Farm Equipment Crash Study is the first scientific evaluation of lighting and marking policies on safety outcomes. We found strong evidence of effectiveness – that lighting and marking policies that align with American Society of Agricultural and Biological Engineers (ASABE) guidelines are associated with reduced crashes. In June of 2016, a new national rule on lighting and marking of agricultural equipment (49 CFR 562) was enacted, based on these ASABE guidelines. While compliance to these guidelines is mandatory for new agricultural equipment that may be operated on public roads, this study recommends that older equipment should be upgraded to conform to these guidelines to maximize the potential reduction of farm vehicle crashes. To support the actual implementation of these policies at the individual-level, we have further engaged in purposeful outreach activities with Departments of Transportation and local farmers, through print, radio, social media, and farm shows. Our outreach products have also included details of roadway, crash, and behaviors that increase the risk of crashing with farm equipment on the roadway and their subsequent injuries.

Specific outputs are detailed in the project summary report that follows. The Farm Crash project produced five peer-reviewed publications and 17 presentations, supported one MS thesis, and was integrated into six academic lectures. Investigators provided consultation on this topic to four entities and provided information to policy makers on 10 occasions, including Department of Transportation representatives, federal legislators, and state congressional delegations.

The Musculoskeletal Disorders among Farmers Study provides the largest epidemiologic musculoskeletal symptoms study among farmers, uniquely combining symptom surveys of 518 agricultural workers with measurements of physical risk factors among a subgroup of 55 of these participants. This study has improved our understanding of the prevalence of MSD symptoms for this diverse workforce, quantifying seasonal differences in low back and neck/shoulder symptoms. It contributed to an understanding of workload across seasons, identifying relatively consistent self-reported average weekly hours (by season) for multiple common agricultural activities, with the exception of *field work with a vehicle* and, to a lesser extent, *handling/storing harvested crop* and *feeding animals*. While few measures of risk factors were associated with MSD symptoms, a statistically significant association was observed between total frequency-weighted acceleration (our primary metric of whole-body vibration exposure) and low back symptoms (OR 1.08, 95% CI 1.03-1.14). Small but statistically significant associations were also observed between the total weekly hours spent engaged in agricultural activities and low back symptoms (0.4% increased odds of symptom per additional hour per week worked), neck/shoulder symptoms (0.4%), and distal upper extremity symptoms (0.5%). While methodological issues, including a highly selected study sample and a high degree of variability in the tools, machinery, and methods used to accomplish agricultural tasks, may have resulted in underestimates of associations between exposure to physical risk factors and musculoskeletal outcomes, the whole body vibration data (112 field measures) identified a strong relationship to health outcomes. We found a significant relationship between whole-body vibration and the experience of low back musculoskeletal symptoms among agricultural workers.

Specific outputs for this project are detailed in the project summary report that follows. The project produced five peer-reviewed publications, with additional manuscripts under review. This project supported two doctoral theses, with intermediate findings presented at eight conferences. The GPCAH has developed educational and display materials to communicate both explain whole body vibration and to identify its risk to low back symptoms. These products are now informing farmers and equipment manufacturers/dealers about these risks and should improve retrofitting of current and designing of future farm vehicles.

Cumulative Enrollment Tables

The Farm Equipment Crash Study was determined to not include human subjects and has no study enrollment to report. The Musculoskeletal Disorders among Farmers study enrolled 518 participants, with enrollment tables included in that project summary, to follow.

Farm Equipment Crash Study (Research Project A)

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Abstract

Each year, approximately 1100 crashes involving farm equipment occur on public roads across nine Midwest states (IA, IL, KS, ND, SD, MN, MO, NE, WI). Prevention efforts require an understanding of the patterns of these crashes to identify effective interventions to reduce crash risks. The goals of this project were to: 1) identify individual, crash, vehicle, and environmental risk factors for crashes involving farm equipment and subsequent injuries, 2) using Geographic Information Systems, identify high frequency locations for these crashes and roadway factors that are associated with crashes, and 3) determine the effectiveness of marking and lighting policies on the reduction of crashes. This project involved analysis of secondary data sources including public roadway crashes from 2005-2010 from nine Departments of Transportation, road segment data available from the Environmental Health Sciences Research Institute, and regulatory statutes on lighting and marking of farm equipment on public roads from legislative databases and LexisNexis. In 2014, a cross-sectional survey was conducted with a stratified random sample of farm operators from the nine-state region in collaboration with the US Department of Agriculture's National Agricultural Statistical Service. The survey collected data on lighting and marking behaviors, miles driven, near misses, and crashes. Geographic Information Systems was used to map the location of crashes onto roadway segments across the region. Multiple statistical approaches were used to identify potential risk factors and to evaluate the impact of lighting and marking policies. ***The following trends were identified in this study:***

- About 30% of crashes involving farm equipment occur in urban zip codes. Compared to rural crashes, urban crashes were more likely to be non-collisions, involve two or more vehicles, involve three or more vehicles, and occur in a town and within one mile of a town.
- Higher traffic volume, higher posted speed limits, farm-to-market roads, and smaller road widths were associated with increased occurrence of farm equipment crashes.
- Roads with increased gradient and sinuosity had fewer farm crashes.
- Youth riding or operating farm equipment have unique crash characteristics. Young passengers had a 4.1 higher odds of injury than operators. Occupants who used restraints had significantly lower odds of injury than those who did not. Youth occupants on farm equipment that was rear-ended or sideswiped had significantly lower odds of injury compared to occupants on farm equipment involved in non-collision crashes.
- Increased conformance of state lighting and marking policies to national agricultural engineering recommendations were associated with reduced crash rates. As the state lighting and marking score increased by 5 units, crash rates reduced by 17% (rate ratio=0.83; 95% CI: 0.78 to 0.88).

To translate findings to stakeholders, a number of outreach products such as radio Public Service Announcements, videos, outreach displays, one-page fliers/handouts, and newspaper and media reports were created and disseminated widely to various audiences through fairs, radio, social media, and traditional print media.

Background

Rural roads have been a persistent occupational threat to the safety of farmers across the Midwestern U.S. From 2005-2008, over 1100 motor vehicles crashed with farm equipment each year were reported in nine Midwestern States (IL, IA, KS, MN, MO, NE, ND, SD, WI), with operators or passengers of the farm equipment/vehicle accounting for 42% of all deaths. Increasing urbanization of rural farming communities has brought farms and population centers into closer geographic proximity, leading to increased interaction on the roadways between farm equipment and passenger vehicles. This occurs primarily on rural roads, which pose unique crash hazards such as being unpaved, two-lane, without traffic control devices, and with poor enforcement of speed. Legislation specific to farm equipment exists, but varies widely across the U.S. Thus, the project goal was to identify risk factors and rates of crashes between farm and other vehicles on roadways throughout the GPCAH region.

Specific Aims

The aims of **Farm Equipment Roadway Crashes: Identification of Risk Factors and Evaluation of Policies** were: 1) identify individual, crash, vehicle, and environmental risk factors for crashes involving farm equipment and subsequent injuries, 2) using Geographic Information Systems, identify high frequency locations for these crashes and roadway factors are that are associated with crashes, and 3) determine the effectiveness of marking and lighting policies on the reduction of crashes.

Methods

These aims were addressed using surveillance data of crashes from nine state Departments of Transportation (Iowa, Illinois, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin) for years 2005 through 2014; by evaluating state regulatory policies on lighting and marking and comparing them to ASABE guidelines; and by implementing a cross-sectional survey of 3600 farm operators from the nine-state region in collaboration with the US Department of Agriculture's National Agricultural Statistical Service. A total of 1768 farm operators responded, and 1667 completed the survey.

Findings

From 2005 to 2010, 7083 crashes involving farm equipment were reported in the nine study states. Average annual crash rates ranged from a low of 85.5 per 100,000 farm operations for ND to a high of 221.7 per 100,000 farm operations for IL. Rates and relative rankings remained relatively steady by year, although NE had a spike in 2009.

Rural-Urban Crash Site Analysis: A total of 4444 crashes were analyzed from 2005-2008, with crashes distributed in both urban and rural parts of the Midwest. Isolated rural zip codes had the highest proportion of crashes (31.6%) followed by urban (30.2%), small rural (19.6%), and large rural (18.7%) zip codes. Characteristics of agricultural equipment crashes also differed by degree of rurality. Crashes were more likely to occur in ***large rural*** (22.7%) than small (17.1%) and isolated (11.5%) rural zip codes ($P < 0.001$). After controlling for covariates, non-collisions (*e.g.*, ran off road) had double the odds of occurring in small as compared to isolated rural zip codes (aOR = 2.03 [1.32–3.14]) compared to rear-end crashes, but no differences in the manner of collision between large and isolated rural zip codes were found. Crashes involving *increasing numbers of vehicles* were more likely to occur in ***small and large rural zip codes*** than in isolated zip codes. Compared to single vehicle crashes, crashes with two vehicles (large rural, aOR = 1.59 [0.99–3.03], small rural, aOR = 1.95 [1.25–3.03]) and crashes with three or more vehicles had increased odds (large rural, aOR = 2.30 [1.04–5.11], small rural, aOR = 3.16 [1.49–6.69]) of occurring in large and small rural settings than in isolated rural areas. Crashes occurring ***within a town*** had 2.4 (95% CI: 1.85–3.11) times the odds of occurring in large rural zip codes than an isolated rural zip code

Effects of Roadway Characteristics on Iowa Crashes: Iowa crash data were analyzed by road segment data using GIS coordinates provided in sheriff crash records. A total of 1371 Iowa farm equipment crashes were reported from 2005 to 2011, and these occurred on 1337 road segments, less than one percent of Iowa's 319,705 road segments. Road segments with ***traffic volume*** of 361–1250 or 1251 or more vehicles per day had 7.43 (95% CI: 5.90–9.34) or 7.00 (95% CI: 5.38–8.85) times the odds of having a farm equipment crash compared to road segments with traffic volume of 30 or less vehicles per day, respectively. Road segments with ***posted speed limits*** in the 50–60 mph category had eight times the odds of a crash compared with road segments with less than 35 mph speed limits (95% CI: 6.59–9.84). The ***route type*** was also significantly associated with crash frequencies: US routes (OR = 4.86, 95% CI: 3.99–5.91), Iowa routes (OR = 5.98, 95% CI: 4.97–7.20), and farm to market routes (OR = 4.67, 95% CI: 4.11–5.32) had higher odds of farm equipment crashes compared to local routes, respectively. For every five-foot increase in ***roadway width***, the odds of a crash decreased by 10% (OR = 0.90, CI: 0.86–0.94). For every five-foot increase in shoulder width, the odds of a crash decreased by 6% (OR = 0.94, CI: 0.89–1.00). However, this estimate was marginally statistically significant.

A GIS-Based Matched Case–Control Study of Road Characteristics in Farm Vehicle Crashes: There were 6,491,811 road segments, and 7,094 farm crashes in the nine states from 2005 to 2010 for this analysis. After geocoding these crashes, there were 6,723 road segments with crashes, 93 of these had two crashes each, three road segments had three crashes each, and four road segments had four crashes each. Hence, overall there were 6,848 cases, representing 0.1% of all available road segments. We found 6,808 matched control road segments for 6,848 case segments while conducting 1:1 matching by ZIP code, road type, and segment length. When a control segment was selected based on its connectedness to the case segment, a total of 24,390 control road segments were matched to 6,848 cases, ranging from 1 to 17 controls per case (median = 5). Adjusted ORs from the matched analyses suggested a potential dose–response relationship such that increases in gradient and sinuosity were associated with lower odds of crashes. Relative to a flat road segment (with less than 1% gradient), the adjusted OR of farm crashes on a road segment with more than 10% gradient was 0.60 (95% CI: 0.49, 0.75) in the 1:1 matched analysis, and was 0.75 (95% CI: 0.61, 0.92) in the 1:*n* matched analysis. Similarly, compared with a straight road (<1% deviation), the adjusted OR of farm crashes on a road segment with 6%–10% deviation was 0.38 (95% CI: 0.29, 0.52) in the 1:1 matched analysis, and was 0.76 (0.56, 1.01) in the 1:*n* matched analysis. *Even though the variation in the effect size is large, all the analyses suggest a common interpretation that fewer crashes occurred on graded and sinuous roads than flat and straight roads*

Characteristics of Farm Equipment-Related Crashes Associated with Injury in Children and Adolescents on Farm Equipment: Of the 7,085 farm equipment-related crashes identified across the nine Midwestern states from 2005 to 2010, ***434 (6.1%) involved child or adolescent occupants*** (505 children) on farm equipment. The proportion of crashes occurring in each state that involved youth occupants on farm equipment ranged from 3% to 12%. The number of crashes was consistent across the 5-year period. The most frequent youth occupant configuration was ***child driver only*** (66%) followed by adult driver and child passenger (30%). The least frequent configuration was child driver and child passenger at 4%. A substantial proportion of farm equipment-related crashes occurred during ***clear weather*** (79%), during the ***growing season*** (42%), at ***daylight*** (78%), or while the farm equipment was ***traveling straight*** (51%). Almost half of all impacts occurred at an ***angle or sideswiped*** (49%) followed by rear-ended (21%) and non-collisions (15%). *Passengers of farm equipment* had a 4.10 (95% CI: 1.88-8.94) higher odds of experiencing an injury compared to *drivers of farm equipment*. We also observed an insignificantly increased odds of injury in youth occupants 12-14 years old compared to those 15-17 years old (1.30, 95% CI: 0.60-2.81). If *restraints were used*, adjusted odds ratios demonstrated significantly lower odds of injury compared to those who did not use restraints (OR = 0.12, 95% CI: 0.03-0.40). Occupants of farm equipment that were *rear-ended* (OR = 0.26, 95% CI: 0.11-0.59) or *impacted by sideswipe or at an angle* (OR = 0.07, 95% CI: 0.03-0.18) had significantly *lower odds of experiencing an injury* compared to youth occupants involved in non-collision crashes. Occupants on farm equipment *turning left or right had significantly lower odds of injury* compared to occupants on farm equipment moving straight (OR = 0.42, 95% CI: 0.18-0.95).

Lighting and Marking Policy Analysis of Nine Midwestern US States: Conformance scores for state policies to the ASABE standard were assigned, ranging from 12 in MO to 69 in IL, with the remaining seven states ranging from 36 to 62. With the exception of SD, state laws were more conforming to lighting recommendations than with marking recommendations. IL (score=73), KA (score=62) and ND (score=58) were the most compliant to ASABE lighting standards. All nine states were conformed to ASABE standards for red taillights, but only one state (IL) required turn signals for new equipment manufactured since 2003. Conformance to marking standards was comparatively lower, although all states fully or partially required slow moving vehicle emblems. Only one state (IL) conformed to ASABE's standard size of reflectors, but only for new equipment. The GEE negative-binomial model estimates measure the impact that a five-unit increase in the policy score would have on the crash rate. A five-point increase in the combined lighting and marking score (rate ratio 0.83; 95% CI 0.78 to 0.88), in the lighting sub-score (rate ratio 0.48; 95% CI 0.45 to 0.51), and in the marking sub-score (rate ratio 0.89; 95% CI 0.83 to 0.96) were associated with 17%, 52% and 11% reduced crash rates, respectively. To put these findings in perspective, we estimated the expected decrease in the number of farm equipment crashes for each state if that state increased its combined lighting and marking score by 25 units, which represents approximately a 25% improvement in conformance in the entire sample. For example, WI could expect an annual average decrease from 164 to 65 crashes per year.

Conclusions and Impact

Farm equipment crashes occur in urban and rural locations; hence, *additional education is needed* for all drivers, both farm operators as well as non-farming residents, to improve the risk awareness of crashes involving farm equipment. Across both rural and urban settings, crashes occurred, on average, approximately two miles from a town. These findings support the notion that agricultural operators are exposed to hazards in both rural and urban locations, as they traverse both rural and urban roadways delivering commodities to markets primarily located near population centers.

Increased traffic volume, reduced road width, roads with 50-60 mph posted speed limits, and specific road types (farm to market roads) increase the risk of a farm vehicle crash. As the *annual average number of vehicles traveled on a road per day increased, the risk of farm equipment crashes also increased*. This suggests that when a piece of farm equipment is on the road with a greater number of vehicles, the increased volume leads to a greater chance of being involved in a crash. *Wider lane and shoulder width* were also protective factors in this analysis, with a five foot increase in road width or shoulder width associated with a 10% or 6% decrease risk of crashing, respectively. *Road type* was also a significant contributor to farm equipment crashes. Farm to market, Iowa and US routes had higher risk of a crash, while interstate roads had the lowest risk. The increased risk observed could be indicative of the increased presence of farm equipment on these types of roads compared with other roads. The inverse may explain the lower risk of farm equipment crashes observed on interstates compared to local routes. Finally, our study also found that roadways with *posted speed limits in the 50–60 mph category were at greater risk for farm equipment crashes*. Motorists driving at higher speeds have less time to react to a slow-moving vehicle, creating significant challenges for approaching vehicles due to the rate of approach.

However, increased sinuosity and gradient of road segments were associated with a *reduced risk* of crashes involving farm vehicles. Contrary to popular belief, this study identified that road segments with greater sinuosity and gradient had *fewer* farm vehicle crashes than straight and flat roads. Interventions like curve and grade signs or pavement reflectors on road might effectively improve driving behavior and reducing the risk of crashes.

Youth are involved in farm equipment crashes in the Midwest. Efforts to reduce their exposure, particularly as passengers on farm equipment is critical. Youth passengers had more than four times the odds of being injured compared to youth drivers, given a crash.

Our study is the first to provide evidence that increased conformance to ASABE standards on lighting and marking of farm equipment is associated with reduced crash rates. Our study provide empirical evidence that state regulations with increased conformance to ASABE standards on lighting and marking of farm equipment is associated with reduced crash rates. The national rule on lighting and marking of agricultural equipment (49 CFR 562), passed on June 22, 2016 and enforceable as of June 22, 2017 now requires national conformance to ASABE recommendations for all new agricultural equipment that may be operated on a public road. Older vehicles should also be upgraded to meet these guidelines.

Outputs and Outcomes

Publications – Peer Reviewed

1. Toussaint M, Smith K, Peek-Asa C, Ramirez MR: [2017] Characteristics of farm equipment-related crashes associated with injury in children and adolescents on farm equipment. *The Journal of Rural Health.* 33:127-134. *[PMID: 26633235]*
2. Greenan M, Toussaint M, Peek-Asa C, Rohlman D, Ramirez MR: [2017] The effects of roadway characteristics on farm equipment crashes: a geographic information systems approach. *Injury Epidemiology.* 3(31):1-7. *[PMC5167682]*
3. Ranapurwala SI, Mello ER, Ramirez MR: [2016] A GIS-based matched case-control study of road characteristics in farm vehicle crashes. *Epidemiology.* 27(6):827-834. *[PMID: 27468005]*
4. Ramirez M, Bedford R, Wu H, Harland K, Cavanaugh JE, Peek-Asa C: [2016] Lighting and marking policies are associated with reduced farm equipment-related crash rates: a policy analysis of nine Midwestern US states. *Occup Environ Med*. 73:621–626. *[PMID: 27405602]*

5. Harland KK, Greenan M, Ramirez M: [2014] Not just a rural occurrence: Differences in agricultural equipment crash characteristics by rural-urban crash site and proximity to town. *Accident Analysis and Prevention.* 70:8-13. *[PMID 24686161]*

Presentations

1. Ramirez M, Harland K: [2017] Get out of my space. When machines meet the road: farm equipment crashes on public highways. Ag Safety Awareness Week webinar, sponsored by American Farm Bureau Federation and the US Agricultural Safety and Health Centers.
2. Gibbs G, Smith K, Cheyney M, Ramirez M: [2016] Distributing best practices for lighting and marking farm equipment: GPCAH farm equipment crash study. Midwest Rural Agricultural Safety and Health Conference, Sioux Center, IA.
3. Ranapurwala, Mello, Ramirez: [2015] Road segment characteristics and the incidence of farm vehicle-related crashes: A GIS based multistate matched case-control study. Society for Epidemiologic Research annual meeting, Denver, CO.
4. Frederick M, Young T, Ramirez M: [2014] Occupant and Environmental Characteristics of Farm Equipment Crashes Associated with Injury among Children and adolescents. ISASH, Omaha NE.
5. Ramirez M, Bedford R, Harland K, Cavanaugh J, Peek-Asa C: [2014] Do Policies for lighting and marking of Farm Equipment on the Roadway reduce crash risk. International Society Agricultural Safety and Health, Omaha NE.
6. Ramirez M, Young T, Harland K, Wu H, Lundell J, Peek-Asa C: [2014] Epidemiology of Farm Equipment Crashes in Nine Midwest States. International Society Agricultural Safety and Health, Omaha NE.
7. Harland KK, Ramirez MR: [2014] Prevalence of Alcohol Testing and Impairment in On-road Farm Equipment-Related Crashes (Oral); 40th Annual International Traffic Records Forum; St. Louis, MO.
8. Ranapurwala SI, Mello E, Ramirez MR: [2014] Effect of road characteristics on the incidence of farm vehicle-relate crashes; 40th Annual International Traffic Records Forum, St. Louis, MO.
9. Toussaint M, Smith K, Ramirez MR: [2014] Characteristics of farm equipment crashes involving youth occupants; 40th Annual International Traffic Records Forum; St. Louis, MO.
10. Young T, Ranapurwala SI, Ramirez MR: [2014] Epidemiology of farm equipment crashes in nine Midwestern states. 40th Annual International Traffic Records Forum (Oral); St. Louis, MO.
11. Ranapurwala, Mello, Ramirez: [2014] Effect of road characteristics on the incidence of farm vehicle-relate crashes. 142nd Annual American Public Health Association Conference; New Orleans, LA.
12. Greenan M, Harland K, Ramirez M: [2014] Utilizing GIS to examine roadway features that may increase the risk of farm vehicle traffic crashes in the state of Iowa. International Society Agricultural Safety and Health, Omaha NE.
13. Greenan M, Harland K, Ramirez M: [2014] Utilizing GIS to examine roadway features that may increase the risk of farm vehicle traffic crashes in the state of Iowa. Midwest Rural Agricultural Safety and Health Conference, Ames, IA.
14. Ramirez M: [2013] Farm lighting policy and frequency of crashes. 2013 National Meeting of the Safe States Alliance and the Society for Advancement of Violence and Injury Research. Baltimore, MD.
15. Harland K, Greenan M, Ramirez M: [2013] Increased risk of farm equipment crashes within urban incorporated places and during the agricultural off-season. 2013 National Meeting of SAVIR, Safe States, and CDC. Baltimore, MD.
16. Harland K, Greenan M, Ramirez M: [2013] Increased Risk of Farm Equipment crashes within urban incorporated places during the agricultural off-season. International Society Agricultural Safety and Health, Sandusky, OH.
17. Ramirez M, Greenan M: [2012] Farm Equipment on the Roadway. Midwest Rural Agricultural Safety and Health Conference, Cedar Rapids, IA.

Dissertations/Thesis

1. Greenan M: [2014] The effects of roadway characteristics on farm equipment crashes: a GIS approach. MS (Master of Science), Department of Occupational and Environmental Health, College of Public Health, University of Iowa. http://ir.uiowa.edu/etd/1460/

Lectures or Seminars

1. Ranapurwala S: [2015] “Causal inference and directed acyclic graphs” to 9 students in the Occupational Injury class. (n=1 lecture)
2. Ramirez M: [2014] “Agricultural Safety and Health” to 11 graduate students in the Epidemiology of Occupational Injuries course. (n=12 lectures)
3. Ranapurwala S: [2014] “Directed Acyclic Graphs: why and how?” to 40 students and 10 faculty in the Epidemiology Seminar. (n= 1 lecture)
4. Ramirez M: [2013] Injury Epidemiology Course delivered to graduate students in Public Health. (n=1 lecture)
5. Ramirez M: [2013] “9-state Partnership” to graduate students in the UI Iowa Prevention Research Center.
6. Ramirez M: [2012] Lecture: “Farm equipment roadway crashes” delivered to NADS investigators and investigators from Marshfield, Queens University, and University of Alabama (n=1 lecture).

Consultation or Information Exchange

1. Ramirez M: [2014] Consult with State Traffic Records committee, Department of Transportation about crashes on rural roads.
2. Ramirez M: [2013] Consultation: with DOT partners about meeting at Ag Summit to share results and get feedback on issues.
3. Ramirez M: [2013] Information sharing: Rural Road Safety and Crash Data for Dubuque County Iowa with Dubuque County Health Department and IBM.
4. Ramirez M: [2013] Consult with John Deere, State Traffic Records committee, and Agricultural Equipment Manufacturers members about Farm Equipment.

Information Provided for Policy Makers

1. Ramirez M: [2014] Farm Crash data presented to the members of the Iowa congressional delegation.
2. Ranapurwala S: [2014] Road characteristics and incidence of farm vehicle crashes. Given to 30 members of the State Traffic Records coordinating committee
3. Ramirez M: [2014] Farm vehicle-related crash study in nine states: 2005 – 2010. Given to 18 Representatives of Departments of Transportation (DOT) of Iowa, Kansas, North Dakota, Nebraska, Minnesota, and Missouri.
4. Ramirez M: [2014] Epidemiology of farm equipment crashes in nine Midwestern states. Given to 18 Representatives of Departments of Transportation (DOT) of Iowa, Kansas, North Dakota, Nebraska, Minnesota, and Missouri.
5. Ramirez M: [2014] Characteristics of farm equipment crashes involving youth occupants: One pager. Given to 18 Representatives of Departments of Transportation (DOT) of Iowa, Kansas, North Dakota, Nebraska, Minnesota, and Missouri.
6. Ramirez M: [2014] Lighting and marking legislation to prevent farm equipment crashes on the road: one pager. Given to 18 Representatives of Departments of Transportation (DOT) of Iowa, Kansas, North Dakota, Nebraska, Minnesota, and Missouri.
7. Ramirez M: [2014] Prevalence of Alcohol Testing and Impairment in On-road Farm Equipment-Related Crashes: One pager. Given to 18 Representatives of Departments of Transportation (DOT) of Iowa, Kansas, North Dakota, Nebraska, Minnesota, and Missouri.
8. Ramirez M: [2014] Not just a rural occurrence: Farm Equipment-related Crashes: One pager. Given to 18 Representatives of Departments of Transportation (DOT) of Iowa, Kansas, North Dakota, Nebraska, Minnesota, and Missouri.
9. Ranapurwala S: [2014] Effect of road segment characteristics on the incidence of farm vehicle-related cashes: One pager. Given to 18 Representatives of Departments of Transportation (DOT) of Iowa, Kansas, North Dakota, Nebraska, Minnesota, and Missouri.
10. Ramirez M: [2013] Farm Equipment on Rural Roadways information provided to federal legislators. Washington, DC.

Translation: Research to Practice Activities
2016 Roadway safety information display, survey, and farmer feedback: Farm Progress Show, Boone, IA; Dakotafest, Mitchell, SD; Husker Harvest Days, Grand Island, NE; Wester Farm Show, Kansas City, MO.

- An interactive roadway safety display was featured; over 300 retroreflective kits were handed out to farmers.
- Surveyed farmers reported that: Only half (50%) of farmers reported current retroreflective materials on tractors, after learning about the ASABE recommendations.
- Overall, 26% of surveyed farmers shared a personal account of an incident or near-miss that occurred while operating farm equipment on roadways: 37% involved being rear-ended, 20% were passed in a 'no-pass' zone, and 13% were hit from the side or front (13%).

Press release in conjunction with the release of Ramirez *et al.* 2016 article resulted in at least 17 national media articles (see release at https://now.uiowa.edu/2016/10/more-stringent-state-policies-lighting-could-reduce-farm-vehicle-traffic-accidents-more-half), identified below.

1. "More stringent state policies on lighting could reduce farm vehicle traffic accidents by more than half." Iowa NOW magazine, Iowa City, IA. October 21st, 2016 (97,000 online viewers)
2. "Study suggests farm traffic vehicle accidents could be reduced by more than half." Science Daily Webnews. October 21st, 2016. (10.1 million online viewers).
3. "UI study: More lighting on farm vehicles would reduce number of crashes." Cedar Rapids Gazette, Cedar Rapids, IA. October 21st, 2016. (997,000 online viewers, 167,000 print subscribers).
4. "Study suggests better marking of farm vehicles could reduce accidents." Missouri Net Online Webnews, October 21st, 2016. (76,000 online viewers).
5. "Midwest study: more lighting would cut farm vehicle crashes by 60%." Insurance Journal Magazine. October 21st, 2016. (400,000 online viewers).
6. "Study: more lighting on farm vehicles would reduce number of crashes." Sauk Valley Newspaper, Sauk Valley, IL. October 24th, 2016 (254,000 viewers, 140,000 print subscribers).
7. "Study suggests better marking of farm vehicles could cut accidents." Southern Iowa Radio Iowa (Iowa Public Radio, IPR affiliate). October 24th, 2016. (45,000 listeners).
8. "Farm vehicle accidents could be reduced by more than half." Feedstuffs Magazine, Bloomington, MN. October 24th, 2016 (75,000 viewers, 10,000 E-News Subscriptions).
9. "Share the road during harvest." Time Essentinel Newspaper, Indiana. October 25th, 2016. (5,000 online viewers, 146,000 print subscribers).
10. "Study: more lighting on farm equipment reduces crashes". Brownfield Ag News Online Webnews, October 24st, 2016. (14,000 online viewers).
11. "Study suggests better marking of farm vehicles could reduce accidents." Ozarksfirst TV station, Springfield, MO. October 25th, 2016 (335,000 online viewers).
12. "Study suggests farm traffic vehicle accidents could be reduced by more than half." KCRG TV Station, Cedar Rapids, IA. October 25th, 2016 (1.3 million online viewers).
13. "More lights and reflectors would help keep farmers safe." WNAX Radio 570 AM, Minnesota. October 26th, 2016. (36,000 listeners).
14. "Reducing accidents involving farm vehicles, new study suggests better marking of farm vehicles could reduce accidents." FourStates Home Page Webnews, Joplin, MO. October 26th, 2016. (108,000 online viewers).
15. "Study: better lighting, reflection on farm vehicles could reduce crashes, research shows Minnesota safety middle of the pack of Midwestern states." Minneapolis Star Tribune, Minneapolis, MN. October 26th, 2016. (10.3 million online viewers, 1.4 million subscribers).
16. "Making farm equipment more visible could reduce accidents by 60%, says study." Successful Farming Magazine. December 6th, 2016. (413,000 online viewers).
17. "Study finds steps that could reduce highway farm equipment accidents by 60%." Growing America Webnews. December 12th, 2016.

PSAs and Safety Videos were developed to communicate hazards and prevention messages.

1. Radio PSA 1: Aired in Iowa from September 21, 2015 to November 2, 2015 on Brownfield and Radio Iowa networks; 22 airings, 924 total station messages aired.

2. Radio PSA 2: Aired on from March 27, 2017, to April 24 2017 on Missouri News Radio; 915 airings
   Radio PSA 2: Aired from March 27, 2017 to April 10, 2017 on Minnesota News Network; 1,278 airings.
3. *Videos (2):* approximately 2.5 minutes each, to communicate lighting and marking guidelines to the broad agricultural community. To be distributed via YouTube and Facebook and promoted by the GPCAH outreach core in preparation for fall harvest 2017.

Cumulative Enrollment

Cumulative Enrollment Table

This project was determined not to be human subjects research; hence, there is no enrollment to report.

Inclusion of Gender and Minority Study Subjects

N/A – This project did not involve human subjects.

Inclusion of Children

N/A – No children were included in this program.

Materials Available for Other Investigators

Digital versions of all materials generated as outputs from this project are available to all at the GPCAH website (www.gpcah.org).

Musculoskeletal Disorders among Farmers (Research Project B)

PI: Nathan Fethke, nathan-fethke@uiowa.edu

Abstract

Musculoskeletal symptoms and disorders continue to be important occupational health problems in most industries, including agriculture. We assessed risk factors for low back, neck/shoulder, and distal upper extremity musculoskeletal symptoms among 518 agricultural workers in the Midwest region of the US, most of who were farm owner/operators. This epidemiologic study used a symptom status survey to assess participants at baseline and every six months during a 36-month follow-up period and, for a subgroup of these participants, field assessments of muscular load, posture/movements, and whole body vibration. The results of this study support a relationship between whole-body vibration and the experience of low back musculoskeletal symptoms among agricultural workers. Methodological issues, including a highly selected study sample and a high degree of variability in the tools, machinery, and methods used to accomplish agricultural tasks may have resulted in underestimates of associations between exposure to physical risk factors and musculoskeletal outcomes.

Background

Agricultural workers are widely believed to be at increased risk of musculoskeletal health outcomes when compared to workers in most other industries. Indeed, population-based surveys of working people across multiple industries have reported increased occurrence of low back pain and increased exposure to physical risk factors (*e.g.*, force, posture, repetitive motion, and vibration) among agricultural workers in comparison to other occupational groups. However, the few longitudinal studies available fail to provide a robust basis for intervention/prevention efforts due to the frequent use of imprecise and potentially biased self-report exposure assessment methods (*e.g.*, “agricultural work”).

Aims

To address this and other methodological limitations of the existing literature, we conducted a longitudinal epidemiologic study addressing the following specific aims:

1. Examine seasonal trends of low back, neck/shoulder, and distal upper extremity musculoskeletal symptoms among agricultural workers in nine rural Midwest states.
2. Characterize exposure to physical risk factors for low back, neck/shoulder, and distal upper extremity musculoskeletal symptoms among agricultural workers in nine rural Midwest states.
3. Estimate the associations between physical risk factors and low back, neck/shoulder, and distal upper extremity musculoskeletal symptoms among agricultural workers in nine rural Midwest states.

Methods

We conducted an epidemiologic study of musculoskeletal symptoms among a random sample of agricultural production workers in nine states served by the GPCAH (IL, IA, KS, MN, MO, NE, ND, SD, WI). Participant symptom status was assessed using standard symptom questions at baseline and every six months during a 36-month follow-up period. Follow-up questionnaires were designed to capture symptom experience during each of the prior two seasons, as well as the average weekly hours spent performing a set of common agricultural activities. A subsample of participants was recruited for on-farm assessment of exposure to physical risk factors using direct measurement methods. The measured exposure data was then combined with the self-reported average weekly hours (among the full cohort) to estimate the associations between physical risk factors and musculoskeletal symptoms.

Study Participants: Names and addresses of randomly selected farm operators served by the GPCAH were obtained from a commercial agricultural marketing database (FarmReach, Baitinger Consulting, Urbandale, IA). The sampling frame for potential participants was regionally distributed in proportion to the number of farms in each of the nine states. Participants were recruited and enrolled during two periods: February 2012 and August 2012. A letter containing all required elements of informed consent and a baseline questionnaire were mailed to 3,207 potential participants In February 2012, and additional 3,208 potential participants were contacted in August 2012. For both rounds of enrollment, study invitations specified that the person completing the questionnaires should (i) be at least 18 years of age and (ii) perform the majority of the work on the farm. Participants enrolled in both rounds formed the full study cohort.

Questionnaires and Study Variables: The self-administered questionnaires collected information about (i) demographics and personal health, (ii) characteristics of the farm operation, (iii) musculoskeletal health outcomes, (iv) average hours per week engaged in common agricultural activities, (v) occupational psychosocial stress, and (vi) affectivity.

Demographics and Personal Health. Demographic information included gender; date of birth, from which age was calculated; height and weight, from which body mass index was calculated in kg/m^2; education level (3 categories); ethnicity (dichotomized); the current position on the farm (owner, co-owner, other); the number of years in the current position on the farm; and three dichotomous variables to indicate proportion of overall farm work, farm as primary occupation, and other labor-intensive job off the farm. *Personal health* information included tobacco use (current, previous, and never); alcohol use (dichotomized); and previous diagnoses of musculoskeletal conditions or systemic autoimmune conditions (each dichotomized).

Farm Operation Characteristics. Characteristics of the farm operation included gross agricultural sales during the previous year (in USD, 4 categories); commodities produced and the proportion of annual revenue attributable to each commodity produced; and the average number of acres in production or number of animals for each commodity produced during the previous five years. All variables selected for inclusion in the farm operation characteristics questionnaire were obtained from analogous items used in the US Census of Agriculture [NASS 2014].

Musculoskeletal Health Outcomes. Musculoskeletal health outcomes of the low back, neck/shoulder, and elbow/wrist/hand were assessed separately. At *enrollment and each semi-annual follow-up* data collection round, we assessed the following musculoskeletal health outcome variables *for the two weeks prior* to completing the survey: (1) Occurrence of symptoms, with a positive response defined as a report of pain, numbness, tingling, or burning (i) of 60 minutes in total duration and (ii) not resulting from acute trauma; (2) Severity of symptoms, using standard 10 cm visual analog scales (VAS); and (3) The number of days in which symptoms interfered with usual work activities. *Also with each survey*, the following were assess for *<u>each</u> of the two preceding seasons*: (1) Occurrence of symptoms, with a positive response defined as a report of pain, numbness, tingling, or burning (i) of one day or more in total duration and (ii) not resulting from acute trauma; (2) Severity of symptoms, assessed using standard 10 cm visual analog scales; and (3) the number of days during which symptoms interfered with usual work activities.

Weekly Hours Engaged in Agricultural Activities. At enrollment and each semi-annual data collection round, participants reported the average hours per week performing a variety of common agricultural activities during each of the prior two seasons, with activities extracted from the NORA AFF Sector Council 2008 definitions.

Occupational Psychosocial Stress. The psychological job demands ("demand") and decision latitude ("control") subscales of the Job Content Questionnaire (JCQ) were used to collect information about occupational psychosocial stress. Participants were assigned to one of four "job strain quadrants" based the distributions of the JCQ subscale respsones: (i) high demand and low control, (ii) high demand and high control, (iii) low demand and high control, and (iv) low demand and low control.

Negative Affectivity. The Positive and Negative Affectivity Scale (PANAS) was used to assess negative affectivity, using the 10 negative emotion states and a five-item Likert scale (1 = "very slightly or not at all"; 5 = "extremely"), with scores ranging from 10 to 50.

On-Farm Exposure Assessment: The primary objective of the on-farm exposure assessments was to obtain representative estimates of biomechanical loading (muscular load and posture/movement profiles) and, as applicable, exposure to whole-body vibration during each common agricultural activity. In addition, we sought to compare exposure distributions between different farm types and sizes and, for whole-body vibration, different types of agricultural vehicles. Participants were recruited from those enrolled in the questionnaire portion of the study. Because not all *a priori* agricultural activities occur each day on each farm, multiple visits were usually required to complete the measurements.

Muscular Load: Muscular loading of the distal upper extremity, shoulder girdle, and trunk was estimated with surface electromyography (EMG) using standard electrode locations over the forearm flexors, forearm extensors, upper trapezius, and thoracic erector spinae (T9 level) muscle groups. The forearm flexors, forearm extensors, and upper trapezius EMG signals were recorded from the dominant side and the thoracic erector spinae (T9) EMG signals were recorded bilaterally. The power spectral density of each EMG recording was examined to identify frequencies of noise contamination and, if necessary, digital filters were applied to attenuate specific noise frequencies. The unprocessed EMG recordings were then converted to instantaneous root-mean-square (RMS) amplitude using a 100-sample moving window with a 50-sample overlap. The RMS-processed EMG files thus had an effective rate of 20 Hz. For each muscle group, muscle activity during agricultural activities was expressed as a percentage of that observed during submaximal, isometric reference contractions (%RVE). *For each agricultural activity, the standard set of EMG summary measures (for each muscle) included* (i) the mean normalized RMS EMG amplitude (%RVE) as a global index of muscular load, and (ii) the normalized 10^{th} and 90^{th} percentiles of RMS EMG amplitudes (*i.e.*, estimates of "static" and "peak" muscular loading).

Posture/Movement Profiles: Postures and movement velocities of the trunk, upper arm, and wrist were estimated using inertial measurement units (IMUs). Five IMUs were used to assess participant posture and movement and were positioned at the following locations: (i) anterior thoracic region of the trunk (sternum), (ii) posterior lumbar region of the trunk (near L5), (iii) upper arm (lateral aspect midway between the glenohumeral and elbow joints), (iv) forearm (dorsal surface just promixal of the wrist joint), and (v) hand (dorsal surface). Due to the widespread presence of ferromagnetic materials in the agricultural environment, magnetometer signals were unusable. Therefore, we derived posture/movement profiles for motions that could be calculated from combinations of accelerometer and gyroscope signals using alternative digital signal processing and sensor fusion algorithms.

Whole-body Vibration: For agricultural activities involving the use of powered vehicles, vibration was measured at the operator/seat interface during actual operating conditions according to procedures specified by the International Organization for Standardization (ISO) 2631-1:1997 standard. Specifically, a semirigid, triaxial seat pad accelerometer was affixed to the vehicle seat to register unweighted acceleration in the three directions. Simultaneously, unweighted vertical acceleration (A_z) was recorded using a single axis accelerometer mounted to the vehicle floor or frame as near as possible to the midline of the seat base. Vibration summary measures were then calculated using procedures in both ISO 2361-1:1997 and ISO 2631-5:2004. Reports include estimated dose acceleration (D_k), vibration dose value (VDV), and seat effective amplitude transmissibility (SEAT).

Findings

We received 654 responses from among the 6415 randomly-selected farm operators to whom invitations and baseline questionnaires were distributed. Of these, 136 indicated that either the farm was no longer in operation, the potential participant (to whom the invitation and questionnaires were addressed) was deceased, or were returned as not-deliverable. The remaining 518 respondents formed the study cohort, where 246 were enrolled in February 2012 and 272 were enrolled in August 2012 (8.2% participation). Some participants completed the study questionnaire at some semi-annual data collection rounds but not others. Considering the full cohort of 518 participants, data were available for 83% of participants at the first semi-annual follow-up (which included the second round of enrollment), 73% at the second follow-up, 61% at the third follow-up, 63% at the fourth follow-up, 56% at the fifth follow-up, and 54% at the sixth and final follow-up. In general, the greatest losses occurred between the enrollment and first follow-up data collection rounds. Once the full cohort was formed, retention from round-to-round was between 83% and 104% (*i.e.*, questionnaire returns in the fourth follow-up exceeded those from the third follow-up). Sixty-eight participants (13% of the full cohort) were censored from the study because they did not remain employed in farming, due to: retirement, sale of the farm operation, placement of previously farmed land into the Conservation Reserve Program, change of primary employment, and medical issues (including death).

Average Weekly Hours Engaged in Agricultural Activities: The average weekly hours of *field work with a vehicle* was the most variable, with mean values and mean standard deviations of 27.2 ± 20.3 hours in the Fall, 10.9 ± 11.7 hours in the Winter, 19.9 ± 18.6 hours in the Spring, and 22.3 ± 17.2 hours in the Summer.

Small increases in average weekly hours were observed for *handling/storing harvested crop* in the Fall compared to the other seasons, for *feeding animals* in the Winter compared to the other seasons, and for *paperwork* in the Winter compared to the other seasons. In general, these observations are consistent with expectations, given the frequency of crop-based operation in the cohort and reduced availability of pasture for feeding animals in the winter months. Relatively little seasonal variation was observed among the other activities. The large mean standard deviations relative to the mean hours observed for each activity reflect the variability in the commodities produced and sizes of the farm enterprises among the study sample.

Self-reported Symptoms (Aim 1): Across all seasons, the prevalence of musculoskeletal symptoms was greatest for the low back (26.6-48.0%), followed by the neck/shoulder (23.1-32.8%), and then the distal upper extremity (17.1-24.8%). Conversely, distal upper extremity symptoms affected a greater number of work days per season (mean of 11.4 days) than either low back symptoms (10.5 days) or neck/shoulder symptoms (10.0 days). The effect of season on low back symptoms was statistically significant. Using "winter" as the referent season, the odds of reporting low back symptoms increased in the fall (odd ratio [OR] 1.40; 95% confidence interval [CI] 1.24-1.58]) and summer (OR 1.22; CI 1.04-1.42). In addition, spring was associated with increased odds of reporting of low back symptoms, although the magnitude of association was not statistically significant (OR 1.14; CI 0.99-1.31), and summer was also associated with increased odds of reporting neck/shoulder pain relative to winter (OR 1.21; CI 1.05-1.40). The effect of season on distal upper extremity symptoms was not statistically significant, nor was the effect of season on the number of days symptoms affected work activities for any anatomical location.

Physical Risk Factors (Aim 2): On-farm measurements were obtained from among 55 study participants (~11% of the total study sample). Few measures were obtained on operations producing beef or specialty commodities, and none were obtained on dairy (only) operations. In total, 232 task-based measurements of muscle activity and posture/movement were obtained from among the 55 participants, and of these nearly half (112 task measures) also involved the measurement of whole body vibration.

Substantial between-subject variability was observed for posture/movement and muscle activity summary measures within each of the agricultural activities. *Field work* had the greatest mean trunk flexion/extension values, but the effect of agricultural activity on the percent time in extreme trunk flexion (>60°) was not statistically significant. We observed a statistically significant effect of agricultural activity (across all farm type and size categories) on both right and left erector spinae mean normalized RMS EMG levels, forearm extensor mean RMS EMG levels, the percent time with the upper arm elevated >90°, and the percent time with wrist angular velocity >90°/s. Post-hoc comparisons revealed the following key observations:

- *Field work with a vehicle* had significantly lower mean percent time with wrist angular velocity >90°/s (3.3%) compared to all other activities except *handling/storing harvested crop* (5.7%); *milking animals* had the highest mean value for this variable (10.2%).
- *Equipment repair and maintenance* had significantly greater mean percent time with upper arm elevation >60° (29.5%) than *field work with a vehicle* (12.3%), *move/load/sort animals* (13.5%), and *feeding animals* (15.3%).
- *Repairing buildings and structures* had significantly greater mean RMS forearm extensor muscle activity (71.0 %RVE) than *field work with a vehicle* (35.7 %RVE)
- *Equipment repair and maintenance* had significantly greater mean RMS left erector spinae muscle activity (73.1 %RVE) than *move/load/sort animals* (42.8 %RVE) and *field work with a vehicle* (47.4 %RVE). *Manual handling of materials* (71.9 %RVE) was also significantly greater than *field work with a vehicle* for this variable.
- *Equipment repair and maintenance* and *manual handling of materials* had significantly greater mean RMS right erector spinae muscle activity (73.1 and 79.9 %RVE, respectively) than *field work with a vehicle* (49.1 %RVE).

Whole body vibration measurements (n=112) had mean $A_{w,total}$ of 0.86 ± 0.38 m/s^2 over a mean measurement duration of 0.67 ± 0.62 hours. Mean frequency-weighted RMS accelerations were greatest in the vertical direction ($A_{w,z}$) across all vehicles and for each vehicle type. In general, *the lowest mean values of $A_{w,total}$, VDV in the vertical direction, and D_k* were observed for measurements made *during combine* *operation*. The combine measurements were also the *least variable*, with coefficients of variation lower than those observed for other vehicles for most summary measures. The ratio of weighted vertical acceleration at the seat/operator interface to the weighted vertical acceleration at the base of the seat was also lower and less variable among combines in comparison to other vehicle types. In contrast, *greatest mean values of $A_{w,total}$, VDV in the vertical direction, and SEAT* were observed for measurements made during *tractor and heavy utility vehicle operation*. The mean vibration crest factor in the vertical direction across all vehicles was 26.0 ± 15.1, suggesting the occurrence of high amplitude mechanical shocks during the recording periods. While the mean value of $A_{w,total}$ among tractors was greatest during field work (1.07 ± 0.42 m/s^2, N=24) and lowest during repairing equipment/structures (0.63 ± 0.13 m/s^2, N= 6), the mean value of *VDV* in the vertical direction was similar during these activities. Also, the difference in the exposure measure distributions between tractors and combines during field work were substantial, with greater mean values and variances observed for tractors compared to combines.

Associations between Physical Risk Factors and Symptoms (Aim 3): The estimate the adjusted associations between demographic and personal health, farm characteristic, psychosocial, and physical risk factors and musculoskeletal outcomes were computed. The distribution of the TWA level for each primary physical risk factor exposure variables was computed. Summary of significant associations with demographics are given in Table 3. Significant associations between measured physical factors and reported symptoms include the following, by anatomical site:

<u>Low back:</u> Unadjusted associations were observed between *low back symptom status* and:
(1) *TWA estimates of total frequency-weight vibration* (OR 1.07, p=0.02),
(2) *mean normalized RMS EMG left erector spinae muscle activity* (OR 1.01, p<0.01), and
(3) *the percent time with neutral posture and low movement velocity* in the flexion/extension motion plane (OR 1.01, p=0.04).

<u>Neck/Shoulder:</u> An unadjusted association was observed between *neck/shoulder symptom status* and both the (1) *TWA estimate of the percent time with the upper arm elevated >90°* (OR 0.96, p=0.02) and (2) *average total number of hours engaged in agricultural activities* (RR 1.01, p<0.01). A greater percentage of time in upper arm elevation >90° was associated with *reduced* odds of reporting neck/shoulder symptoms during the course of the study, indicating a protective effect.

<u>Upper extremity:</u> No significant unadjusted associations were observed between *distal upper extremity symptom status* and any of the TWA estimates of physical risk factors.

Table 3: Demographic, personal health, farm and psychosocial factor associations with reported symptoms in back, neck/shoulder, and distal extremities

Demographic	Back	Symptoms reported in: Neck/Shoulder	Distal Extremity
Age	OR 0.98, p<0.01	OR 0.99, p=0.09	-
Gender (female vs male)	-	OR 0.57, p=0.11	OR 2.12, p<0.05
Education	-	Yes*, p=0.04	-
BMI	OR 1.03, p=0.01	-	-
Tobacco Use	-	-	p=0.02
Alcohol Use	-	OR 1.29, p=0.02	OR 1.38, p=0.02
Prior diagnosis of condition to region matching symptom	OR 2.80, p<0.01	OR 2.61, p<0.01	Hand: OR 3.39, p<0.01 Elbow : OR 2.03, p<0.01
Autoimmune condition	-	OR 1.46, p=0.04	OR 2.22, p<0.01
Farm Type	Yes* (p<0.01)	-	OR 0.79 (for large vs small), p=0.03
Season	Yes*, p<0.01	Yes*, p=0.06	-
Job strain ratio	OR 12.7, p<0.01	OR 1.39, p=0.05	OR 1.38, p=0.08
Negative affectivity	OR 1.15, p=0.10	OR 1.38, p<0.01	OR 1.31, p=0.02
Number of weekly hours engaged in agricultural activities	RR 1.01, p<0.01	RR 1.01, p<0.01	OR 1.005; CI 1.002-1.008

*Significant with OR varying across categories
OR=odds ratio; RR=rate ratio

Conclusions and Impact

The observed prevalence estimates of musculoskeletal symptoms in this study appear within the range reported in previous studies. However, our repeated-measures design and seasonal analyses suggest stability in the burden of musculoskeletal symptoms over time, although low back symptom prevalence was somewhat elevated in the Fall. The results of this study represent among the few efforts to examine the seasonal variation in musculoskeletal symptoms among agricultural workers (predominantly farm owner/operators) in the Midwest region of the US. Physical risk factor exposure information collected using direct measurement methods among a subset of participants highlighted the differences in biomechanical loading between several common agricultural activities. *Statistically significant associations were observed between the seasonal average weekly hours engaged in common agricultural activities and musculoskeletal symptoms.* However, among the *a priori* exposure variables, only the total frequency-weighted vibration level was associated with low back pain. Methodological issues, including a highly selected study sample (average age of 61 years and average age first working in agriculture of 17 years) and a high degree of variability in the tools, machinery, and methods used to accomplish agricultural tasks may have resulted in underestimates of associations between exposure to physical risk factors and musculoskeletal outcomes.

Outputs and Outcomes

Publications – Peer Reviewed

1. Schall M, Fethke NB, Chen H, Oyama S, Douphrate D: [2016] Accuracy and repeatability of an inertial measurement unit system for field-based occupational studies. *Ergonomics.* 59:591-602. *[PMID: 26256753]*
2. Fethke NB, Merlino L, Gerr F, Schall MC, Branch CA: [2015] Musculoskeletal pain among Midwest farmers and associations with agricultural activities. *American Journal of Industrial Medicine.* 58(3): 319-330. *[PMID: 25345841]*
3. Schall M, Fethke NB, Chen H, Gerr F. 2015: [2015] A comparison of instrumentation methods to estimate thoracolumbar motion in field-based occupational studies. *Applied Ergonomics*. 48:224-231. [PMID: 25683549]

Dissertations/Thesis

1. Chen H: [2017] The effects of movement speeds and magnetic disturbance on inertial measurement unit accuracy: the implications of sensor fusion algorithms in occupational ergonomics applications. PhD dissertation, University of Iowa. http://ir.uiowa.edu/etd/5437/
2. Schall M: [2014] Application of inertial measurement units for directly measuring occupational exposure to non-neutral postures of the low back and shoulder. PhD dissertation, University of Iowa. http://ir.uiowa.edu/etd/2008/

Presentations

1. Chen H, Merlino L, Branch C, Schall M, Gerr F, Fethke NB: [2015] Seasonal effects of common farm tasks on the experience of low back pain. ISASH. Bloomington-Normal, IL (June 21-24, 2015).
2. Schall M, Fethke NB, Ramaswamy M, Chen H, Branch C, Merlino L, Watabe J, Gerr F: [2015] Whole-body vibration among agricultural workers performing common agricultural activities. ISASH. Bloomington-Normal, IL.
3. Fethke N: [2015] Associations between exposure to physical risk factors and musculoskeletal plain among agricultural workers. Occupational Hygiene in Agriculture – Roundtable Session. AIHce. Salt Lake City, UT.
4. Chen H, Schall M, Fethke N, Oyama S, Douphrate D: [2015] Accuracy of inertial measurement units for wrist posture measurement. 13th Annual National Occupational Research Agenda (NORA) Young/New Investigators Symposium. University of Utah, Salt Lake City, UT.
5. Schall M, Chen H, Merlino L, Gerr F, Fethke N: [2014]. A prospective study of musculoskeletal symptoms among agricultural workers in the Midwest region of the United States. 7th International Symposium: Safety & Health in Agricultural & Rural Populations: Global Perspectives. Saskatoon, SK, Canada.
6. Fethke NB, Gerr F, Merlino L, Branch C, Schall M: [2014] Exposure to physical risk factors for musculoskeletal health outcomes during common agricultural activities. International Society for Agricultural Safety and Health meeting, June 22-26, 2014; Omaha, NE.
7. Fethke NB, Gerr F, Merlino L, Branch C, Schall M: [2013] Musculoskeletal symptoms among Midwest farmers. 2013 Midwest Rural Agricultural Safety and Health conference, Nov. 19-20, 2013;Ames, IA.
8. Fethke NB, Gerr F, Merlino L, Branch C, Schall M: [2013] A prospective study of musculoskeletal symptoms among agricultural workers. International Society of Agricultural Safety and Health conference, June 23-27, 2013; Sandusky, OH.

Cumulative Enrollment

Cumulative Enrollment Table

PHS Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

OMB Number: 0925-0001 and 0925-0002
Expiration Date: 10/31/2018

***Study Title (must be unique):** GPCAH - Musculoskeletal Symptoms among Agricultural Workers (Research Project B)

* Delayed Onset Study? ☐ Yes ☒ No

If study is not delayed onset, the following selections are required:

Enrollment Type	☐ Planned	☒ Cumulative (Actual)
Using an Existing Dataset or Resource	☒ Yes	☐ No
Enrollment Location	☒ Domestic	☐ Foreign
Clinical Trial	☐ Yes	☒ No

NIH-Defined Phase III Clinical Trial ☐ Yes ☐ No

Comments:

Racial Categories	**Ethnic Categories**									
	Not Hispanic or Latino			Hispanic or Latino			Unknown/Not Reported Ethnicity			**Total**
	Female	**Male**	**Unknown/ Not Reported**	**Female**	**Male**	**Unknown/ Not Reported**	**Female**	**Male**	**Unknown/ Not Reported**	
American Indian/ Alaska Native	0	0	0	0	0	0	0	0	0	0
Asian	0	0	0	0	0	0	0	0	0	0
Native Hawaiian or Other Pacific Islander	0	0	0	0	0	0	0	0	0	0
Black or African American	0	1	0	0	0	0	0	0	0	1
White	31	485	0	0	1	0	0	0	0	517
More than One Race	0	0	0	0	0	0	0	0	0	0
Unknown or Not Reported	0	0	0	0	0	0	0	0	0	0
Total	31	486	0	0	1	0	0	0	0	518

Inclusion of Gender and Minority Study Subjects:

Women and those of minority racial/ethnicity were not excluded from participating in the research project. The proportions of women (6%) and those of minority status (<1%) among the study sample reflected the gender and minority make-up of the population of farm owner/operators in the Midwest region of US, which is predominantly male and Caucasian based on US Census of Agriculture.

Inclusion of Children:

No children were included as study subjects in this project

Materials Available for Other Investigators

Digital versions of all materials generated as outputs from this project are available to all at the GPCAH website (www.gpcah.org).

GPCAH Prevention / Intervention Core

Intervention to Reduce Aerosol Exposures in CAFOs

GPCAH Prevention / Intervention Core

PIs: T. Renée Anthony (renee-anthony@uiowa.edu)

Description

The GPCAH Prevention / Intervention Core consisted of only one project: The Intervention to Reduce Aerosol Exposures in CAFOs. This project tested whether an industrial ventilation control solution would be effective and suitable for use in livestock production as a way to improve the air quality in swine production buildings. This work was performed in an educational swine farrowing building, with input provided by the swine production manager throughout the duration of the project. As the study progressed, the National Pork Board responded favorably to the intervention methodology and provided input on our outreach materials, resulting in a new collaborative partnership. While deployment was local, the proof of concept was necessary prior to deploying a system in a commercial production operation. Since the GPCAH region outweighs any other in the US for hog production, the findings of this study was important to the Center as it has long-term impact on improved health to workers throughout the region. The project included three distinct phases: modeling to rank the effectiveness of ventilation and treatment parameters, bench and field testing, and validation of models with field testing data.

Intervention to Reduce Aerosol Exposures in CAFOs - Activities

Baseline field testing identified background concentrations at the test site to inform the model development and sampling protocol for intervention assessment. This phase also allowed us to evaluate whether manure pit fans provide sufficient contaminant control. Pit fan operations reduced ammonia and hydrogen sulfide concentrations, but dust and other hazards were not sufficiently controlled. This work also recommended using multiple fixed area monitors to adequately characterize room concentrations.

Simulation models were developed, using time-varying generation, temperature, and production factors, to determine the effects of ventilation rates, clean makeup air, and heating costs. The model simulated concentrations for the field site, providing rankings of system design by effectiveness and operating costs. Simulations showed multiple cost-effective (<$1/pig) options capable of controlling dust concentrations using 1000-2000 cfm with filtration or cyclonic treatment, limiting fresh air replacement to $\leq$ 25%. This simulation identified a previously unreported hazard: gas heaters contributed significantly to CO_2 in production buildings. Field studies were revised to include both CO_2 and aerosol control.

Ventilation field testing occurred over two winters, with heater effects evaluated in a third winter. The ventilation systems operated at 1000 cfm (5.4 air changes per hour), with two exhaust locations and treated air returned near the ceiling above the two feeder aisles. Both systems were effective at reducing inhalable (large) dust concentrations (33-44%), but removal of respirable (small) dust particles was more effective with the filtration unit (41%) compared to the cyclone (18%). Replacement of the commonly-used unvented heaters with a new model that exhausted combustion gases outside of the room improved room concentrations of CO_2 by 800 – 1000 ppm and significantly reduced ultrafine dust concentrations near the heater.

The final phase of this study validated the simulation models with the field data. Shortcomings in the model included poor simulation of room ammonia concentrations, but the model was able to estimate dust and CO_2 concentrations, validated with field measurements.

Significant findings from this study are summarized below. Results from these field assessments provides evidence necessary to livestock producers and building designers to consider adopting control technologies that can reduce dust, endotoxin on dust, CO_2 associated with health declines in livestock production workers.

Key Finding 1: This project provided evidence that engineering control options can be used to reduce airborne concentrations in swine production (farrowing) buildings to improve dust and carbon dioxide (CO_2) contaminant levels *without increasing* concentrations of acute hazards of ammonia (NH_3) or hydrogen sulfide (H_2S) from the under floor manure pits.

Key Finding 2: Adopting newer vented heaters at an incremental $500/unit can reduce CO_2 concentrations by ~1000 ppm.

Key Finding 3: Recirculating ventilation with dust treatment ($0.31-0.51/pig) effectively reduced hazardous dust concentrations.

We realize that widespread adoption of these technologies require the additional burden of proof that the air quality improvement identified in this study is correlated with improved production (animal health), which requires deployment in modern production buildings. However, the basic and applied research incorporated into this intervention study provides sufficient evidence to ensure livestock producers do not increase the risk of disease to their livelihood.

Outputs and Outcomes

This project identified engineering control options that can effectively improve the air quality in livestock buildings, which has the potential to reduce the burden of disease in swine production workers. The widespread adoption of these technologies requires additional changes in building construction and design, but the ***potential outcomes*** of this work would include reduced incidences of respiratory inflammation, prevention of lung function declines, and reductions in self-reported respiratory symptoms (cough, phlegm) for workers in swine production operations.

While disease outcomes were not specifically measured in this study, this applied research and intervention project identified effective tools that can reduce three of the major airborne contaminants in swine production operations (dust, endotoxin on dust, carbon dioxide) while ensuring no increase in other major airborne contaminants (ammonia and hydrogen sulfide). This is an improvement over traditional recommendations to have workers “wear respirators,” which only reduce exposures to the dust components and which still demonstrates low adoption by the farming population. Rather than relying on consistent adoption of personal protective equipment, the adoption of readily available technologies that are widely used in other industrial operations has the potential to improve the health of both workers and livestock. The controls evaluated in this study have the potential to fit into a “one health” approach which can significantly improve the working conditions and productivity on even small farms.

This project resulted in eight peer-reviewed manuscripts, with another under review. Work on this project was used to support seven graduate master’s theses, and findings have been presented at eleven professional conferences.

Cumulative Enrollment Tables

The Intervention to Reduce Aerosol Concentrations in CAFO was determined to not include human subjects. There are no enrollment tables.

Prevention/Intervention Core/Project A: Intervention to Reduce Aerosol Exposures in CAFOs

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Abstract

This project evaluated whether a recirculating ventilation system with dust removal is an effective method to improve the air quality in Midwestern livestock production buildings. Investigations focused on high exposure periods (winter) in swine operations, where mechanical and natural ventilation is often minimized to save heating costs. While all work was performed using a single swine production building, models were developed to allow customization of building and production parameters, allowing future simulations to adapt to varied building designs throughout the region. The project included three distinct phases: modeling to rank the effectiveness of ventilation and treatment parameters, bench and field testing, and validation of models with field testing data.

Baseline field testing identified background concentrations at the test site to inform the model development and sampling protocol for intervention monitoring. This phase also allowed us to evaluate a question whether manure pit fans provide sufficient contaminant control. Pit fan operations reduced ammonia and hydrogen sulfide concentrations, but dust and other hazards were not sufficiently controlled. This work also recommended using multiple fixed area monitors to adequately characterize room concentrations.

Simulation models were developed, using time-varying generation, temperature, and production factors, to determine the effects of ventilation rates and percent clean makeup air on heating costs and room air quality. The model simulated concentrations for the field site, providing rankings of system design by effectiveness and operating costs. Simulations showed multiple cost-effective (<$1/pig) options capable of controlling dust concentrations using 1000-2000 cfm with filtration or cyclonic treatment, limiting fresh air replacement to $\leq$ 25%. This simulation identified a previously unreported hazard: gas heaters contributed significantly to CO_2 in production buildings. Field studies were revised to include both CO_2 and dust control.

Ventilation field testing occurred over two winters, with heater effects evaluated in a third winter. The ventilation systems operated at 1000 cfm (5.4 air changes per hour), with two exhaust locations and treated air returned at ceiling above the two feeder aisles. Both systems were effective at reducing inhalable (large) dust concentrations (33-44%), but removal of respirable (small) dust particles was more effective with the filtration unit (41%) compared to the cyclone (18%). Replacement of the commonly-used unvented heaters with a new model that exhausted combustion gases outside of the room improved room concentrations of CO_2 by 800 – 1000 ppm and significantly reduced ultrafine dust concentrations near the heater.

The final phase of this study validated the simulation models with the field data. Shortcomings in the model included poor simulation of room ammonia concentrations, but the model was able to estimate dust and CO_2 concentrations, as verified with field measurements.

This project identified low-cost recommendations to livestock producers that can protect the health of workers. Using newer vented heaters (incremental $500/unit) can improve CO_2 concentrations. Dust treatment ($0.31-0.51/pig) may be effective to reduce hazardous dust concentrations. This work demonstrates that ventilation and equipment substitution can improve the air quality in livestock production rooms without introducing new hazards (no increases of ammonia or hydrogen sulfide from the manure pit). Deployment in modern production buildings can evaluate improvements in worker health and production.

Background

An estimated 200,000 to 500,000 workers in indoor livestock buildings are at substantial risk of adverse respiratory outcomes associated with poor air quality in these operations. Our objective in this project was to quantify the effects of ventilation design and operation on contaminant concentrations within swine buildings, specifically in farrowing operations. By investigating alternative designs, we identified which option reduces contaminant concentrations in heavily occupied areas. Our central hypothesis was that the quality of air in swine farrowing rooms can be improved using standard mechanical ventilation design methods, typical of industrial ventilation. To have the largest impact on the protection of human health, the study focused on the production cycle associated with the highest exposure (winter in the Midwest) in areas where workers have the highest exposure risks due to full-shift building occupation (farrowing barns).

Aims

This project had three specific aims:

1. Provide rank-ordered system designs based on efficient contaminant removal.
2. Provide control option optimization with determination of air recirculation feasibility.
3. Evaluate final design in the field.

Throughout this study, all field work was conducted at one test, namely the Mansfield Swine Education Center at Kirkwood Community College, Cedar Rapids, IA.

Methods

To complete the project, design and field testing progressed in the following order: conduct baseline testing; build simulation models; bench-test filtration unit; use model to evaluate the effect of flow, percent recirculation, and temperature on air quality and cost (optimization for deployment); install and test in field; validate computer model with field data; evaluate performance and recommend intervention to producers. Significant methods for each activity in this project are included in discussions of the Findings.

Findings

Baseline Assessment – Test Site: This step deployed multiple direct-reading monitors at *seven* fixed locations, which data logged while mobile mapping was performed by collecting 2-minute samples at 43 positions throughout the room. Mobile mapping was repeated three times on each of five sample days. Comparisons between data collection method were made to establish the necessary sampling strategy to adequately characterize room concentrations during interventions: mapping (short sample time but high spatial resolution), multiple fixed area stations (longer sample time with moderate spatial resolution), or the commonly used single location (long duration but no spatial resolution). The room average concentrations using (a) center of room, (b) multiple fixed stations, and (c) mobile mapping were computed and ranked from high to low. A multiple fixed-location scheme was recommended over both mobile mapping (high personnel costs) and single center of room fixed monitoring station. (See Reeve *et al.*, 2012.)

Baseline Assessment – Control Devices: Bench-top testing of a 1000 cfm filtration unit was selected and tested in the lab prior to deployment in the field, as this technology was both low-cost (capital, annual) and easy to operate (Shaker Dust Collector [SDC] Model 140, United Air Specialists Inc., Cincinnati, OH). Laboratory baseline assessments were performed to evaluate: (1) initial efficiency (unloaded), (2) pressure drop changes and efficiency change over time, and (3) frequency of anticipated cleanout over the field deployment period. The pressure drop approached the recommended maximum, with 163 mg m^{-3} day to reach the target loading of 950 Pa. Data extrapolated from the bench tests identified that, to treat barn concentrations of 1 mg/m^3, a pristine filter might last 160 days, with 130 days between subsequent cleaning. The SDC collected >95% particles larger than 5 μm at all stages of filter loading. Smaller particles were collected with high efficiency only once the filter built sufficient dust layer (99% efficiency for 1 μm) with a small decrease in efficiency post-shaking (90%). After loading, repeating the shaking activation did *not* substantially recover pressure drops, and to save filter life, only one activation of the shaker is recommended in the field. (See Peters *et al.*, 2015.)

Model Development: MatLab with the Simulink plugin was used to develop time-dependent concentration estimates of contaminants, energy costs, temperature, and humidity based on ventilation intervention options. The model was developed to allow customized building parameters (*e.g.*, room dimensions, pit volume, heat lamps, heat transfer coefficients based on building materials, sow and pig counts). The test simulations, however, were matched on the physical structure at the test site used throughout this project (the west farrowing room).

The initial model used baseline concentrations obtained from Reeve *et al.* (2012) field study. Outdoor temperature was a critical input for the model, as heat loss through the building affects indoor room temperature, which in turn affected heater operation and room concentrations of contaminants generated by the heater. Initial simulations relied on a *theoretical equation* to represent seasonal and diurnal temperature changes over a 90-day winter period. Three “winter” simulations were generated to evaluate the system, representing mild, cold, and extreme cold winter. This allowed for comparing between-winter costs of operating the gas fired heaters currently in use (Park *et al.*, 2013). Later models (Park *et al.*, 2017) used actual 2013-14 meteorological data from a nearby weather station as input to the model, which allowed model validation using weather conditions and room-concentrations from the initial field investigation study. In-room concentration estimations were sensitive to the pit-air exchange ratio parameter, particularly ammonia.

The simulation model was then used to simulate conditions representative of our test barn to perform the optimization study, where we examined the effects of ventilation rate (500 to 2000 cfm), recirculation percentage (0 – 100%), and dust treatment options (5 devices) suitable for deployment at the test site. Particularly important parameters were the airflow through the ventilation-control unit and the percentage of fresh air that was introduced into the building, as these required selection for the intervention phase of the project. In some control option cases, the additional option of increasing flow through the manure pit fan was included. Simulations where the temperature could not be maintained at 20°C were considered *failures* because piglet health requirements would not be met. Both cost and concentration were used to rank control options.

There was no condition where the in-room CO_2 was below the 1540 ppm industry recommendation. Many options were capable of reducing inhalable dust to < 1 mg/m^3 while maintaining CO_2 below 2500 ppm, mostly with 1000 to 2000 cfm and 75-100% recirculation. The incremental operating cost to achieve <1 mg/m^3 inhalable dust over a 90-day period was pennies per pig more than allowing inhalable dust to be controlled to only 2.8 mg/m^3 (50% TLV). Finally, this simulation experiment was used to determine the effect of the heater operation on room CO_2 concentrations: if the “heater” was turned off as a CO_2 source, then the room concentration could be reduced to below 1300 ppm, achieving the desired health protective target. This result provided evidence to expand the scope of this intervention to include evaluation of the effectiveness of a new heater that vents combustion gases outside of the building (*e.g.*, with a heat exchanger). This was integrated into the subsequent field studies (Year 4 and 5). (See Park *et al.*, 2013 for model development; Anthony *et al.,* 2014 for optimization.)

Field Deployment - Methods: A new recirculating ventilation system was installed in the fall of 2013 in preparation for use starting in December 2013. The air was exhausted at two locations at the end of the two “head” aisles, positioned at the top of the crate heights. Room air was conveyed through 8” ducts to the outside air cleaner, which in the first deployment was a filtration unit SDC unit tested in the lab (with pristine filters) and in the subsequent year was a cyclone (Model 16, Donaldson Inc., Minneapolis, MN). Treated air was returned to the room via 10” galvanized ducts that transitioned to two fabric air diffusers (Softflow Diffusers, Air Distribution Concepts, Delvan, WI) suspended from the ceiling above the two head-aisles. Air handlers of both air cleaner units operated at 1000 cfm. Based on computer simulations, the field deployment recirculated 100% of the treated air, with no fresh outdoor air introduced into the room. The room heaters were replaced with vented heaters (Effiinity 93) before the cyclone testing began in the second test period.

Since only one test room was available at this test site, the sampling strategy obtained baseline concentrations (system off) at three time points: before system activation (3 measures), half-way through the winter (3 measures), and at the end of the season (2 measures). This was important to adequately quantify time-dependent concentration changes in livestock buildings, particularly with gas concentrations unaffected by the air cleaner, namely ammonia. System performance was characterized by comparing room concentrations for the system off compared to the system on.

Integrated and direct-reading samplers were deployed over 24-hours to characterize room concentrations, positioned at six fixed sampling locations. Crates were suspended from the ceiling, with sampler inlets positioned 1.5 m above the floor to represent breathing zone height of workers in the room. Sampler inlets were positioned approximately 2.7 m away from the east and west walls along the three central aisles of the room.

Field Deployment - Findings: The filtration unit reduced respirable dust concentrations from 0.20 to 0.11 mg/m^3 (41%) and inhalable dust from 1.01 to 0.68 mg/m^3 (33%). The following year, the cyclone reduced the inhalable dust from 1.04 to 0.57 mg/m^3 (44%) but respirable dust was insignificantly reduced from 0.11 to 0.09 mg/m^3. In both winters, this increased airflow was not associated with any increased gas concentrations (ammonia, hydrogen sulfide) in the room. Carbon dioxide concentrations were substantially reduced using the new heater, with linear regression identifying that replacement of the heater accounted for a reduction of 800 to 1000 ppm.

Conclusions and Impact

This project identified engineering control options that can effectively improve the air quality in livestock buildings, which has the potential to reduce the burden of disease in swine production workers. The widespread adoption of these technologies requires additional changes in building construction and design, but the ***potential outcomes*** of this work would include reduced incidences of respiratory inflammation, prevention of lung function declines, and reductions in self-reported respiratory symptoms (cough, phlegm) for workers in swine production operations.

While disease outcomes were not specifically measured in this study, this applied research and intervention project identified effective tools that can reduce three of the major airborne contaminants in swine production operations (dust, endotoxin on dust, carbon dioxide) while ensuring no increase in other major airborne contaminants (ammonia and hydrogen sulfide). This is an improvement over traditional recommendations to have workers “wear respirators,” which only reduce exposures to the dust components and which still demonstrates low adoption by the farming population. Rather than relying on consistent use of personal protective equipment, the adoption of readily available technologies that are widely used in other industrial operations has the potential to improve the health of both workers and livestock. The successfully trialed controls evaluated in this study have the potential to fit into a “one health” approach, which can significantly improve the working conditions and productivity on farms.

Outputs and Outcomes

Publications – Peer Reviewed

1. Anthony TR, Cai C, Mehaffy J, Sleeth DK, Volckens J: [2017] Performance of a prototype high-flow inhalable dust sampler in a livestock production facility. *Journal of Occupational and Environmental Hygiene.* 15(5):313-322. *[PMC: 5503137]*
2. Park JH, Peters TM, Altmaier R, Jones SM, Gassman R, Anthony TR: [2017] Simulation of air quality and operational cost to ventilate swine farrowing facilities in Midwest US during winter. *Transactions of the ASABE. 60(2):465-477. [PMC5536187]*
3. Jones S, Anthony TR, Sousan S, Altmaier R, Park JH, Peters TM: [2016] Evaluation of a low-cost aerosol sensor to assess dust concentrations in a swine building. *Annals of Occupational Hygiene.* 60(5):597-607. *[PMC4879606]*
4. Peters TM, Sawvel RA, Park JH, Anthony TR: [2015] Evaluation of a Shaker Dust Collector for Use in a Recirculating Ventilation System. *Journal of Occupational and Environmental Hygiene.* 12(9):D201-D210. [*PMC4753559]*
5. Anthony TR, Altmaier R, Jones S, Gassman R, Park JH, Peters TM: [2015] Use of recirculating ventilation with dust filtration to improve wintertime air quality in swine farrowing room. *Journal of Occupational and Environmental Hygiene*. 12(9):635-646. *[PMC4756717]*
6. Anthony TR, Park JH, Altmaier R, Peters TM: [2014] Modeled effectiveness of ventilation with contaminant control devices on indoor air quality in swine farrowing facility. *Journal of Occupational and Environmental Hygiene.* 11(7):434-449. *[PMC4753560]*
7. Park JH, Peters TM, Altmaier R, Sawvel RA, Anthony TR: [2013] Simulation of air quality and cost to ventilate swine farrowing facilities in winter. *Journal of Computers and Electronics in Agriculture.* 98:136-145. *[PMC4770838]*
8. Reeve KA, Peters TM, Anthony TR: [2013] Wintertime factors affecting contaminant distribution in a swine farrowing room. *Journal of Occupational and Environmental Hygiene.* 10(6):287-296. *[PMC4753562]*

Dissertations/Thesis

1. Beswick- Honn, J: [2017] Evaluation of low-cost H_2S monitors for agricultural use, MS Thesis, University of Iowa. http://ir.uiowa.edu/etd/5417/
2. Dausman, T: [2017] Low-cost monitors in agriculture, MS Thesis, University of Iowa. http://ir.uiowa.edu/etd/5451/
3. Jones S: [2015] Evaluation of a low-cost aerosol sensor to assess occupational exposures, MS Thesis, University of Iowa. http://ir.uiowa.edu/etd/1858/
4. Gassman R: [2015] Effect of dust filtration control on CO_2 and NH_3 concentration in a swine farrowing room, MS Thesis, University of Iowa. http://ir.uiowa.edu/etd/1969/
5. Yang A: [2015] Effect of heater type on CO/CO_2 concentrations in a farrowing barn, MS Thesis, University of Iowa. http://ir.uiowa.edu/etd/1939/
6. Sawvel R: [2014] Evaluation of shaker dust collector for use in a swine farrowing barn, MS Thesis, University of Iowa. http://ir.uiowa.edu/etd/1393/
7. Reeve K: [2012] Wintertime factors affecting contaminant distribution in farrowing barns, MS Thesis, University of Iowa. http://ir.uiowa.edu/etd/3371/

Presentations

1. Beswick JM, Peters TM, Anthony TR: [2016] Method to assess low-cost H_2S monitors for use in agriculture. Poster presentation. American Industrial Hygiene Conference and Exposition, AIHA, Baltimore, MD, May 25, 2016
2. Anthony TR: [2015] Controlling exposures in CAFOs: An engineering approach, oral presentation, American Industrial Hygiene Conference and Exposition, Salt Lake City, Utah, June 3, 2015
3. Anthony TR: [2015] Improving Air Quality in Swine Barns: Results of Intervention Study, oral presentation, MRASH, MRASH, Decorah, IA, November 17, 2015
4. Yang AY, Park JH, Gassman R, Altmaier R, Jones S, Peters TM, Anthony TR: [2015] Combustion Gas Reduction in a Farrowing Barn. Poster presentation. American Industrial Hygiene Conference and Exposition, AIHA, Salt Lake City, UT, June 3, 2015.
5. Anthony TR, Altmaier R, Jones S, Gassman R, Sawvel R, Peters TM: [2014] Evaluation of Air Quality Improvements in a Swine Farrowing CAFO, oral presentation, MRASH, MRASH, Ankeny, IA, Nov 19, 2014
6. Anthony TR, Gasman R, Sawvel R, Jones S, Altmaier R, Park JH, Peters TM: [2014] Improving indoor air quality of swine farrowing buildings, Oral presentation, International Society of Agricultural Health and Safety, International Society of Agricultural Health and Safety, ISASH, Omaha, NE, June 23, 2014
7. Gassman R, Altmaier R, Jones S, Anthony TR: [2014] A method to assess air quality in swine CAFO, poster presentation, International Society of Agricultural Health and Safety, ISASH, Omaha, NE, June 23, 2014
8. Sawvel R, Jones S, Altmaier R, Peters TM, Anthony TR: [2014] Recirculating ventilation system design for use in swine farrowing barn, poster presentation, International Society of Agricultural Health and Safety, ISASH, Omaha, NE, June 23, 2014
9. Sawvel RA, Park JH, Peters TM, Anthony TR: [2014] Evaluation of shaker dust collector for use in a swine farrowing barn. Poster presentation. American Industrial Hygiene Conference and Exposition, AIHA, San Antonio, TX, June 4, 2014.
10. Anthony TR, Park JH, Peters TM, Altmaier R, Sawvel R: [2013] Improving indoor air quality in swine CAFO using enhance ventilation and engineering controls. Oral presentation, June 26, 2013, International Society of Agricultural Health and Safety, ISASH, Sandusky, OH
11. Reeve KA and Anthony TR: [2012] Wintertime factors affecting contaminant concentration in farrowing barns. Poster presentation. American Industrial Hygiene Conference and Exposition, AIHA, Indianapolis, IN. June 20, 2012

Media Stories

1. Anthony TR (2014) "New Iowa Model Weighs up Farrowing Room Ventilation Options". The Pig News website at http://www.thepigsite.com/swinenews/34243/iowa-model-weighs-up-farrowing-room- ventilation-options.
2. Anthony TR (2014) "Simulation of Air Quality and Cost to Ventilate Swine Farrowing Facilities in Winter". American Association of Swine Veterinarians, https://www.aasv.org/news/story.php?id=6741.

3. Masad J (2012) “Healthier pigs, less $: Decreasing air pollution while increasing heating efficiency,” *Graduate Education at Iowa* newsletter.

Cumulative Enrollment

Cumulative Enrollment Table
N/A – This study did not involve human subjects.

Inclusion of Gender and Minority Study Subjects
N/A – This project did not involve human subjects.

Inclusion of Children
N/A – No children were included in this program.

Materials Available for Other Investigators
Digital versions of all materials generated as outputs from this project are available to all at the GPCAH website (www.gpcah.org).

GPCAH Translation Core

Building Capacity Project

Research to Practice (R2P) with Community Partners Project

GPCAH Translation Core

PIs: Diane Rohlman (diane-rohlman@uiowe.edu), Fredric Gerr (fred-gerr@uiowa.edu)

Description

The GPCAH Translation Core consisted of two projects: *Building Capacity* and *Research to Practice (R2P) with Community Partners*. Both projects aimed to translate broad agricultural safety and health knowledge to producers and their advocates. The Building Capacity project aimed to enhance the competency in primary, secondary and tertiary prevention of agricultural injury and illness among this workforce by providing a comprehensive educational program targeted to agricultural enterprise safety managers, human resource specialist, public health students, nurses, physicians, veterinarians, and others interested in the special health and safety needs of agricultural workers and communities. Materials for the 40-hour course, the Agricultural Medicine Core Course (AMCC), is housed by the GPCAH, but technical content is generated in collaboration with experts across the country. The R2P project aimed to develop and nurture 12-17 community partners who can influence health and safety among farmers, providing an ongoing mentoring and collaboratively developing translation and outreach materials to enhance the collaborative group's ability to protect the agricultural population they serve.

Building Capacity - Activities

During this project period, the following activities were undertaken to improve the curriculum and to increase the impact of this 40-hour training program: (i) the AMCC curriculum and associated training materials were revised and modernized through a national consensus process, (ii) the course was delivered annually at the University of Iowa and at the University of Nebraska, and (iii) identification of sustainable curriculum delivery to maximize impact and ensure the long-term viability of this course. A complete external and internal review of the course structure, module content, and examination / evaluation process were completed this cycle, and distance learning options were piloted and evaluated to identify optimal distance learning formats.

Significant findings from this project are summarized, with details provided in the Project Summary, to follow this section.

Key Finding 1: Demand for this course continued, with 22 sessions offered this project period, resulting in 470 trainees completing the course.

Key Finding 2: Course content was reviewed following a consensus process, relying on subject-matter experts. Partners with expertise in agricultural production contributed to the final review of these materials. The week-long class was substantially improved by incorporating case studies and field visits to build skills learned in the classroom.

Key Finding 3: Evaluation identified the need for distance learning modules. Efforts to conduct distance learning using standard webinar technology was less than effective, and new, interactive self-paced modules were piloted with encouraging feedback.

Key Finding 4: Course materials were made available to all NIOSH AFF Center educators at a September 2016 workshop.

Research to Practice with Community Partners - Activities

The R2P project aimed to create an active process to translate research findings into prevention programs that directly impact agricultural producers at the grassroots level. Formal partnerships were developed with community partners to identify both persistent and emerging topics relevant to protecting farmers throughout the Center's nine-state region. Quarterly meetings (3 conference calls, one face-to-face) focused on understanding the needs of our community partners and prioritizing translation and research needs to protect farmers. Persistent hazards and findings from research projects during this project period were prioritized by the RAC, and translations were disseminated throughout the region via community partners and other advocate organization identified by the RAC. The RAC recommended additional ways to improve the impact of this collaboration across the region, providing suggestions for new partnerships, customizing materials for specific audiences, and increasing the interactions with the agricultural community to build recognition as experts.

Key Finding 1: Increasing the impact of research findings required a multi-tiered approach to communicate safety and health messages, including: quarterly newsletters, monthly news articles in agricultural publications, annual conferences, one-on-one interactions with an estimated 7650 farmers, and sharing messages via website/social media. New dissemination outlets were identified and nurtured throughout this project period, including producer organizations (National Pork Board, Cattlemen's Association, and Practical Farmers), who have shared production-specific messages critical to protecting the health and sustainability of their producers.

Key Finding 2: New formats of communication were needed to maximize the relevance of prevention messages to farm workers, including translating research findings into infographic and poster-ready guidance, while sustaining traditional networks that are still highly valued by our region's farmers (*e.g.*, newsprint). Our community partners have helped identify priorities for persistent and emerging issues, and Center personnel have developed best-practice guidance for our partners and the Center to communicate with affected workers.

Key Finding 3: Our community partners have been mentored through the R2P process to improve their ability to garner community grants and have shared their lessons learned through Center-sponsored mechanisms, including presentations at the Midwest Rural Agricultural Safety and Health conference and articles for the *Farm Families Alive and Well* newsletter. Our partners have also provided connections to farmers to respond to emerging issues (*e.g.*, avian flu) and have used translated information in their organization's educational activities. Continued nurturing of these important relations is needed to ensure that targeted safety and health knowledge adequately addresses and reaches farmers, necessary to achieve the mission of the Center, namely to prevent agricultural injury and illness and to improve safety and health among agricultural communities.

Outputs and Outcomes

These projects confirmed that multiple stakeholders benefit the development and dissemination of safety and health messages to the agricultural community. By making many stakeholders aware of materials available and by allowing for iterative revision of simple to understand but technically accurate prevention guidance, the final work product is better. More importantly, participants are more invested in the materials and more likely to incorporate messaging into their organizational activities. While this project was not designed to measure reductions in work-related morbidity, mortality or exposure, these intermediate outputs have been shared with influencers, including producers organizations, medical providers, building designers, and safety managers that can ultimately assist with long-term translation into improved health and safety of our region's agricultural workers.

Outputs are detailed in individual project summaries, to follow. The *BC project* resulted in three peer-reviewed manuscripts, five presentations at professional conferences, and education of 470 trainees in the week-long AMCC. The *R2P project* generated two peer-reviewed publications and 17 presentations and professional meetings; presented at 46 community/agricultural educational events; generated 27 "Safety Watch" articles (newsprint), and co-sponsored six Midwest Rural Agricultural Safety and Health (MRASH) conferences, with 505 attendees over the project period. Regional partner contributions to R2P activities included 14 MRASH presentations and eight columns for the *Farm Families Alive and Well* newsletter; five of the 23 pilot grants from the GPCAH Pilot/Feasibility Program were awarded to organizations who have served on the regional advisory committee.

Cumulative Enrollment Tables

Both the Building Capacity and the R2P projects did not involve human subjects, hence there was no enrollment.

Translation Core: Building Capacity Project (Sept. 2012 – Sept. 2016)

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Abstract

This project was funded from 2012-2016. This project provided a framework to revise a nationally recognized agricultural safety and health course, expand partnerships, and develop a strategy to provide educational resources to improve the capacity of health and safety advocates who contribute to protecting the health and safety of farmers and rural populations. The centerpiece of this project is the Agricultural Medicine Core Course (AMCC), a 40-hour course that provides a strong foundation in the principles of occupational/agricultural safety and health for agricultural enterprise safety managers, human resource specialist, public health students, nurses, physicians, veterinarians, and others interested in the special health and safety needs of agricultural workers and communities. During this Center funding cycle, (i) the Core Course curriculum and associated training materials were revised and modernized through a national consensus process, (ii) the course was delivered at the University of Iowa (annually) and other host institutions, and (iii) Great Plains Center faculty and staff facilitated delivery of the course to 470 trainees.

Background

Agricultural medicine, a subspecialty of occupational safety and health, addresses the specific health and safety needs of the agricultural workforce. However, many persons engaged in agricultural safety and health practice do not have adequate training in areas needed to protect the health and safety of rural and agricultural population of the Great Plains Center for Agricultural Health (GPCAH) region. To address this need, the Building Capacity Project's main deliverable is a 40-hour *Agricultural Medicine Core Course,* which targets the education of rural health providers, veterinarians, and other safety and health practitioners who serve agricultural populations. Members of each of these groups provide direct safety and health services to members of the agricultural community and serve as interpersonal influencers of farmers and valued community leaders who advocate for safe and healthy work environments and communities.

This project aimed to modernize and continue to deliver an effective, sustainable, and accessible agricultural medicine training course both within and beyond the nine-state GPCAH region. The course develops health and safety expertise among a multidisciplinary group of rural health and safety professionals, key providers of health and safety services to agricultural communities. This project was designed to provide these professionals with skills and knowledge not readily available to them in their traditional training. An important goal of the project was to provide resources to organizations both within and outside of the GPCAH region to ensure the maximum geographic impact of the course. The principal investigator for this proposal (Dr. Donham) retired in 2013, when Drs. Diane Rohlman and Fred Gerr assumed leadership of this project.

Aims

To achieve the goal of increasing the ability of rural health and safety professionals, improve the health care professionals and other influencers abilities to protect farmers, the following aims were proposed:

1. Review and revise existing curriculum of the AMCC by:
   a. establishing a Curriculum Advisory Committee of national agricultural health experts to review and recommend revisions and updates to the current curriculum.
   b. with the assistance of Curriculum Committee members and regional agricultural health and safety specialists, developing additional agricultural health and safety curriculum tailored to regional variations in workforce demographics and culture and to regional agricultural health and safety risks.
2. Create instructional materials for trainers and trainees, including lecture notes, PowerPoint presentations and other educational materials, to support the delivery of the AMCC by qualified instructors other than those at the University of Iowa.
3. Offer revised AMCC:
   a. To health care and occupational health and safety professionals in the Upper Midwest, annually
   b. With regionally appropriate content to health care and occupational health and safety professionals in Texas and Alabama.

4. Create an "academy" of agricultural medicine instructors (AAMI) who receive in-depth training, mentoring, and certification to establish a sustainable pool of trainers across the country.
5. Expand distance education delivery methods to supplement classroom teaching, provide continuing education for AMCC instructors, and ensure broad dissemination of programs.
6. Conduct ongoing evaluation and meta-evaluation of the Building Capacity program.

Methods

The content of the original Agricultural Medicine Core Course was established during a consensus process during which national experts were asked to identify topics necessary for effective agricultural safety and health service delivery. A second consensus process in 2012 reviewed the original concepts and led to recommendations to improve the course's relevance and impact. In 2015, a third consensus process meeting was convened among national partners who had delivered the course at their home organizations. Representatives from the University of Iowa, University of Nebraska, North Carolina State University, University of Vermont, University of Texas, and the AgriSafe Network attended to review the curriculum and to recommend revisions to lecture materials and other activities, such as case studies that address current topics and farm site visits. Participants were also invited to provide feedback and guidance related to the sustainability of the course, particularly the need for distance learning options.

In the classroom-based setting at the University of Iowa, the 40-hour Building Capacity course is taught collaboratively by educators from the University of Iowa and elsewhere. The content is categorized into four broad units. The first unit is an introduction to the major issues in agricultural safety and health and includes an examination of current surveillance data and a discussion of the economics and culture of agriculture, rules and regulations associated with agricultural safety and health, and emerging issues. The second unit addresses injury and risk prevention through presentations on transportation hazards; agricultural injuries; livestock handling and physical hazards; physical agents such as thermal, noise, ultraviolet radiation, and vibration; and control methods including engineering, ventilation, and personal protective equipment use. The third unit addresses causes and prevention of agricultural diseases including lectures and discussions about pesticides, zoonotic diseases, respiratory disease, skin disease, musculoskeletal disorders, and behavioral health. The final content unit is devoted to programmatic approaches to prevention and wellness among agricultural populations and includes a discussion of the NIOSH Total Worker Health program, barriers and best practices related to prevention methods, safety interventions, rural health care delivery, and other safety and health resources. Each unit concludes with in-depth discussions of emerging issues and concerns. In addition to course presentations, students benefit from group case study problem solving exercises related to key concerns in agricultural safety and health. Field trips to area farms incorporate hands-on learning opportunities such as conducting on-site farm safety audits, viewing equipment and livestock operations, and learning directly from agricultural producers. Participants complete course evaluations at the end of the week and again at six months following the weeklong course.

Findings

Since 2007, the course has been delivered thirty-four times in nine states as well as in Australia and Turkey, with US offerings identified in Table 4. A total of 809 trainees from eight countries have completed the course. Course attendees were primarily healthcare providers, veterinarians, medical students, and health and safety professionals. We know of no other agricultural health and safety educational program that has achieved such widespread dissemination and enjoyed such enthusiastic reception.

Aim 1: Review and revise existing curriculum of the Agricultural Medicine: The Core Course (AMCC)
The original course curriculum was developed in 2006 through a consensus process. In 2012, a second consensus process was implemented to evaluate and update the curriculum and to address regional variations in agricultural safety and health concerns. To accomplish these goals, a 30-member Curriculum Advisory Committee was recruited and assembled to provide systematic input into the review and revision of core objectives, competencies, and topics for the course. The Curriculum Advisory Committee consisted of several of the original 2006 advisory committee members and additional agricultural health specialists with broad geographic representation of the country. Also, representatives from seven of the nine NIOSH-funded Agricultural Health centers participated in the second consensus process, as well as three

international representatives from countries where the course was presented or was in development. Initially, an electronic survey was administered to all members of the Curriculum Advisory Committee for input on the topics, objectives, and competencies that should be included in the revised course. On November 14, 2012, 16 members of the Curriculum Advisory Committee met to discuss the results of the electronic survey, consider other input, and achieve consensus on content of the course and the topics to be included in the revised edition of the course curriculum.

The results of the survey and the meeting were compiled into a consensus document that was distributed to the Curriculum Advisory Committee for comment and input. All of those who reviewed and responded to the request voted to approve the document. The final consensus-based, revised curriculum served as the main academic/didactic resource for updating and revising the course. Among the important recommendations made by the 2012 advisory committee was for the legacy course curriculum to be modified to more fully emphasize identification and mitigation of safety and health hazards for the purpose of preventing of agricultural injury and illness [Rudolphi and Donham, 2015 articles].

Table 4: Building Capacity AMCC Course Offerings, US

Organization Offering AMCC	State	Years offered
University of Iowa	Iowa	2007, 2008, 2009, 2010, 2011, *2012*, **2013, 2014, 2015, 2016**
Rural Medicine Scholars Program, College of Community Health Science, The University of Alabama	Alabama	**2014**
Southern Illinois University School of Medicine	Illinois	2008, 2009
Central States Center for Agricultural Safety and Health, University of Nebraska Medical Center	Nebraska	2011, *2012*, **2013, 2014, 2015, 2016**
North Carolina Agromedicine Institute, East Carolina University, North Carolina State University, North Carolina A & T State University	North Carolina	2009, *2012*, **2013, 2014, 2015**
Lake Region State College Dakota Center for Technology Optimized Agriculture	North Dakota	2011
Southwest Center for Agricultural Health, Injury Prevention and Education, The University of Texas Health Northeast	Texas	**2014 / 2015**
Vermont Farm Health Task Force University of Vermont	Vermont	2008, 2010, 2011, **2013, 2015**
Marshfield Clinic	Wisconsin	2009 / 2010, 2011, 2012

Bold indicates current project period.

A third consensus process was conducted in January 2015 among partners who had offered the course locally. The goal was to guide content revisions and to offer suggestions for long-term sustainability. Attendees consisted of experts who have contributed to course development and who have implemented the course at sites other than the University of Iowa. Representatives from five organizations attended the meeting: Ralph Altmaier (IA), Ellen Duysen (NE), Fred Gerr (IA), LaMar Grafft (NC), Jean McCandless (VT), Matt Nonnenmann (IA), Diane Rohlman (IA), Josie Rudolphi (IA), Carolyn Sheridan (AgriSafe), and Amanda Wickman (TX).

In September 2016, we hosted a two-day workshop at the University of Iowa, which brought together partners offering the course in other states as well as educators from agricultural safety and health organizations who have developed complimentary training, including NIOSH AFF Center educators. The goal was to nurture a national collaboration among agricultural safety and health educators, foster cooperation among national centers of agricultural safety and health, and minimize across-center duplication of effort. All agricultural health educational materials (*e.g.*, lecture notes, PowerPoints) developed by Building Capacity personnel were disseminated to all workshop participants and are available to agricultural educators online. In response to our stakeholder needs, we have initiated a large-scale project to develop online self-paced agricultural safety and health training modules to increase distance learning opportunities.

With respect to aim 1b, the course has been delivered domestically to trainees in nine states, with regionally specific agricultural health and safety content incorporated to each location. Working with our partners at each site, regional variations in agricultural production and safety and health hazards were identified, teaching materials relevant to those unique features were developed, and questions covering those materials were written and incorporated into the certification examination question bank.

No changes to Aim 1 were implemented. However, one Aim 1 “measurable outcome” was revised. Specifically, we no longer included the “Publication of 2nd edition of textbook” as an outcome. We believe that publication of a textbook by a private publishing company was outside the scope of activities of this federally-funded agricultural safety and health research center. Rather, all effort to revise the curriculum was summarized in the revised curriculum materials which were made available to agricultural health and safety specialists on the Great Plains Center website. This material was disseminated to all partners as well as the NIOSH Agricultural Centers during a meeting held in 2016 at the University of Iowa.

Aim 2: Create instructional materials to support the delivery of the AMCC by any qualified instructor. Revised and updated PowerPoint presentations outlining specific goals, objectives, and competencies were produced and pilot-tested for all core course topic areas and lectures. These presentations are available as part of the comprehensive course manual prepared by Building Capacity personnel and presented to our partners who administer the core course at other sites. In addition, PowerPoint presentations corresponding to every topic and lecture were disseminated to representatives from all NIOSH Agricultural Centers in September 2016 and will be available on the Great Plains Center website without restrictions or charge. Core content includes: Overview of Agricultural Health and Safety, Safety/Industrial Hygiene, Respiratory Disease, Agricultural Trauma/Injury, Zoonotic Diseases/Biological Risk Management, Livestock Handling, Children on Farms/Aging Farmers, Global Health and Safety, Migrant/Seasonal Farmworkers, Physical Agents, Behavioral Health, Cancer, Ergonomics/Musculoskeletal Disorders, PPE, Pesticides, Skin Diseases, Health Care Delivery, Transportation, Prevention, Farm Tours, and Interactive Case Studies. Learning objectives are available for each topic, which include the scope of the problem, the hazards and health effects associated with specific agricultural tasks and settings, and the methods used to mitigate the hazard or evaluate the health effects.

Materials developed by NIOSH and other Agricultural Safety and Health Centers are incorporated into course curriculum and case studies. A series of interactive activities and case studies have been developed to address a range of topics (*e.g.*, youth in agriculture, rural roadway safety, heat safety, PPE). In addition, farm tours are used to demonstrate course concepts and provide hands-on experience, such as grain bin engulfment demonstrations. At the conclusion of the AMCC, local organizations that provide services to rural and agricultural communities participate in a panel discussion. Past participants in the panel conducted at the University of Iowa include: Iowa’s Center for Agricultural Safety and Health, Farm Safety 4 Just Kids, Easter Seals Rural Solutions and Assistive Technology Center, Extension / Iowa Concern Hotline, AgriSafe, Proteus, and the University of Iowa Telehealth program.

University of Iowa remains responsible for distributing content to other sites hosting the course, tracking student demographics, maintaining pre- and post-test scores, and conducting six-month follow-up evaluations. The course director and key faculty meet with each site as needed to support course delivery, discuss the current course offering, assist with promotion, provide content, and/or identify speakers.

Aim 3: Offer the revised AMCC. This 40-hour course was offered each year of this project period at the University of Iowa. Faculty at Texas and Alabama completed the course at Iowa prior to the successful delivery of the core course at their home institutions. In 2014, project personnel provided administrative support, technical assistance, travel cost assistance, and access to an extensive library of training materials to faculty of the University of Alabama, College of Medicine, where the 40-hour core course was administered. In 2014/15, similar support was provided to the NIOSH South West Center for Agricultural Safety and Health in Texas, where the 40-hour core course was delivered successfully for the first time in that region. Additional offerings are indicated in Table 4.

Since 2011, the course has been delivered twenty-two times in eight states as well as in Australia and Turkey. *Since 2011, a total of 470 trainees have completed the course*. Trainees included healthcare providers, veterinarians, medical students, and health and safety professionals. We know of no other agricultural health and safety educational program that has achieved such widespread dissemination and enjoyed such enthusiastic reception. The annual delivery of the course at the University of Iowa was available for graduate college credit or Continuing Medical and Continuing Nursing Education Units. In addition, the Core Course, with assistance from GPCAH faculty and staff, has been delivered in Vermont, Nebraska, North Carolina, North Dakota, Wisconsin, Alabama, Texas, and Australia. Delivery of the course in each location included the development of regionally-relevant agricultural health and safety content.

Aim 4: Create an "academy" of agricultural medicine instructors (AAMI). Building Capacity project leadership chose to refocus this aim to develop and disseminate curriculum that would be available and useful to any organization interested in offering the course. Once a potential course delivery partner organization was identified, the course coordinator and/or instructors from partner institutions were invited to attend the course at Iowa to and to observe the process and receive training. This was followed discussions to develop an on-line curriculum and evaluation process. To formalize the role of local and regional stakeholders in the ongoing development and revision of the course, we developed a national partnership of agricultural educators who have delivered the Building Capacity course at their home institutions. The January 2015 Building Capacity consensus process meeting gathered representatives from five organizations to review updated curriculum and assess professional suitability and discuss sustainability.

University of Iowa faculty were available to deliver course components at other sites, and performed assessments and follow-up evaluations, managing the complete database of course participants. To improve the engagement of the Building Capacity Partners, we also cross-promoted partner activities via the GPCAH website, including: calls for pilot grant proposals at other NIOSH funded centers; class or job offerings at other institutions, new resources or outreach materials; or events, webinars, or presentations given by Building Capacity Partners.

Ultimately, the process of involving geographically-diverse stakeholders in the ongoing development of the AMCC, developing and disseminating quality and current course materials to partnering organizations (including complete PowerPoint presentations and associated lecture notes), and providing logistical and technical support for course delivery has achieved the original intent of Aim 4, which was to enable quality delivery of core course content across the United States and internationally.

Aim 5: Expand distance education delivery methods to supplement classroom teaching, provide continuing education for AMCC instructors, and ensure broad dissemination of programs. As successful as the Building Capacity training program has been, a fundamental barrier to even greater participation is the time-intensive, classroom-based teaching format. Based on repeated feedback that time pressures were an important limiting factor to additional enrolment in the course, there is evidence that development and dissemination of an asynchronous, self-paced, on-line digital learning product will dramatically increase the number of stakeholders who can (and will) participate in the course. We initially included distance components in the core courses delivered in the following states: ND, NE, VT, and NC. These components were simply recorded presentations that were made available to these sites. Although they provided the necessary information, the interactive component was lacking. Based on discussion with our partners, in year 5 we developed a pilot module for online curriculum, demonstrated at the September 2016 workshop. The GPCAH will use this module and feedback to develop a distance curriculum to replace in-class sections of the 40-hour course.

Aim 6: Conduct ongoing evaluation and meta-evaluation of the Building Capacity program Consistent methods were developed and used to track participant completion and to evaluate the quality and effectiveness of the course. Course evaluations include standard demographics, pre- and post-test examination results, instruction evaluations, and a 6-month follow-up questionnaire. These forms and data are maintained at the University of Iowa, even for other locations conducting the course, and are reviewed annually to assess content and exams.

Participants complete course evaluations at the end of the week-long course and again at six months following course completion. The six-month evaluation shows that over 80% of course participants agree or strongly agree that their ability to anticipate, diagnose, treat, or prevent agricultural occupational illnesses and injuries improved as a result of taking the agricultural medicine course. Nearly 85% of course participants agreed or strongly agreed the information they received during the agricultural medicine course has helped them address the occupational and environmental hazards of the agricultural community in their region. Nearly 70% of trainees agreed or strongly agreed they feel confident when recommending personal protective equipment (PPE) for the farming population.

Conclusions and Impact

Over this project period, the 40-hour AMCC has been delivered 22 times in eight states, with additional offerings in Turkey and Australia. This project period, 470 trainees have completed the course, increasing the capacity of primary healthcare providers, veterinarians, medical students, and health and safety professionals in their ability to recognize, evaluate and recommend controls to protect the health and safety of farmers and rural populations. During this project period, the course has been revised to encompass a broader range of health hazards and to increase emphasis on prevention. In response to the demand for the course and the need to ensure continued sustainability, this project period identified new partners to review and provide regionally-appropriate content for online self-paced training modules to be available to all.

Outputs and Outcomes

Publications – Peer Reviewed

1. Brumby SA, Ruldolphi J, Rohlman D, Donham KJ: [2017] Translating agricultural health and medicine education across the Pacific: a United States and Australian comparison study. *Rural Remote Health*. Jan-Mar;17(1):3931. Epub 2017 Mar 14. *[PMID: 28292189]*
2. Rudolphi JM, Donham KJ: [2015] Toward a national core course in agricultural medicine and curriculum in agricultural safety and health: the "building capacity" consensus process. *Journal of Agromedicine*. 20(1): 77-83. *[PMID: 25635745]*
3. Rudolphi JM, Donham KJ: [2015] Increasing the number of trained health and safety professionals in agricultural medicine: evaluation of the "building capacity" program, 2007-2013. *Journal of Agromedicine*. 20(1): 21-830. *[PMID: 25635740]*

Presentations

1. Rohlman DS, Duysen E, Grafft L, Wickman A, McCandless J, Guin S, Sheridan C: [2016] *From Past to Future: Education for Agricultural Safety and Health Professionals,* presentation, International Society of Agricultural Health and Safety, June, 2016, Lexington, KY.
2. Rohlman DS, Gerr F, Nonnenmann M, Rudolphi J: [2015] *Developing a Sustainable Training Program for Agricultural Safety and Health Professionals,* presentation, International Society of Agricultural Health and Safety, Bloomington-Normal, IL (June 21-24, 2015)
3. Rohlman DS, Gerr F, Nonnenmann M, Rudolphi H, Mohling K, Duysen E, Grafft L, Guin S, McCandless J, Wickman A: [2015] *Safety and Health Education in Agriculture,* presentation, International Society of Agricultural Health and Safety, Bloomington-Normal, IL (June 21-24, 2015).
4. Rudolphi J, Donham K: [2013] Educational Changes to Agricultural Medicine. Midwest Rural Agricultural Safety and Health Conference. November 19-20, 2013.
5. Donham KJ: [2011] Building capacity in agricultural medicine training. Midwest Rural Agricultural Safety & Health Conference. November 16-17, 2011, Johnston, IA.

Consultation or Information Exchange

470 agricultural safety and health advocates trained, totaling 18,800 contact hours.

Instructional materials made available to all NIOSH AFF Center educators at a September 2016 workshop. Learning objectives are available for each topic which include the scope of the problem, the hazards and health effects associated with specific agricultural tasks and settings and the methods used to mitigate the hazard or evaluate the health effects. Core content includes:

- Overview of Agricultural Health and Safety
- Safety/Industrial Hygiene
- Respiratory Disease
- Agricultural Trauma/Injury
- Zoonotic Diseases/Biological Risk Management
- Livestock Handling

- Children on Farms/Aging Farmers
- Global Health and Safety
- Migrant/Seasonal Farmworkers
- Physical Agents
- Behavioral Health
- Cancer
- Ergonomics/Musculoskeletal Disorders
- Personal Protective Equipment
- Pesticides
- Skin Diseases
- Health Care Delivery
- Transportation
- Prevention
- Farm Tours
- Interactive Case Studies

Cumulative Enrollment

Cumulative Enrollment Table

N/A – This project did not involve human subjects.

Inclusion of Gender and Minority Study Subjects

N/A – This project did not involve human subjects.

Inclusion of Children

N/A – No children were included in this program.

Materials Available for Other Investigators

Digital versions of materials generated as outputs from this project, including educational modules, are available to all by contacting GPCAH directly or via the web (www.gpcah.org).

Translation Core: Research to Practice with Community Partners

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Abstract

The research-to-practice (R2P) project served as a mechanism to provide outreach to farmers and their advocates. A network of community partners was formed (Regional Advisory Committee, or RAC) and nurtured to improve information exchange between Center personnel and those who can influence farmer safety and health throughout the GPCAH region. The Center enhanced the basic skills and knowledge of these partners on a variety of safety and health topics, and our partners identified risks and barriers to safety and health from the field. Persistent hazards and findings from GPCAH projects during this project period were prioritized by the RAC, with findings translated to relevant messages for multiple stakeholder use. These translations were disseminated throughout the region via community partners and other advocate organization identified by the RAC. A multi-tiered approach for communicating safety and health messages included: quarterly newsletters, monthly news articles in farmer publications, annual conferences, one-on-one interactions with an estimated 7650 farmers, and website/social media content. New dissemination outlets were identified and built, including producer organizations (National Pork Board, Cattlemen's Association, and Practical Farmers) who have shared production-specific messages critical to protecting the health and sustainability of their producers. New methods to communicate research findings and persistent hazards have been developed, including translating research findings into infographic and poster-ready guidance, while sustaining traditional networks that are still highly valued by our region's farmers (*e.g.*, newsprint). Our community partners have helped identify priorities for persistent and emerging issues, and Center personnel have developed best-practice guidance for our partners and the Center to communicate with affected workers. Our community partners have been mentored to improve their ability to garner community grants and have shared their lessons learned through Center-sponsored mechanisms, including presentations at the Midwest Rural Agricultural Safety and Health conference and articles for the *Farm Families Alive and Well* newsletter. Our partners have also provided connections to farmers to respond to emerging issues (*e.g.,* avian flu) and have used translated information in their organization's educational activities. Continued nurturing of these important relations is needed to ensure that targeted safety and health knowledge adequately addresses and reaches farmers to achieve the mission of the Center, to prevent agricultural injury and illness and to improve safety and health among agricultural communities.

Background

In order to improve the health and safety outcomes throughout the nine state region of the Great Plains Center for Agricultural Health (GPCAH), a partnership between the GPCAH and regional health and safety advocates is needed. A clear need to develop and distribute evidence-based resources to enhance the expertise and ability of these partners was identified throughout the region.

Aims

This project's goal was to provide information, supportive services, and other resources for the translation of agricultural safety and health research to equip our community partners with tools to develop and deliver effective interventions to the grassroots farming population. By increasing the quality and reach of science-based prevention programs to the grassroots farm and farmworker population, and by enhancing the expertise and skills of our community partners, this project was intended to both strengthen the abilities of these organizations and to achieve the long-term goal of reducing agricultural injuries and illnesses throughout the Midwest. The specific aims of this project were:

1. Communicate the results of relevant agricultural health and safety research in the U.S. to community partners and assist these partners in the translation of these findings into meaningful agricultural health and safety practice.
2. Establish pathways for the two-way flow of information between agricultural producers and farm workers to the GPCAH via community partner staff in order to better understand the exposures, needs, and effectiveness of interventions.

3. Provide pilot funding to community partners for promising R2P activities through the proposed Outreach Program of the GPCAH by an open, widely-publicized, and competitive process.
4. Improve the relevancy and effectiveness of the GPCAH community partners and outreach programming through a formative and summative evaluation process.

Methods

The key elements to improving the partnerships between the GPCAH and safety and health advocates are summarized in Table 5.

Essential to the success of this project was the assembly of the Regional Advisory Committee (RAC). RAC members actively participated in quarterly phone calls and one in-person meeting per year. Over time, the makeup of the committee changed, as personnel and organizations reorganized. Table 6 highlights the makeup of the regional advisory board at the beginning and end of the project cycle.

Table 5: Key activities incorporated into the R2P project to improve the knowledge, skills, and impact of regional partner efforts to protect the health and safety of agricultural workers.

Objective	Method	Frequency/Activity	Relevant Aim
Communicate Best Practices	Regional Advisory Committee (RAC)	Quarterly conference calls	1,2,4
	Farm Families Alive and Well newsletter	Quarterly newsletter	1
	Midwest Rural Agricultural Safety and Health (MRASH) Conference	Annual conference	1,2,4
	GPCAH Web Site	Website revision in 2014	1,2,4
	Direct-to-farmer contacts (*GPCAH on-the-go*)	Farm shows and invited speaking engagements	2
	"Safety Watch" articles for Lee Agrimedia publications	Monthly articles, launched Feb. 2015	1,2
	Social Media (Facebook, Twitter)	Launched in 2015	1,2,4
Translate Research Findings	Injury surveillance communication (GPCAH press clipping, NIOSH FACE, CFOI)	Synthesize findings into prevention recommendations	2,4
	Provide consultation to community partners	Respond to requests, as needed	1,2
	Provide interpretation to emerging issues, as warranted	Respond to requests, as needed	1,2

Pilot grants to community members (Aim 3) was incorporated directly into the Pilot/Feasibility Project program, with results reported previously in the Pilot/Feasibility Program (p 15).

Findings

This project focused on the translation and dissemination of both research-generated knowledge and well-studied persistent hazards important to the region. High impact activities that addressed these aims include the generation of: 68 prevention articles in 20 quarterly newsletters (3666 subscribers), 26 Safety Watch articles in Iowa/Illinois/Missouri Farmer Today (116,000 subscribers), 505 attendees of six two-day conferences (MRASH), and mentoring of nine community-based pilot grant awardees.

Table 6: Regional Advisory Committee (RAC) members

Organization	Representative Yr 1	Representative Yr 5
AgriSafe Network	Carolyn Sheridan	Carolyn Sheridan
AgriWellness	Michael Rosmann	-
Farm Safety for Just Kids	David Schweitz	Shari Burgess
National Education Center for Agricultural Safety	Dan Neenan	Dan Neenan
Proteus	Krista Barnes	Peg Bouska
Organizations Added (year)		
UMASH (2)	-	Ruth Rasmussen
CSCASH (2)	-	Ellen Duysen
National Pork Board (4)	-	Karen Hoare
WI Center for Dairy Farm Safety (4)	-	Connie Smith
Extension:		
Illinois	Robert Aherin	Robert Aherin
Kansas	John Slocombe	Kerri Ebert
Minnesota	Katerhine Waters	-
Missouri	Karen Funkenbush	Karen Funkenbush
Nebraska	Sherry Nielsen	Sherry Nielsen
North Dakota	Staci Lee	Erin Cortus
Wisconsin	Cheryl Skjolass	-
Iowa	-	Alex Ramirez

Many outputs were generated from the collaboration between the community partners and GPCAH. Significant contributions that combined education with best practice recommendations to farmers and their advocates are detailed in brief.

***Alive and Well Newsletter*:** This newsletter was distributed to 3666 subscribers, via a combination of hard copy and email, with a repository now housed on the GPCAH web site for continued access. The newsletter is a vehicle to update farmers and their advocates on events, resources, and translated research findings relevant to protecting the safety and health of agricultural workers throughout the region. Of 68 stories run from September 2011 through March 2017 (excluding announcements of upcoming activities), *12% were written by RAC members, 6% by other partners, and 13% by GPCAH pilot grant awardees.*

Midwest Rural Agricultural Safety and Health (MRASH) Conference: These annual conferences were co-sponsored by GPCAH, allowing dissemination of research findings to community partners across the GPCAH region. Over the 5-year project period, attendees from 11 states (AK, CO, IA, IN, IL, KS, MO, MN, NE, WI, SD) and Canada (in 2015) and Sweden (in 2012) have participated in the event. Although affiliations of attendees changed over time, attendance was dominated by researchers (Midwest universities and NIOSH AFF centers), and healthcare providers, agricultural safety and health professionals, public health workers, agribusiness representatives, and producers also attended. Of the 174 oral/poster presentations at these conferences, 16% were provided by GPCAH investigators, 10% by other AFF center investigators, 8% by RAC members, and 9% by pilot grant recipients.

GPCAH Website Development**:** Another key method to update the community on events, best practices, and translated research is the web site (http://www.public-health.uiowa.edu/gpcah/). Significant efforts throughout the project period improved the content and format of this website, and we began to magnify its presence via GPCAH Facebook and Twitter accounts for the GPCAH. In 2013, fact sheets were developed and posted on critical persistent hazards (hearing loss, heat illness, tractor safety, aging farmers, grain safety). In 2014, online resources available to farmers were vetted and links were posted to aid visitors. In 2015, manure gas awareness materials and avian flu personal protective equipment recommendations were prepared and posted. In 2016, research project findings were translated by the R2P project team into visual data displays ("infographics") and posted.

GPCAH on-the-go: In the middle of this project cycle, the need to increase the recognition of the GPCAH as a resource to the farming community was identified by the RAC, with a score of "low" on our direct-to-farmer connections. Because of the successful participation by farmers at the 2013 community events, the "GPCAH on-the-go" was added as an additional R2P activity to increase the exchange of informational resources directly with farmers. Throughout 2014-16, the staff provided outreach via safety and health demonstrations at multiple agricultural events throughout the region. When feasible, collaboration with other AFF centers (CS CASH, UMASH, SW Ag Center, Children's Center), RAC members (MO Extension, NECAS), and state health departments helped magnify safety and health messages. From 2014-16, 37 events were attended in eight of the nine GPCAH states (Table 7).

On-the-go outreach activities included two-way exchanges with farmers, and many allowed collaborations between NIOSH AFF centers attending the same events. Outreach activities that demonstrated substantial information exchange, often with surveys, include:

2014: Heat illness, providing 700 water bottles and urine color charts; Hearing protection promotion (1000 earplugs distributed); Health and safety needs assessment (190 farmers).

2015: Personal protective equipment use survey with 800 kits distributed and 699 farmers participating in use survey (440 completed follow-up 3 months later).

2016: Manure gas survey (with co-sponsorship by John Deere, Inc.) and demonstration (88 survey participants); tractor lighting and marking display with survey (313 participants).

"Safety Watch" Articles *in Iowa/Illinois/Missouri Farmer Today Magazine:* During the project period, collaborations between Iowa FACE, ICASH and GPCAH has resulted in the development of a monthly "Safety Watch" column beginning in February 2015 (repository at: http://www.public-health.uiowa.edu/gpcah/safety-watch/). This weekly farm newspaper has a circulation over 116,000, and the readers have provided positive response to the conversational style of safety messages with production and farmer perspectives in mind. Twenty five of the 27 articles translated research into practical information and covered a wide range of topics, including: safety (electrical, fire, management, working solo, youth), chemical hazards and respiratory protection, manure gas hazards, tractor and roadway safety, and hearing protection, mapping to regional needs assessment priorities.

Social Media: Initial activities in social media were incorporated into Center operations in 2016 in efforts to provide short messages with links to longer study findings or prevention tips to a more interactive audience.

Injury Surveillance Communication: Information from the GPCAH surveillance project and data from the Iowa Fatality Assessment and Control Evaluation (FACE) project were incorporated into newsletters (3/2012) and into the Building Capacity course materials to demonstrate intervention prioritization and build motivation for course participants in introductory sessions. In addition, collaboration with the Injury Prevention Center and the surveillance project of this Center, CFOI data from 2005-2012 (1858 cases) were evaluated for similar fatality trends using BLS data from 12 states (GPCAH region plus IN, MI, OH), with results actively communicated to state epidemiologists as well as web delivery (see http://www.public-health.uiowa.edu/gpcah/center-projects/surveillance-of-agricultural-injuries-and-fatalities/) and incorporated into Safety Watch articles, when appropriate.

Table 7: GPCAH on-the-go topics (number of events)

Event	2014	2015	2016
Ag Safety Day	Heat Illness Prevention (4)	Hearing Loss Prevention Hand Hygiene (4)	Safety Signs (4)
County Fairs	Hearing Loss Prevention (1)	Ag Safety Jeopardy (2)	Noise, Gas Monitors (2)
National Association of County Agricultural Agents Conference	-	Ag Safety Jeopardy, Heat Illness Prevention for Kids	ASH Core Course
4-State Farm Show (KS)	Hearing Loss Prevention	-	Hearing Loss Prevention
Dakotafest (SD)	Hearing Loss Prevention	Hearing Loss Prevention/ PPE Use Study	Gas Monitors, Roadway Safety
Farm Progress Show (IA/ IL alternating)	Heat Illness Prevention, Ag Safety and Health at UI, Roadway Safety	Hearing Loss Prevention / PPE Use Study	Roadway Safety Gas Monitors Noise
World Beef Expo	Hearing Loss Prevention	-	-
Husker Harvest Days (NE)	Hearing Loss Prevention	Hearing Loss Prevention / PPE Use Study	Roadway Safety, Hearing Loss Prevention
Ozark Fall Farmfest (MO)	-	Hearing Loss Prevention/ PPE Use Study	-
Minnesota Farm Fest (MN)	Hearing Loss Prevention	Hearing Loss Prevention / PPE Use Study	Gas Monitors, Child Safety
Iowa Pork Congress (IA)	-	Manure Gas Safety	Gas Monitors
Interaction tracking (completed surveys / items distributed)	700: Heat illness/safe play 750: Noise (youth) 1000: Noise awareness 190: Health & safety needs	600: Noise (youth) 800: PPE use	313: Reflective kits 137: HPD selection 88: Manure safety
Interactions with:	1890 farmers	1400 farmers	538 farmers

Community Partner Consultations: Over the 5-year project period, Center personnel on this project provided substantial informational resource exchanges/consulting with farmers and advocates (58), policy makers (26), and media (78), all with the goal of communicating best-practices to prevent farmer injuries and illnesses.

Emerging Issues Consultation: The GPCAH administration and R2P team solicited expertise from Center personnel to respond to emerging issues over the project period, most importantly Avian Flu and manure gas hazards. In collaboration with NE and MN AFF centers and AgriSafe, the GPCAH participated in the development of PPE recommendations for producers affected by the avian flu and provided guidance to community partners with real-time questions during the 2015 Midwest outbreak. In response to the two double fatalities in IA and WI in July 2014, manure gas safety materials were developed and presentations were given at hog-producer meetings to increase awareness and provide guidance on best practice. Case summaries from fatality investigations were used to motivate adoption of best practices, and recommendations to prevent hydrogen sulfide fatalities and methane gas exposures were prepared for farmers (and reviewed by the National Pork Board) and were incorporated into ongoing educational programs (*e.g.*, Building Capacity project).

Improve the relevancy and effectiveness of the GPCAH community partners and outreach programming through a formative and summative evaluation process

Ongoing efforts to preplan messaging and translation has been incorporated into new mechanisms of outreach, particularly monthly *Safety Watch* articles in agriculture media and bringing translated messages to farmers at farm show. In 2016, GPCAH developed a calendar of timely topics, by production and high-risk activities and exposures, to identify best practices and prevention messages throughout the multiple outlets of the Center (*e.g.*, on the website, in newsletters and articles, and via social media). These initially addressed persistent hazards, then emerging issues, and finally incorporated results from GPCAH project findings. Highlights of effective communications, coordinated by the R2P project team, include:

Manure gas: Safety Watch articles focusing on awareness and prevention (use of gas monitors) have been developed and published during high-risk seasons (post-harvest fall, early spring) when manure pumping occurs; social media and web postings were released to magnify the distribution of this information. In 2016-17, 27 GPCAH social media posts focused on manure gas awareness and were shared on Facebook and Twitter. These messages reached over 7,000 individuals and had an engagement rate of 9.7%.

Ammonia burns: State hospitals identified a significant increase in chemical burns during pre-planting fertilizing in 2014. A Safety Watch article (Anhydrous injury survivors share stories, April 2015) was published to remind farmers of the risk and preventative measures to take when working with anhydrous; rates of injuries were reportedly lower than in the previous year.

Roadway safety: Results from the Farm Vehicle Crash Study (Research Project A) were used to generate three public service announcements (PSAs), which have been disseminated just prior to harvest and planting seasons via radio networks listened to by farmers throughout the region. The R2P team constructed a press release that led to more than 17 news articles, published nationally (*e.g.*, Minneapolis Star Tribune, Successful Farming Magazine). The R2P team worked with the College's communications department to generate a 1-minute "Farm Vehicle Safety" video to share study findings, and R2P collaborated with the Farm Vehicle Crash Study team to generate two more short videos for deploying on YouTube networks. These will be marketed via social media and press releases, again in conjunction with increased farm vehicle activities, in Sept. 2017.

The RAC identified an important gap in the Center's partners and outreach efforts, namely agricultural educators. The RAC also provided recommendations to simplify recommendations to farmers and producers and to make materials more interesting. In the final year of this project, the R2P project team translated data across multiple center projects into posters incorporating infographic design principles. RAC members reviewed and recommended revisions for a set of posters designed for multiple audiences including agricultural educators. In March, 2017, hard copies of posters were mailed to 120 educators and the RAC members, with guidance on how to incorporate each poster into an agriculture curriculum (https://www.public-health.uiowa.edu/gpcah/ag-educators-posters/). Five weeks after mailings, the web page was viewed 61 times by 37 unique individuals, with a 34% longer time spent on this page than any other GPCAH page. By August 2017, the page had been viewed 224 times, with people spending an average of 3 minutes on the page, with 57% of all visitors now arriving to these materials from Facebook postings. Three emails were received by individuals wanting to share the posters (electronically and print) with their organizations and during a Safety Day in Wisconsin event. These posters are available to all for downloading and printing.

Conclusions and Impact

This project confirmed that multiple stakeholders who collaboratively develop and disseminate safety and health messages to the agricultural community can magnify the reach of an AFF center. By making many stakeholders aware of materials available and by allowing for iterative revision of simple to understand but technically accurate prevention guidance, the final work product better meets the needs of multiple users. More importantly, participants are more invested in the materials and more likely to incorporate messaging into their organizational activities. While this project was *not* designed to measure reductions in work-related morbidity, mortality or exposure, these intermediate outcomes have been shared with influencers in practice, including producers organizations, medical providers, building designers, and safety managers that can ultimately assist with long-term translation into improved health and safety of our region's agricultural workers.

Outputs and Outcomes

Publications – Peer Reviewed

1. Chiu S, Cheyney M, Ramirez M, Gerr F: [2015] Where do agricultural producers get safety and health information? *J Agromedicine*. 20(3): 265-72. [PMID: 26237716]
2. Donham KJ, Kline AK, Kelly KM, Lange JL, Rautiainen RH: [2013] Respirator and hearing protection use in the certified safe farm. *J Agromedicine*. 2013; 18(1):18-26. [PMCID: 23301887]

Presentations (Abstracts and Conference Presentations)

1. Cheyney M, Gerr F (2016). But do they use it? Factors influencing the use of hearing protection among farmers. International Society for Agricultural Safety and Health, June, 2016, Lexington, KY.
2. Cassidy A & Cheyney M: [2014] U.S. Agricultural Safety and Health Centers YouTube Channel. 13th Annual Midwest Rural Agricultural Safety & Health Conference, Ankeny, IA.
3. Leonard S, Anthony TRL [2013]. Agricultural Fatality Case Studies. Midwest Rural Agricultural Safety and Health Conference, Ames, IA. Nov 19-20, 2013.
4. Cheyney M, Gerr, F, Ramirez, M: [2013]. Where do farmers get health and safety information? Midwest Rural Agricultural Safety and Health Conference, Ames, IA. Nov 19-20, 2013.
5. Anthony TR, Park JH, Peters TM, Altmaier R: [2013] Evaluation of air pollution control devices to improve indoor air quality of swine farrowing building, Midwest Regional Agricultural Safety and Health, Ames, IA.
6. Anthony TR, Sawvel R, Jones S, Altmaier R, Park JH, Peters TM: [2014] Improving Indoor Air Quality of Swine Farrowing Buildings. International Society of Agricultural Safety and Health (ISASH) Conference (Session 11D), Omaha, NE.
7. Duff and Lasley: [2013] Today's Farmers: Perspectives on Who They Are and How They Farm. Midwest Rural Agricultural Safety & Health Conference. Ames, IA.
8. Gunderson P: [2013] How is Technology Changing Agriculture and Corresponding Health & Safety Needs. Midwest Rural Agricultural Safety & Health Conference. Ames, IA.
9. Fisher E: [2013] Motivating Families to Create Safe Play Areas on Farms: Intervention Results. International Society Agricultural Safety and Health 2013 Annual Meeting. Sandusky, OH.
10. Madsen M, Donham K: [2013]: Farm and Ag injuries in press clips. 2013 Upper Midwest Agricultural Safety and Health Annual Forum. St. Paul, MN.
11. Gerr F: [2012] Neurobehavioral effects of solvent exposure among agricultural works. International Society Agricultural Safety and Health 2012 Annual Meeting. Burlington, VT.
12. Ramirez M: [2012] Agriculture injury surveillance: collaborations between academia and government. Midwest Rural Agricultural Safety & Health Conference. Cedar Rapids, IA.
13. Donham K: [2012] Lecture: "Farm Safety Day" Rural Health Clinic of Greater Johnson CO. Delivered to farm families from Johnson, Iowa, Keokuk, and Washington Counties, Iowa City, IA.
14. Donham K: [2012]: Lecture: Personal protective equipment demonstration and use, Farm Progress Show, Boone, IA.
15. Burgus S: [2011] Working Farm Youth Education. Midwest Rural Agricultural Safety & Health Conference. Des Moines, IA.
16. Kirschenmann. [2011] Opportunities for Sustaining Rural Communities in the Face of Future Challenges. Keynote Address, Midwest Rural Agricultural Safety & Health Conference. Des Moines, IA.
17. Stallones: [2011] Weathering Change: Stress and Behavioral Health. Keynote Address, Midwest Rural Agricultural Safety & Health Conference. Des Moines, IA.

Webinars

1. Donham K: [2013] Webinar: "SW Center for Agricultural Health, Injury Prevention, and Education Update" delivered to the AgriSafe Network.
2. Donham K: [2013] Webinar: "High Plains Center for Agricultural Health and Safety Update" delivered to the AgriSafe Network.
3. Donham K: [2013] Webinar: "SE Center for Agricultural Health and Injury Prevention Update" delivered to the AgriSafe Network.

4. Donham K: [2013] Webinar: “National Children's Center for Rural and Agricultural Health and Safety Update” delivered to the AgriSafe Network.
5. Donham K: [2012] Webinar: Certified Safe Farm Translation to Practice.
6. Donham K: [2011] Webinar: Certified Safe Farm Translation to Practice.
7. Donham K: [2011] Webinar: Agricultural Musculoskeletal Diseases.
8. Donham K: [2011] Webinar: Agricultural Hearing Loss and Other Physical Factors.
9. Donham K: [2011] Webinar: Human Health Hazard of Veterinary Pharmaceuticals.
10. Donham K: [2011] Webinar: Agricultural Respiratory Conditions.

Workshops and/or Presentations/Outreach to the Community

1. Cheyney M: [2017] Gas Monitors in Livestock Production. Pork Congress, Des Moines, IA.
2. Gibbs JL: [2017] Farm Vehicle Roadway Safety, Practical Farmers of Iowa Conference, Ames, IA.
3. Cheyney M and Trenkamp E: [2016] Gas Monitor Display and Farm Youth Safety, Minnesota Farmfest, Redwood Falls, MN.
4. Cheyney M: [2016] Hearing Loss Prevention and Farm Vehicle Roadway Safety, Husker Harvest Days, Grand Island, NE.
5. Cheyney M: [2016] Farm Vehicle Roadway Safety and Gas Monitor Displays, Dakotafest, Mitchell, SD.
6. Cheyney M: [2016] Ag Health and Safety Core Course (Building Capacity), National Association of Country Agricultural Agents Annual Conference, Little Rock, AR.
7. Cheyney M, Gibbs JL, DeVito C, Trenkamp E: [2016] Hearing Loss Prevention and Gas Monitor Displays, Johnson County Fair, Iowa City, IA.
8. Cheyney M, Gibbs JL, DeVito C, Trenkamp E: [2016] Hearing Loss Prevention and Gas Monitor Displays, Washington County Fair, Washington, IA.
9. Cheyney M, Gibbs JL, DeVito C, Trenkamp E, Faust K: [2016] Hearing Loss Prevention, Gas Monitors Display, and Farm Vehicle Roadway Safety, Farm Progress Show, Boone, IA.
10. Gibbs JL: [2016] Gas Monitor Display and Farm Vehicle Roadway Safety, Women Food and Agricultural Network (WFAN) Conference, Nebraska City, NE.
11. Gibbs J and DeVito C: [2016] Hearing Loss Prevention, Four State Farm Show, Pittsburgh, KS.
12. Cheyney M: [2016] “Safety Signs” to 96 elementary students at the Garrison EMS Services Agricultural Safety Day in Garrison, IA.
13. Cheyney M: [2016] “Safety Signs” to 220 elementary and high school students at Progressive Ag Safety Days at the National Education Center for Agricultural Safety in Peosta, IA.
14. Cheyney M: [2016] “Safety Signs” to 184 elementary students at the BMG Agricultural Safety Day in Brooklyn, IA.
15. Cheyney M: [2015] Ag Safety Jeopardy, Heat Illness Prevention for Kids, National Association of Country Agricultural Agents Annual Conference, Sioux Falls, SD.
16. Cheyney M and Gibbs JL: [2015] Hearing Loss Prevention and Personal Protective Equipment Use Survey. Ozarks Fall Farmfest, Springfield, MO.
17. Cheyney M and Neenan D: [2015] Safety Signs Game, NECAS Youth Safety Days, Peosta, IA (4 events).
18. Cheyney M: [2015] Hearing Loss Prevention, Dakotafest, Mitchell, SD.
19. Cheyney M: [2015] Manure Gas Hazards. Pork Congress, Des Moines, IA.
20. Cheyney M and Gibbs JL: [2015] Ag Safety Jeopardy, Johnson County Fair, Iowa City, IA.
21. Cheyney M and Gibbs JL: [2015] Ag Safety Jeopardy, Washington County Fair, Washington, IA.
22. Cheyney M and Gibbs JL: [2015] Hearing Loss Prevention and Personal Protective Equipment Use Survey, Farm Progress Show, Decatur, IL.
23. Cheyney M and Bucklin R: [2015] Hearing Loss Prevention and Personal Protective Equipment Use Survey, Minnesota Farmfest, Redwood Falls, MN.
24. Cheyney M and Bucklin R: [2015] Hearing Loss Prevention and Personal Protective Equipment Use Survey, Husker Harvest Days, Grand Island, NE.
25. Cheyney M and Neenan D: [2015] Hearing Loss Prevention and Hand Hygiene, NECAS Youth Safety Days, Peosta, IA (4 events).

26. Cheyney M: [2015] Hearing Loss Prevention and Personal Protective Equipment Use Survey, Dakotafest, Mitchell, SD.
27. Cheyney M: [2015] Training on Heat Illness Prevention given to 200 migrant agricultural workers in Williamsburg, IA.
28. Gibbs JL: [2015] Heat Illness Prevention, Women Food and Agricultural Network (WFAN) Conference, Davenport, IA.
29. Bucklin R, Cheyney M: [2015] Workshop on Heat Illness prevention at Camp Clover, Elmwood, IL. Presented to 25 children.
30. Cheyney M: [2014] Hearing Loss Prevention, Dakotafest, Mitchell, SD.
31. Cheyney M: [2014] Hearing Loss Prevention, World Beef Expo, Burnett, WI.
32. Cheyney M and Ramirez M: [2014] Hearing Loss Prevention, Roadway Safety, Ag Health and Safety Programs at the University of Iowa. Farm Progress Show, Boone, IA.
33. Cheyney M: [2014] Hearing Loss Prevention, Minnesota Farmfest, Redwood Falls, MN.
34. Cheyney M: [2014] Hearing Loss Prevention, Four State Farm Show, Pittsburgh, KS.
35. Cheyney M: [2014] Hearing Loss Prevention, Husker Harvest Days, Grand Island, NE.
36. Cheyney M: [2014] Hearing Loss Prevention, Johnson County Fair, Iowa City, IA.
37. Cheyney M and Neenan D: [2014] Heat Illness Prevention, NECAS Youth Safety Days, Peosta, IA (4 events).
38. Cheyney M (2014) Workshop on Heat Illness prevention at the Jefferson County Fair - June 2014.
39. Cheyney M (2014) Workshop for Ag-Citing Program at the Clay County Fair – September 2014.
40. Jennissen C: [2014] ATV Safety Panel Discussion, Midwest Rural Agricultural Safety and Health Conference, Ankeny, IA.
41. Donham K (2013) Presentation: "The Progress and Development of the Rural Health and Safety Clinic of Greater Johnson County", delivered to the Johnson County Board of Health, County Board of Supervisors, Public Health Staff, and Community members.
42. Donham K: [2012] Lecture: Personal protective equipment demonstration and use, Farm Progress Show, Boone, IA.
43. Adkisson J, Adherin R: [2012] Grain Safety Panel Discussion. Midwest Rural Agricultural Safety & Health Conference. Cedar Rapids, IA.
44. NIOSH R2P Panel Discussion: [2012] Midwest Rural Agricultural Safety & Health Conference. Cedar Rapids, IA.
45. Donham K: [2012] Lecture: "Farm Safety Day" Rural Health Clinic of Greater Johnson CO. Delivered to farm families from Johnson, Iowa, Keokuk, and Washington Counties, Iowa City, IA.
46. Donham K: [2011] Workshop: Agricultural Medicine: the Core Course, Vermont Farm Health Task Force, Burlington VT.

Media Articles – GPCAH Authored

1. Leonard S: [2017] Plan now for safe manure handling. Iowa/Illinois/Missouri Farmer Today, March 2017.
2. Janssen B: [2017] Small steps affect beginning farmers' safety. Iowa/Illinois/Missouri Farmer Today, February 2017.
3. Leonard S: [2017] Winter repair work presents stability risks. Iowa/Illinois/Missouri Farmer Today, January 2017.
4. Janssen B: [2016] Suicide rate among farmers at historic high. Iowa/Illinois/Missouri Farmer Today, December 2016.
5. Leonard S: [2016] Producers respond to H2S deaths. Iowa/Illinois/Missouri Farmer Today, November 2016.
6. Janssen B: [2016] Farming with diabetes requires balancing act. Iowa/Illinois/Missouri Farmer Today, October 2016.
7. Leonard S: [2016] Risky moves rise as farmers move fast, solo. Iowa/Illinois/Missouri Farmer Today, September 2016.
8. Janssen B: [2016] Responders prep for safe harvest. Iowa/Illinois/Missouri Farmer Today, August 2016.
9. Leonard S: [2016] Attention to surroundings makes shared roadways safer. Iowa/Illinois/Missouri Farmer Today, July 2016.

10. Janssen B: [2016] Keep new, young employees safe on the farm this season. Iowa/Illinois/Missouri Farmer Today, June 2016.
11. Leonard S: [2016] Micotil injections can be lethal. Iowa/Illinois/Missouri Farmer Today, May 2016.
12. Brigioni M and Janssen B: [2016] Collaboration keeps Argentine farmers safe. Iowa/Illinois/Missouri Farmer Today, April 2016.
13. Leonard S: [2016] The right respirator. Iowa/Illinois/Missouri Farmer Today, March 2016.
14. Janssen B: [2016] Farming safety, profitability—are you a good risk? Iowa/Illinois/Missouri Farmer Today, February 2016.
15. Leonard S: [2016] Bin fires can create CO danger. Iowa/Illinois/Missouri Farmer Today, January 2016.
16. Janssen B: [2015] Tale precautions to avoid farm fires this winter. Iowa/Illinois/Missouri Farmer Today, December 2015.
17. Leonard S: [2015] Various risks associated with pressure washing. Iowa/Illinois/Missouri Farmer Today, November 2015.
18. Janssen B: [2015] ICASH Grants help spread safety to future farmers. Iowa/Illinois/Missouri Farmer Today, October 2015.
19. Leonard S: [2015]. Everyday lessons. Iowa/Illinois/Missouri Farmer Today, September 2015.
20. Leonard S: [2015]. Patience prevents accidents with baling, moving hay. Iowa/Illinois/Missouri Farmer Today, August 2015.
21. Janssen B: [2015] Take precautions to avoid heat-related illness. Iowa/Illinois/Missouri Farmer Today, July 2015.
22. Leonard S: [2015]. Knock down effects of hydrogen sulfide. Iowa/Illinois/Missouri Farmer Today, July 2015.
23. Janssen B: [2015] Farming can be challenging after knee, shoulder injury. Iowa/Illinois/Missouri Farmer Today, June 2015.
24. Ramirez M and Ellis T: [2015] Help kids stay safe on the farm. Iowa/Illinois/Missouri Farmer Today, May 2015.
25. Leonard S: [2015]. Anhydrous injury survivors share stories. Iowa/Illinois/Missouri Farmer Today, April 2015.
26. Janssen B: [2015] Spring-cleaning: tips for safe and successful controlled burns on the farm. Iowa/Illinois/Missouri Farmer Today, March 2015.
27. Leonard S and Gerr F: [2015] Hearing protection never too early or too late. Iowa/Illinois/Missouri Farmer Today, February 2015.

Sponsored Conferences

1. Midwest Rural Agricultural Safety and Health Conference (MRASH): [2016] Safeguarding Farm Livelihoods. Sioux Center, IA. (55 attendees)
2. Midwest Rural Agricultural Safety and Health Conference (MRASH): [2015] Working Together for a Safer Tomorrow. Decorah, IA. (87 attendees)
3. Midwest Rural Agricultural Safety and Health Conference (MRASH): [2014] Transforming Safety & Health in the Heartland. Ankeny, IA. (100 attendees)
4. Midwest Rural Agricultural Safety and Health Conference (MRASH): [2013] The Many Faces of Agriculture. Ames, IA. (80 attendees)
5. Midwest Rural Agricultural Safety and Health Conference (MRASH): [2012] Reaping the Rewards: Research to Practice. Cedar Rapids, IA. (118 attendees)
6. Midwest Rural Agricultural Safety and Health Conference (MRASH): [2011] Weathering the Elements. Des Moines, IA. (65 attendees)

Cumulative Enrollment

Cumulative Enrollment Table

N/A –All surveys performed during outreach events were reviewed by the University of Iowa Humans Subjects Office and were determined not to be human subjects research.

Inclusion of Gender and Minority Study Subjects

N/A – This project did not involve human subjects.

Inclusion of Children
N/A – No children were included in this program.

Materials Available for Other Investigators
Digital versions of all materials genearated as outputs from this project are available to all at the GPCAH website (www.gpcah.org).

GPCAH Evaluation Core

Surveillance

Center Evaluation

GPCAH Evaluation Core

PIs: Corinne Peek-Asa (corinne-peek-asa@uiowa.edu); Edith Parker (edith-parker@uiowa.edu)

Description

Two distinct activities were included in the GPCAH Evaluation Core. A specific Surveillance component, led by Dr. Corrine Peek-Asa, aimed to: provide Center partners with information about trends and characteristics of agricultural traumatic fatalities and injuries, provide an infrastructure to assist with the integration of surveillance data into their research, and identify agricultural injury trends and characteristics for the region. The Center Evaluation component, led by Dr. Edith Parker, aimed to develop an overall Center evaluation process to guide Center management and project investigators in the efforts to maximize the impact of their programs and projects aimed to reduce agricultural injury and illness.

Surveillance - Activities

The data sources examined in the surveillance component included: newspaper clippings of agriculture-related deaths in nine Midwestern states, data on agricultural fatalities from the Midwest region of the Census of Fatal Occupational Injuries, and the Iowa Trauma Registry. Newspaper clippings were collected regionally through a news clipping agency; CFOI and trauma registry data were accessed through data use agreements with the Bureau of Labor Statistics and the Iowa Department of Public Health, respectively. Several resources for collaborators were established. Based on the newspaper clippings, we created a map of agricultural fatalities with a short description of the victim gender, age, and cause of injury. After further analysis of the newspaper clipping data against fatality surveillance data, we concluded that the catchment of the newspaper clippings did not warrant further use of clipping services. From the CFOI data, we produced annual reports and downloadable PowerPoint presentations summarizing regional trends in agricultural injury deaths. The Surveillance team also partnered with the farm equipment project and others to produce and air two roadway safety PSAs in Iowa, Minnesota, and Missouri. Research to describe trends and characteristics of agricultural injuries included topics such as: comparing fatalities in animal vs. crop production, non-fatal causes of tractor-related injuries, time trends in agricultural injuries, time to definitive treatment comparing rural agriculture with other rural occupational injuries, and payer sources of agricultural injuries. Key findings for these surveillance activities include:

Key Finding 1: 3.1% of trauma patients were injured on the farm, although only half of these were attributed specifically to work duties.

Key Finding 2: Over a ten-years, tractors were involved in 513 traumatic injuries in Iowa. Rollovers were the most frequent mechanism of injury (25%), followed by falls (20%). Run overs, rollovers, and collisions were significantly associated with *higher injury severity*.

Key Finding 3: Farmers were significantly delayed in the discovery, response, and transport intervals compared to other persons injured in rural locations. A method to improve recognition and notification of injuries is critical.

Key Finding 4: Between 2005 and 2013, there were significant increases over time in the number of traumatic injuries from falls, transportation, machinery, and from natural/environmental exposures, such as heat exposure.

These important surveillance findings have been incorporated into Center priorities, including pilot/feasibility project announcements, where funding of three community pilot projects have been supported (2014-17) to identify whether and how interventions at the community level can improve on the farm emergency actions and response.

Center Evaluation - Activities

Both the process and outcomes were included in the Center evaluation. Data sources used for this evaluation included internal advisory committee meeting minutes, project progress reports, and both focus groups and in-depth interviews using open-ended questions with GPCAH investigators and staff. Barriers were identified at monthly meetings, with Center Director follow up after meetings to identify threats to the successful completion of a project or aim. Outcomes evaluations relied on multiple data sources, including those identified above and annual surveys of other advisory GPCAH committee surveys (External Advisory, Regional Advisory), reported outputs, records of Center administration, and the 2014 needs assessment survey.

Outputs and Outcomes

Using multiple data sets available to characterize both fatal and non-fatal traumatic injuries, we found that the catchment of fatal injuries via newspaper clippings did not warrant further use for rigorous surveillance reporting. The trauma registry provided substantial information to make important assessments of Iowa farmers, which have been communicated throughout the region.

The major output for the Center Evaluation project were reports to the Center, with substantial contributions to annual report generation using the evaluation database of outputs. Key outcomes to improve the Center Outputs that will increase the ability to achieve its impact of preventing agricultural illness, injuries and death that have been adopted during this cycle include:

- Expanding face-to-face contacts with farmers (achieved through R2P on-the-go activities),
- Incorporating translation messaging into trusted resources (achieved through R2P Safety Watch activity), and
- Improving distance education technology for the AMCC (examined in year 5).

Recommendations evaluation that will be incorporated in future funding cycles include:

- Develop Spanish language material/training (from regional advisors),
- Incorporate video technology into training (from regional advisors), and
- Split the 40-hour course into modules, possibly distance learning (from BC working groups).

Detailed outputs are indicated in individual project summaries, to follow. The surveillance project reports six peer-reviewed publications, ten presentations, and one PhD dissertation associated with analysis from the surveillance activities.

Cumulative Enrollment Tables

Both the Surveillance and the Center Evaluation projects did not involve human subjects, hence there was no enrollment.

Evaluation Core: Surveillance Activities

PI: Corinne Peek-Asa, Corinne-peek-asa@uiowa.edu

Abstract

The surveillance component of the GPCAH Evaluation and Surveillance Core aimed to: provide Center partners with information about trends and characteristics of agricultural traumatic fatalities and injuries, provide an infrastructure to assist with the integration of surveillance data into their research, and identify agricultural injury trends and characteristics. The data sources included: newspaper clippings of agriculture-related deaths in nine Midwestern states, data on agricultural fatalities from the Midwest region of the Census of Fatal Occupational Injuries (CFOI), and the Iowa Trauma Registry. Newspaper clippings were collected regionally through a news clipping agency; CFOI and trauma registry data were accessed through data use agreements with the Bureau of Labor Statistics and the Iowa Department of Public Health, respectively. Several resources for collaborators were established. Based on the newspaper clippings, we created a map of agricultural fatalities with a short description of the victim gender, age, and cause of injury. After further analysis of the newspaper clipping data against fatality surveillance data, we concluded that the catchment of the newspaper clippings did not warrant further data capture. From the CFOI data we produced annual reports and downloadable PowerPoint presentations summarizing regional trends in agricultural injury deaths (http://www.public-health.uiowa.edu/gpcah/center-projects/surveillance-of-agricultural-injuries-and-fatalities/). The Surveillance Core also partnered with the Farm Equipment Crash Study project and others to produce and air two roadway safety PSAs in Iowa, Minnesota, and Missouri. Research to describe trends and characteristics of agricultural injuries included topics such as: comparing fatalities in animal vs. crop production, non-fatal causes of tractor-related injuries, time trends in agricultural injuries, time to definitive treatment comparing rural agriculture with other rural occupational injuries, and payer sources of agricultural injuries.

Background

Although it is well-established that agriculture is among the most dangerous work sector worldwide, surveillance of agricultural injuries and their risk factors is a key strategy for prevention but is poorly conducted and wrought with methodological challenges. Databases often used for population-based surveillance of occupational ***injuries***, such as the Census of Fatal Occupational Injuries, the Survey of Occupational Injuries and Illnesses, hospital records, and Workers' Compensation (WC) claims, are subject to under-utilization, underreporting, and misclassification of work-relatedness. Surveillance of non-fatal agricultural injuries is challenging because few national data sources have both a designation of work-relatedness and information about occupation and industry. This project aims to identify regional trends and characteristics of traumatic injuries and fatalities among agricultural workers.

Aims

The specific aims for the surveillance activities within the Evaluation Core were to:

1. Provide local and state agencies with information about trends and characteristics in agricultural traumatic fatalities and injuries
2. Provide an infrastructure to assist GPCAH collaborators to integrate surveillance data in their research
3. Identify agricultural injury trends and characteristics

Methods

To meet these aims, we examined three data sources, and with each we conducted a combination of outreach and research-based activities to align with the three aims. Detail on the results from these efforts are provided according to the *three data sources* examined.

Newspaper Clippings from Nine Midwestern States

The purpose of this activity was to describe agricultural-related fatalities using newspaper clippings. Tracing deaths to agricultural activities is difficult, as no single source of information accurately identifies these activities. Understanding the trends and characteristics of agricultural fatalities can help us intervene with safety engineering, policies, education, and environmental change.

Newspaper clippings were captured by Newz Group, a media monitoring service with partnerships in a number of Midwestern states. The precise number of publications covered by Newz Group and its partners fluctuates, but the coverage for our project area included over 2,000 publications. Search criteria used by Newz Group to capture the clippings used in our program included deaths occurring on farms, ranches, and agricultural industries; deaths of pilots of crop dusters and individuals involved in agricultural work while on roadways; and deaths in agricultural industries such as vendors, cooperatives, hunting, fishing, and trapping.

Of the nine states included in the program, Newz Group reported direct, comprehensive coverage of all newspapers in Iowa, Kansas, Missouri, North Dakota, and South Dakota. As of February, 2012, this included 342 newspapers in Iowa, 249 in Kansas, 320 in Missouri, 118 in North Dakota, and 156 in South Dakota. A Newz Group representative has stated that their service works with other bureaus in Minnesota, Nebraska, Wisconsin, and Illinois to provide coverage for our project. The service in Minnesota reportedly considers their full publication list to be proprietary information, so we were unable able to obtain an exact number of Minnesota publications. The Nebraska service reportedly covers all 175 newspapers in that State, the Wisconsin service has covered nearly 300 newspapers, and Illinois has reported that they cover approximately 400 publications.

After receiving the clippings from Newz Group, duplicates were identified and collated. Data were abstracted and entered into a database. Incident level information included date and time of the incident, city and state, location, number of victims, and the source of the press clipping. A brief description of the incident was also entered into the database. The location of the incident was coded as home, farm, mine, industry, street/highway, other specified place, or unknown/unspecified place.

Person-level information included name, age, gender, relation to agricultural activities, the external cause of the injury, whether or not agricultural machinery was involved, the type of agricultural machinery involved, and the outcome of the incident. Relation to agricultural activities was classified as either direct or indirectly related to agriculture. For example, a tractor rollover would be classified as directly related to agriculture, but a passenger in a car that died in a crash with a tractor would be classified as indirectly related to agriculture. Classifications for external cause of injury included motor vehicle, agricultural machinery, fall, fire or smoke, struck by/against or crushed, and injury caused by animal, poisoning, electrocution, or suffocation. Outcome of incident classifications included died at scene, died at hospital, died at unknown location, no treatment required, treated at hospital, and treatment refused. A brief narrative description of the activity that the victim was engaged in at the time of the incident was also entered into the database.

Census of Fatal Occupational Injuries, Midwestern Region

In order to explore regional characteristics of agricultural-related fatalities, the Surveillance team established an agreement with the Census of Fatal Occupational Injuries to analyze agricultural fatalities for their Midwestern region, which consists of 11 states (GPCAH states plus Indiana and Ohio). From these data, we produced report that summarized trends and characteristics of agricultural injuries, as well as a downloadable PowerPoint Presentation that Center stakeholders can use for their own presentations. The slideshow can be downloaded with our without notes, in the form of comments about the content of each slide. The report and PowerPoint slides were reviewed and approved annually for distribution by the Bureau of Labor Statistics, and this information is available on the Center website.

In addition to information developed for the use of Center partners and stakeholders, we used the CFOI data to examine characteristics of agriculturally-related fatalities by production type. Though agriculture is recognized as a hazardous industry, it was unclear how fatal agricultural injuries differ by production type. A cross-sectional study was conducted among crop and animal producers using data from the Census of Fatal Occupational Injuries in the Midwest region from 2005-2012. Rates of fatal injury by production type were estimated. The frequency of fatal injury in each production type was also reported by demographic and injury characteristics. Finally, a logistic regression model was performed to determine whether age, gender, injury timing, and causes of injury were associated with crop or animal production.

Iowa Trauma Registry

In order to provide information about non-fatal agricultural injuries, the Surveillance team established a Memorandum of Understanding with the Iowa Department of Public Health to examine data from the Iowa Trauma Registry, which includes designations for farm-related and work-related injuries. The Iowa State Trauma Registry (STR) is a data repository managed by the Iowa Department of Public Health (IDPH) and is the surveillance and quality improvement component of the Iowa Trauma System. Iowa hospitals are certified at one the four levels of trauma care following guidelines from the American College of Surgeons. The Iowa Trauma System is comprised of 118 acute care hospitals in Iowa, including two Level I, four Level II, 19 Level III, and 93 Level IV trauma care facilities. Level I hospitals provide the highest level of specialty care, as well as providing leadership in education, research, and system planning. Level II hospitals are capable of providing definitive trauma care regardless of the severity of injury, and provides 24-hour availability of all essential specialties, personnel, and equipment yet they don't have the same research and education requirements as Level I centers. Level III hospitals have the resources to provide stabilization for all trauma patients and may provide surgical and/or critical care when appropriate. Level IV hospitals provide initial evaluation, stabilization, diagnostic capabilities, transfer to a higher level of care when appropriate, and may also provide surgical care when appropriate.

Acute care hospitals designated as Level I, II, or III are required through the State Trauma Act to report information about trauma cases to the STR, while reporting for Level IV hospitals is voluntary. Reporting is required for patients who had at least one injury ICD-9 diagnosis code between 800.00 and 959.9 and met one of two conditions: they were admitted to a Level I–III hospital, transferred to a Level I–III hospital, or the patient died in the hospital; or, the hospital trauma team was activated. Because of concerns about reporting bias, we included in the current analysis data reported by only hospitals accredited as Level I, II, and III Trauma Hospitals. The data entry system at the trauma centers includes the specific identifier of "farm-related", providing a comprehensive system to investigate severe non-fatal injuries throughout one of nine GPCAH states.

Findings

Newspaper Clippings from Nine Midwestern States

When comparing the total number of agricultural fatalities captured by the 2011 newspaper clippings to the total number of fatalities reported by CFOI, we observed that the clippings service was not a highly reliable method of collecting comprehensive information on agricultural fatality cases. Results varied between states, with some states showing a higher number of fatalities in CFOI and others showing a higher number of fatalities in the newspaper clippings. In no state were the CFOI and newspaper clipping numbers equal. CFOI does not allow individual linkages with other data sources so we were not able to compare overlap between the two sources. Iowa had the most fatalities in both collection methods, with 39 fatalities identified through clippings and 27 reported by CFOI. Iowa also had the largest difference between sources, with nine more fatalities identified through clippings than CFOI. Iowa also had the highest number of newspapers in the clipping services. Nebraska had the fewest fatalities according to the clippings with 11 total, but CFOI reported that Nebraska had 18 agriculture related fatalities in 2011. According to CFOI, North Dakota that had the fewest fatalities at 7, but the clippings service captured 12.

Overall, newspaper clippings identified 167 agricultural fatalities in 158 incidents in 2011. Of the 164 agricultural-related fatalities in which the age of the victim was provided, 64% of the victims were age 45 or older and nearly a third were age 65 or older. Age was unknown in three of the cases, and gender was unknown in one of the cases. We examined fatalities based on whether the victim was directly conducting agriculturally-related activities or was indirectly fatally injured because of other's conducting agricultural activities. The overwhelming majority of deaths reported in newspaper clippings were due directly to agricultural activities. All fatal injuries that were indirectly related to agriculture were the result of motor vehicle crashes with agricultural machinery. All but one of them occurred on streets or highways. It is likely that newspaper clippings under-report indirect deaths associated with agricultural activities. For example, a newspaper clipping that identifies the death of a motor vehicle occupant may not identify that the other vehicle in the collision was a farm vehicle. Agricultural machinery was the leading cause of injury among both males and females, accounting for 70 of the 166 fatalities in which gender of the victim was known

(42.17%). Motor vehicles were the second leading cause of fatal injury, responsible for 31 fatalities (18.7%). According to the newspaper clippings, no females died as a result of agriculture related falls, fire or smoke, or suffocation.

Census of Fatal Occupational Injuries, Midwestern Region

The CFOI data included 1,858 fatal agriculture-related injuries, with 1,341 in crop production and 517 in animal production. The estimated rate of fatal injury in crop production was nearly twice that of animal production (35.7 vs. 18.6 per 100,000 operators). Fatal injuries among young and elderly workers were significantly associated with crop compared to animal production. Animal assaults, falls, and exposure to harmful substances/environment were significantly associated with animal production.

Fatal agricultural injury was more common in crop production. However, the characteristics and risk factors of fatal injuries differed by production type. Intervention strategies may be guided by considering the production-specific risk factors.

Iowa Trauma Registry

During the period of 2005-2011, a total of 79,740 trauma patients were included in the Iowa Trauma Registry, of which 2,490 (3.1%) were designated as farm-related. These data were used to answer several research questions, identified with collaborators on Center projects and through interaction with Center partners.

Demographics of Injuries on the Farm: Farm-related injuries are an important public health problem in agriculture because of their impact on individuals, families, and farm operations. While surveillance programs such as the CFOI is available to track fatal agricultural injuries, more work is needed to quantify the burden of non-fatal agricultural injuries. Data involving agricultural injuries were collected from the Iowa Trauma Registry from January 1, 2005 through December 31, 2011. A total of 2,490 trauma patients were found to have been classified as having a farm-related injury. These non-fatal farm-related injuries were compared by work-relatedness, injury severity score, length of hospital stay, and hospital discharge status. Also reported are the age and gender of the trauma patients, as well as the population of the county in which the injury occurred. Among the 2,490 farm-related injuries from 2005 – 2011 in the Iowa Trauma Registry, 51.7% were attributed specifically to work and the remaining 48.3% were not attributed to work duties. In our analysis, we found that work vs. non-work relatedness had little effect on injury severity, but that work-related injuries did result in longer average hospital stays. Injuries occurring in counties of lower population size tended to be slightly more severe and be more likely to have non-routine discharges. Farm environments pose hazards that are persistent for those working and living on the farm, regardless of whether or not they are engaged in work-related activities. Public health prevention approaches that consider work and non-work farm environments may be helpful in designing interventions to reduce injury.

Non-Fatal Tractor-Related Injuries: Five-hundred thirteen nonfatal tractor-related injuries were identified in the Iowa Trauma Registry from 2002 – 2012. Rollovers were the most frequent mechanism of injury (25%), followed by falls (20%). Run overs, rollovers, and collisions, were significantly associated with higher injury severity ($p < 0.05$).

Impact of Access to Definitive Care on Health Outcomes: We have examined access to definitive care to identify whether individuals with agricultural-related injuries experience delays in reaching medical care. We have identified that, compared to rural work injuries, injuries related to agriculture have longer periods in the time from injury to the time the injured person is discovered (*e.g.,* an ambulance is called), time to reach a hospital, and time to reach definitive medical care. This work led to a Student Research Award for Dr. Amanda Swanton, who used these data for her dissertation. Farmers had significant delays in the discovery, response, and transport intervals, but they experienced no delays of service at the scene.

Non-fatal Injury Trends over Time: Between 2005 and 2013, a total of 1,238 agricultural injuries were reported to the trauma registry by Level I, II and III trauma facilities. From 2005 to 2013, the rate of agricultural injuries per 100,000 hired workers, ranchers, and farm operators increased by 11% for every unit increase in year and had nearly tripled over this time period. From 2005 to 2008 there was a significant annual increase of 31.74% in the number of agricultural injuries whereas from 2008 to 2013 there was a non-significant annual increase of 3.70%. The number of moderate and severe/critical injuries increased steadily and significantly over the study period, with annual percent increases of 13% and 20%, respectively.

Translation: The Surveillance team has also partnered with the R2P project team to develop materials to translate our findings to GPCAH partners. Infographics (posters) have been developed to communicate trends in injuries, best practices for injury prevention, and injury patterns. Partnering with the Farm Crash Study team resulted on collaborative production of public service announcements/videos to prevent crashes, using surveillance information on injuries. Data from tractor-related injuries warranted partnering with investigators in the Farm Equipment Crash Study (Ramirez) to develop public safety announcements in Iowa, Minnesota and Missouri to bring awareness of specific risk factors to agricultural workers and the general public.

Conclusions and Impact

Using multiple data sets available to characterize both fatal and non-fatal traumatic injuries, we found that the catchment of fatal injuries via newspaper clippings did not warrant further use for rigorous surveillance reporting. The trauma registry provided substantial information to make the following assessments of farmer risks, which have been communicated throughout the region:

- 3.1% of trauma patients were injured on the farm, although only half of these were attributed specifically to work duties.
- Over a ten-years, tractors were involved in 513 traumatic injuries in Iowa. Rollovers were the most frequent mechanism of injury (25%), followed by falls (20%). Run overs, rollovers, and collisions, were significantly associated with *higher injury severity* ($p < 0.05$).
- Farmers were significantly delayed in the discovery, response, and transport intervals compared to other persons injured in rural locations. A method to improve notification of injuries is critical.
- Between 2005 and 2013, there were significant increases in the number of traumatic injuries from falls, transportation, machinery, and from natural/environmental exposures, such as heat exposure.

These important findings have been incorporated into Center priorities, including pilot/feasibility project announcements, where funding of three community pilot projects have been supported (2014-17) to identify whether and how interventions at the community level can improve on the farm emergency actions and response.

Outputs and Outcomes

Publications – Peer Reviewed

1. Swanton AR, Peek-Asa C, Young T: [2016]. Characteristics of agricultural fatal injuries by production type. *Journal of Ag Safety and Health*. 22(1):74-85. *[PMID 24024994]*
2. Gross N, Young T, Ramierez M, Leinekugel K, Peek-Asa C: [2015] Characteristics of work and non-work-related farm injuries. *J Rural Health*. 31(4):401-406. *[PMID: 26032601]*
3. Missikpode C, Peek-Asa C, Young T, Swanton A, Leinenkugel K, Torner J: [2015] Trends in non-fatal agricultural injuries requiring trauma care. *Inj Epidemiol*. 2(1):30-35. [*PMC4669366]*
4. Swanton AR, Young TL, Leinenkugel K, Torner JC, Peek-Asa C: [2016] Nonfatal tractor-related injuries presenting to a state trauma system. *J of Safety Research*. 53: 97-102. *[PMID: 25934002]*
5. Ramirez M, Roth L, Young T, Peek-Asa C: [2013] Rural roadway safety perceptions among rural teen drivers living in and outside of town. *J Rural Health*. 29(1):46-54.

Publications – Under Review

1. Missikpode C, Peek-Asa C, Wright B, Ramirez M: [2017] Payer source for non-fatal agricultural injuries. (In Review)

Presentations

1. Swanton AR, Young TL, Peek-Asa C: [2015] Time to Definitive Care for Severely Injured Pediatric Patients in a Rural State. American Public Health Association Annual Meeting, Oct 31 -Nov 4, 2015, Chicago, IL.
2. Missikpode C, Peek-Asa C, Young T: [2015] Trends in transportation farm-related injuries. 2015 Mid-Continent Transportation Research Symposium, Ames, IA (August 2015)

3. Swanton AR, Young TL, Peek-Asa C: [2015] Use of Emergency Medical Services among Farm-Related Injuries in Iowa. Poster session presented at: Iowa Medical Society Annual Conference; Cedar Rapids, IA (May 2-3, 2015)
4. Swanton AR, Young TL, Peek-Asa C: [2015] Do Farmers Experience Delays in Reaching Definitive Trauma Care Following Occupational Injury? Poster session presented at: Health Sciences Research Week, University of Iowa; Iowa City, IA (April 22-24, 2015)
5. Swanton AR, Young TL, Peek-Asa C: [2015] Time to Definitive Care for Severely Injured Pediatric Patients in a Rural State. Poster session presented at: College of Public Health Research Week, University of Iowa; Iowa City, IA (April 7, 2015)
6. Swanton AR, Young TL, Peek-Asa C: [2015]Time to Definitive Care for Severely Injured Pediatric Patients in a Rural State. Poster session presented at: Pediatrics Research Day, University of Iowa; Iowa City, IA (April 17, 2015)
7. Swanton AR, Young TL, Peek-Asa C: [2015] Use of Emergency Medical Services among Farm-Related Injuries in Iowa. Poster session presented at: Medical Scientist Training Program (MSTP) I Heart Science Poster Session, University of Iowa; Iowa City, IA (February 19, 2015)
8. Swanton AR, Young TL, Peek-Asa C: [2015] Non-Fatal Traumatic Injuries Associated with Tractors. Proceedings of the Midwest Rural Agricultural Safety and Health Conference; Ankeny, IA (November 19-20, 2014)
9. Toussaint M, Smith K, Ramirez MR: [2014] Characteristics of farm equipment crashes involving youth occupants; 40th Annual International Traffic Records Forum; St. Louis, MO (October, 2014)
10. Swanton A, Young T, Ramirez M, Peek-Asa C: [2014]. Time to definitive care following traumatic injury in farmers. International Society of Agricultural Safety and Health (ISASH), Omaha NE, June 2014.

Workshops and/or Presentations/Outreach at Agricultural Shows/Fairs

1. Peek-Asa C: [2015] “Trends in Non-Fatal Agricultural Injuries in Iowa.” Presented to 20 Community members in Grinnell, IA (1.5 contact hours)

Dissertations/Thesis

1. Swanton A: [2015] Evaluation of trauma response to agricultural injuries. PhD Thesis, University of Iowa Carver College of Medicine, Iowa City, IA. http://ir.uiowa.edu/etd/5654/

Publicly Available Outreach Materials

1. Tractor-Related Injuries – Poster, at https://www.public-health.uiowa.edu/gpcah/ag-educators-posters/
2. Tractor Safety: How to Prevent Injuries – Poster, at https://www.public-health.uiowa.edu/gpcah/ag-educators-posters/
3. How Farmers Get Hurt – Poster, at https://www.public-health.uiowa.edu/gpcah/ag-educators-posters/
4. Swanton A, Young T, Peek-Asa C, Ramirez M, Gerr F. Trends in Fatal Occupational Injuries in Selected Agricultural Industries. http://www.public-health.uiowa.edu/gpcah/center-projects/surveillance-of-agricultural-injuries-and-fatalities/.

Cumulative Enrollment

Cumulative Enrollment Table

N/A – This project was determined to not involve human subjects.

Materials Available for Other Investigators

Digital versions of all materials genearated as outputs from this project are available to all at the GPCAH website (www.gpcah.org).

Evaluation Core: Center Evaluation

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Abstract

The Center Evaluation project conducted both a *process evaluation*, focusing on progress toward completing planned activities, and an *outcomes evaluation*, focusing on the impact of the GPCAH. Turnover of the investigator and staff for the Research to Practice (R2P) through Community Partnerships (Translation Core) in year 2 was the main challenge in process, but bringing in a new investigator and performance of a formal needs assessment survey provided evidence-based focus for this team. Outcomes evaluations focused on four Center objectives. Increased knowledge of agricultural illness and injury was demonstrated by: an increase in Regional Advisory Committee members rating of the perception of the usefulness of GPCAH programs (55% in year 2 to 90% in year 4). Improved agricultural health and safety programs was demonstrated through timely and collaborative responses to the avian flu epidemic in poultry farming and to manure gas hazard responses (Administrative Core), hearing protection selection and use (R2P project, with subsequent pilot project funding), and lighting and marking to improve rural roadway safety (Farm Equipment Crash Study research project combined with R2P project). Updates to the Agricultural Medicine Core Course (AMCC) curriculum in the Building Capacity project (Translation Core) was also identified as improvements to the Center program. The third outcome, enhancing agricultural injury prevention and control capacity in the region, was demonstrated by offering the 40-hour AMCC course to 470 participants, with 85% agreeing or strongly agreeing that the course helped them address occupational hazards of the agricultural community in their region. The Center also identified, through the surveillance project efforts (Evaluation Core), critical factors associated with traumatic injuries and poor outcomes, which provided priorities to the Center's translation efforts (R2P project) and pilot/feasibility program solicitations. The final outcome, translation of research to practice and policy, was assessed through outputs from R2P efforts (68 prevention articles in 20 quarterly newsletters; 27 Safety Watch articles, 505 attendees in regional conferences, and mentoring nine community-based pilot grant awardees). The Farm Equipment Crash study informed state DOTs on ways to reduce farm vehicle crashes. In addition, the level of engagement and translation of specific findings and outreach associated with research projects has been communicated with appropriate stakeholders, including sharing outcomes from the (1) Intervention to Reduce Aerosol Exposure in CAFOs (Intervention Core) with producer organizations (National Pork Board), standard setting organizations (ASABE) and builders (through regional cooperatives); (2) Farm Vehicle Crash Study with standard setting organizations (ASABE), state Departments of Transportation, agricultural educators, and directly to the public and farmers via public service announcements. Activities resulted in direct interactions educating over 4,600 farmers/farm families in on-the-go activities (R2P project), over 3910 study/survey participants across Center and pilot project grants, and over 116,000 readers of the "Safety Watch" articles, all targeted to improve knowledge, increase awareness, and understand available prevention strategies to protect farmers from numerous health and safety hazards on the farm that are associated with the burden of injuries and illnesses throughout the region.

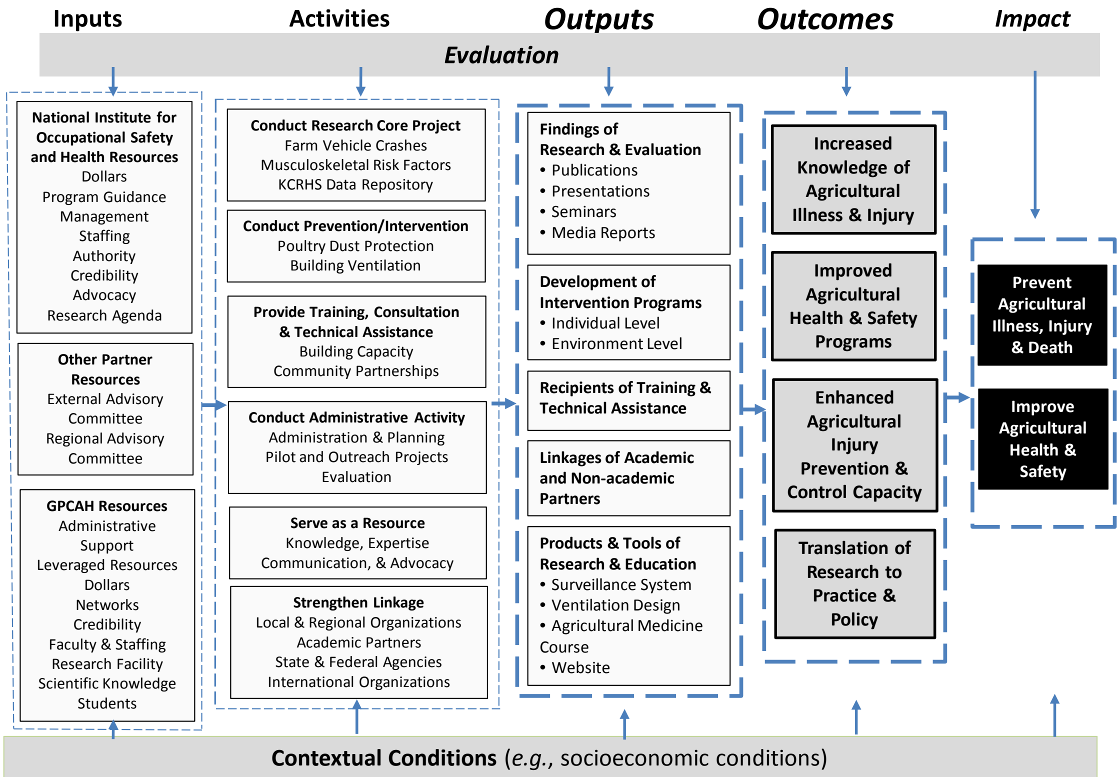
Background

NIOSH identified that "effective, consistent, and realistic and convincing evaluation is essential for both short- and long-term progress towards improving agricultural safety and health." To maximize the impact of Center activities on improvements of agricultural safety and health, the GPCAH developed a comprehensive evaluation program to systematically collect quantitative and qualitative data from Center personnel, advisory committee members, and multiple external stakeholders to assess whether both individual projects and the Center as a whole made efforts toward this goal.

Aims

The central aim of the Center Evaluation activities was to develop an overall center evaluation process to guide Center administration and project investigators in their efforts to maximize the impact of their programs and projects on the prevention of agricultural injury and illness. The Evaluation team evaluated both the *processes* used to complete the proposed projects and the *outcomes* that were generated from the center activities. Project and core outputs have been provided previously in this report. This evaluation summary is for the outcomes, as indicated in the GPCAH Center-wide logic model (Figure 1).

Figure 1: GPCAH Center-wide logic model, 2011-2016



Methods

The overall Center evaluation plan followed a “nested” case study design, with the evaluation activities of the individual research and dissemination projects “nested” within the case study design of overall Center activities. A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context. Case studies rely on multiple sources of evidence and are particularly useful when quasi-experimental or experimental designs are not possible, as is the case in the overall evaluation of the Center’s processes and impact.

Three principles of data collection for case studies include: (1) multiple sources of evidence (2) a well-organized and documented database, and (3) a well-kept chain of evidence. Within the case study design, individual projects had their own evaluation activities, some of which, when feasible, employ experimental research designs. We have achieved these principles by:

1. Collecting both process and outcome qualitative and quantitative data. Data sources used for this evaluation included: surveys of Center personnel, Internal Advisory Committee (IAC) members, and Regional Advisory Committee (RAC) members; interviews with IAC and RAC members; feedback from External Advisory Committee (EAC) members in annual meetings; website analytics; findings from Center projects and cores; administrative records and documentation.
2. Developing a well-designed and maintained database: A Microsoft Access database was developed during grant year 2 to organize the reported outputs and activities of Center projects and staff members. During an IAC in early 2015, it was brought to the attention of the evaluation team that investigators who worked in more than one of the department’s NIOSH Centers were reporting the same information several times each month. Evaluators from the three NIOSH Centers met and collaborated to create a web-based reporting survey using REDCap to decrease the reporting burden for the Centers’ investigators and to improve documentation of collaboration between Centers. The REDCap database was piloted in April 2015 and was used for the remainder of the grant cycle to solicit outputs across all Center activites.
3. Reviewing extensive documentation of the various aspects of our logic model. Investigator indicators (inputs, activities, outputs, outcomes, and impacts) were reported monthly by Center personnel.

While *Outcome Evaluations* focused on all data sources, above, the *Process Evaluation* focused on data sources from IAC meeting minutes, project progress reports, and focus groups and in-depth interviews (both using open-ended questions) with the IAC and Center Planning and Administration personnel.

During the 2011-2016 project period, the Center evaluation team implemented three additional activities to what was proposed in the original evaluation program. First, a needs assessment survey was administered to 190 farmers in the GPCAH region during the *summer and fall of 2014*. The results were used to *prioritize outreach topics* for the coming years and for Center strategic planning. Secondly, at the request of the Center Director, an *evaluation of leadership and administration* was conducted during the fall and winter of 2013-2014 among Center investigators and staff, and the RAC. Results were shared with the Center Director, who shared it with the Internal Advisory Committee and DEO of the University of Iowa, Department of Occupational and Environmental Health. Finally, website analytics were incorporated into an assessment of the website redesign, where data tracking began in February 2016.

Findings

Process Evaluation occurred throughout the five-year project period, with implementation plans revised when difficulties were encountered. Several changes to the proposed implementation resulted in additional investigations rather than reduced outputs or more efficient methods to complete the proposed objectives. Highlights are shown in *Table 8*. The *Process Evaluation* program lead to early identification of both threats and opportunities that were addressed to ensure efficient achievement of project and Center goals throughout the project period.

Table 8: ***Process Evaluation*** Highlights

Project	Challenges/Barriers	Changes to Implementation
Administration	Changes in personnel; persistent funding threat; Limited regional profile as H&S resource	• Coordinated more tightly with R2P activities beginning in Y2 to increase recognition of Center as a regional expert, providing staff and central coordination of a new on-the-go program.
Pilot / Feasibility	Low quality in community proposals; One project made no progress, so funding was cancelled; community grants had little IRB expertise	• Developed separate application and review guidelines for community grants • Solicited proposals twice in some years • Center Coordinator submitted and coordinated IRB reviews for community grants, as needed • Evaluation staff provided assistance to several projects to administer evaluation plans for project
Farm Eqpt. Crash	NASS survey took longer to coordinate than anticipated	• Instead of meeting each of the 9 state DOTs, met at Traffic Records Forum.
MSD Symptoms	Low recruitment	• Two rounds of enrollment needed; expand area for field recruitment
Intervention in CAFOs	CFD simulations non-converging	• Performed time-dependent simulations with Matlab/Simulink instead; tested additional devices in field; identified potential to control an additional contaminant (CO_2) based on findings in years 1-3.
Building Capacity	PI retired in year 2 Some audiences cannot attend 40 hours all in one week	• New faculty transitioned to PI with Center PI providing continuity • Academy was not feasible; changed to Leaders in ASH Professionals group partnership; solicited feedback on webinar format (negatives outweighed the positives); solicit input for prioritizing stand-alone on-line modules to relieve 40 hour requirement for in person attendance
R2P	PI retired in year 2 Lack of use of telephone hotline in proposal	• Center Director took over as the PI with investigator retirement • Added web component for “hotline”, with minimal success. Direct contacts with PIs tracked was more productive (included in monthly reporting) • Developed the “on-the-go” and “Safety Watch” mechanisms to improve direct reach to farmers.
Surveillance	Slow data use agreements affected schedule	• Changed timeline; all objectives were achieved

The *Outcomes Evaluation* focused on identifying the impact of the GPCAH in relation to the outputs and outcomes for the Center. The impact was evaluated relative to the *four outcomes* identified in the project proposal (Logic Model, Figure 1):

1. Increased knowledge of agricultural illnesses and injury
2. Improved agricultural health and safety programs
3. Enhanced agricultural injury prevention and control capacity
4. Translation of research into practice and policy.

Table 3 summarizes the evaluation summaries of each of the four outcomes used to assess the overall impact of the Center in 2011-2016. Data to demonstrate achieving each of the four Center-level outcomes were compiled from monthly progress reporting data bases and interviews/surveys conducted throughout the project period.

As shown in Table 9, four specific recommendations were realized by the Center as outcomes to the evaluation process. These specifically address ways to improve the outcomes and impact of Center and Project efforts:

- R2P: Spanish language materials/training is needed
- R2P/BC: Lack of video training
- BC: 40 hours is too much at one time for professionals; break up components into off-site components
- R2P: Spanish translation of posters

Progress towards implementing these changes to improve the impact of the GPCAH on the region have been integrated into projects and activities for the next project cycle.

Conclusions

While direct measures of impact with regards to actual prevention of illness, injury or death were not achievable with this 5-year project, the GPCAH provided education and outreach that were widely distributed, based on best-practice, translated from scientific studies, which focused on key risk factors relevant to exposures and injuries relevant to our region.

Outputs and Outcomes

None

Cumulative Enrollment

Cumulative Enrollment Table

N/A – This project was determined to not involve human subjects.

Materials Available for Other Investigators

Digital versions of all materials genearated as outputs from this project are available to all at the GPCAH website (www.gpcah.org).

Table 9: ***Outcomes Evaluation*** metrics and results

Outcome	Tool/Metric	Significant Result
Increased knowledge of agricultural illness and injury		
Improve skills of RAC	Member rated usefulness of meetings toward information exchange (Y2 and 4)	• Unanimous reporting of useful information exchange
	Demonstrations of hazard awareness	• Reports of addressing what they learned with stakeholders post discussions; reported referring questions to knowledgeable persons when did not know answers
	Identification of priority hazards and reviewing Center materials	• 4/yr collect information on emerging issues; needs assessment identified consensus persistent hazards; reviews of Center materials provided interactive method to improve RAC skills in hazard ID
Usefulness of GPCAH programs/activities in improving knowledge	Usefulness Survey of products/Center	• Improved from 55% in Y2 to 90% in Y4. Reasons included: Increased regional outreach; Increased collaboration with other ASH organizations; Improved website with more user-friendly resources ***Future recommendations for improvement:*** Spanish language materials/training is needed (under production)
Establish scientific evidence for best practices in agricultural safety and health	Intervention to reduce aerosol exposure in CAFO: was this effective?	• Results identified low and moderate cost interventions, communicated via peer-reviewed journals and in presentations to stakeholders (National Pork Board; ASABE; cooperative safety directors)
	Farm Crash Study partners	• Identified significant associations between risk factors and farm vehicle crashes to recommend interventions to regulators, DOT, equipment manufacturers, farmers
Improved agricultural health and safety programs		
Extent of needs met and exposures addressed	Surveys with collaborators, including RAC and informal networks	• RAC/AFF Collaboration: PPE Recommendations for Avian Flu • Sharing with Extension, Safety Watch: Manure Gas Hazard Information Sheets • RAC review: Hearing Protection (R2P), Roadway(Crash Study), Injury trends (Surveillance) • Roadway safety dissemination: distribution of lighting and marking kits; video/PSA; integration into AMCC course (Building Capacity); interactive displays (R2P) ***Future Recommendations for Improvement:*** lack of video training
Effectiveness of the intervention program in hazardous exposure reduction	Success of the Intervention study identified substantial reductions	• Low-cost reductions to reduce indoor CO_2 (heater substitution) • Moderate-cost reductions to reduce respirable and inhalable dust (filtration better than cyclonic treatment)
Enhanced agricultural injury prevention & control capacity		
Develop and disseminate AMCC training	AMCC curriculum updated to increase emphasis on: safety, prevention, hands-on activities	• Partner with locals for site visits (Amana Farms, NECAS) and equipment for demonstrations (Stutsman, UI Children's Hospital) • 80% of attendees agree in ability to anticipate, diagnose, treat, or prevent ag illnesses or injuries following the course • 70% of attendees felt confident in ability to recommend PPE for farmers ***Future Recommendations for Improvement:*** *40 hours is too much at one time for professionals; break up components into off-site components*
Surveillance system	Surveillance project investigated three data sources	• News clipping catchment was low, compared to BLS CFOI for the region • State Trauma Registry identified non-fatal injury trends for agricultural workers; although limited to one state, it provided new, comprehensive, and critical surveillance data
RAC evaluation of GPCAH impact	Outreach material review and prioritization	• Following RAC suggestions to come up with new outreach tools, the R2P program collaborated with project investigators to develop outreach materials (posters) to incorporate infographic techniques to improve communication to farmers and advocates; developed with input to develop RAC member buy in ***Future Recommendations for Improvement:*** Translate into Spanish
Translation of research into practice and policy		
Implement community pilot grants	Solicit and fund pilot grant applications from community advocates	• Of 23 grants made, 12 were to community organizations dedicated to protecting farmers; these projects trained 4600 individuals and resulted in 98 media stories, expanding the reach of S&H practice
Extent of GPCAH efforts to support practice and policy	Broadly disseminate to practitioners	• 68 prevention articles in 20 newsletters; 505 attendees in five 2-day conferences • Mentored 9 community-based pilot grant awardees; Shared best-practices on: PPE recommendations for avian flu; manure gas hazards; hearing protection; roadway safety
	Share findings with key stakeholders	• Shared findings on CAFO air quality improvements with co-operatives, ASABE, National Pork Board
		• Shared Farm Vehicle Crash project findings with ASABE and with DOT to support adoption of new lighting and marking and roadway design factors associated with crashes