2021- 2022 Annual Report
NCCC-09 Multistate Committee

MWPS: Research and Extension Educational Materials

The mission of NCCC-009 is to enhance the outreach, research, and teaching programs of participating Land-Grant universities by facilitating a learning community that provides a collaborative mechanism for engineers and scientists to exchange knowledge and to cooperate in the development of multi-state/regional educational projects related to feed, food, fiber and energy production systems.

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Contact Information

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Current Participants

2021-2022 Officers

Past Chair: Daniel Andersen, Iowa State University
Chair: Neslihan Akdeniz, University of Illinois at Urbana-Champaign
Vice Chair: Zifei Liu, Kansas State University
Secretary: Brett Ramirez, Iowa State University
Administrative Advisor: John Lawrence, Iowa State University
NIFA Representative: Steven Thomson and Erin Riley, NPL for Agricultural/Biosystems Engineering

Official Participants
Neslihan Akdeniz, University of Illinois at Urbana-Champaign
Erin Cortus, University of Minnesota
Rich Gates, Iowa State University
Jay Harmon, Iowa State University
Morgan Hayes, University of Kentucky
Kenneth Hellevang, North Dakota State University
Kevin Janni, University of Minnesota
Dana Kirk, Michigan State University
Zifei Liu, Kansas State University
Amy Schmidt, University of Nebraska-Lincoln
Brett Ramirez, Iowa State University
John McMaine, South Dakota State University

Unofficial Participants
Daniel Andersen, Iowa State University
Kapil Arora, Iowa State University
Rebecca Larson, University of Wisconsin-Madison
Teng Lim, University of Missouri-Columbia
Jiqin Ni, Purdue University
Steven Safferman, Michigan State University
Tom Scherer, North Dakota State University
Lingying Zhao, Ohio State University
Joseph Harner, Kansas State University
Richard Stowell, University of Nebraska-Lincoln
Joe Zulovich, University of Missouri-Columbia
Xufei Yang, South Dakota State University

Business Meeting

The annual meeting occurred virtually on July 25th, 2022 from 1:00 to 3:00 pm (CST)

Minutes were prepared by Morgan Hayes, edited by Brett Ramirez.

Attendees: Nesli Akdeniz, Teng Teeh Lim, Amy Schmidt, Lingying Zhao, Joe Zulovich, John Lawrence, Ken Hellevang, Rich Gates, Zifei Lu, Brett Ramirez, Erin Riley, Morgan Hayes, Steven Thomson, Marguerite Tan, Jay Harmon

- Agenda provided by Nesli
- Updates/Reports
    - Erin Riley from NIFA focusing on communication offered to help the group upon request
    - Steven Thomson from NIFA discussed tech based programs, such as, cyberphysical systems (3 of 5 funded are animal agriculture), aquaculture funding is increasing, new investigators are able to apply for seed funds, 150k rider on the 650k grant (up to $800k) for partnership international or strengthening partnership institution
    - John Lawrence (academic advisor) stated annual report is due within 60 days, the NCCC-09 time to renew (due to renew in 2023), so the process begins Sept 15, 2022 when renewal request is required, October objectives are due, and full proposal is due December 1, 2022. Need to find next academic advisor as he will be retiring in March 2023.
    - Rich Gates, Director of the Egg Industry Center, provided an overview of the Egg Industry Center and current challenges and opportunities facing US egg production.
    - Marguerite Tan, Director of Environmental Programs at National Pork Board, provided an update of recent NPB programs and sustainability efforts.
- Station/State Reports
    - NE
        - Advancing knowledge and practices regarding applying manure for cropland resilience
        - ‘I am responsible’- food safety and security on both human and animal production side
        - Manure treatment with MO and AR
        - Mortality composting study with NPB
    - ND
        - Personnel changes- have hired Leon Schumacher to be Dept Head, Ken Hellevang 3 month interim Ag and Natural Resource Extension Asst Dean and is back to faculty role

    - § Dr Shafi Rahman and Dr Narun Rahman? left for NIFA which opened 2 faculty positions, Clermont Clemenson is working in processing interest in grain, Iris Feng from Purdue focusing on bio-environmental and structural coursework, also hiring a precision ag candidate (2 interviews this month)
    - § Extension work and increased interest in subsurface drainage
    - § Soybean storage research- immature soybean due to early frost
- MO
    - § Manure treatment project had workshops at Waste to Worth and Manure Expo as well as ASABE AIM. Hoping to release tool in early 2023
    - § Chesapeake Bay Poultry and other mortality composting project
    - § Work with eXtension
    - § Biosecurity project and trailer within MO
    - § Manure and cover crop project tracking over multiple years
    - § EDEN-emergency preparedness website
    - § Horticulture and small commercial greenhouse project
    - § ASABE Livestock Ventilation Design standard; ASHRAE Air Change Rate discussions; NFBA Construction curriculum textbook completed and online course will be there shortly
- KY
    - § CARE project with Iowa State and Nebraska focusing on swine ventilation and working on updating ASABE standard and ASHRAE Handbook; will also work to update the MWPS Mechanical Ventilation Publication into an e-book. Looking for NCCC-9 members to review this update.
    - § Reducing energy requirement and cost by using more effective fans and controllers in swine and dairy barns, CIG demonstration project with Ohio State
- IA
    - § USDA CARE proposal covered by Morgan
    - § Draft emission reviewing
    - § Jacek Koziel left for USDA ARS, his position will be opening in controlled environment
    - § MWPS the publications are still being offered mostly online although some printed as well, sheep and septic publications in particular
    - § Also short publication on reducing fire risk from barns
- OH
    - § Ammonia dispersion from layer barn with Purdue
    - § Dust control in poultry housing electrostatic with Iowa State and Egg Industry Center?
    - § Hosted Waste to Worth in Toledo and ran air quality workshop and technologies for ammonia and dust control

        - § Green Home- airflow and design within household
    - KS
        - § Joe Harner retired but did update numerous publications before he retired
        - § Endotoxin exposure in swine barns
        - § Climate smart sensors, methane emissions from ruminants
        - § KS wetland burning special project
- Business meeting:
    - New Secretary: Xufei Yang from SDSU will be asked via email by Brett
    - Quarterly Calls – Zifei is interested in leading these as the incoming leader
    - Renewal proposal – Neslihan to confirm
    - Meeting with Minnkota in March next year to be discuss with Brett and Erin

Activities & Projects

As part of the NIFA CARE grant (ISU, UNL, and UKY), Brett Ramirez (with Morgan Hayes) supplied substantial updates to the ASHRAE HVAC Applications Chapter 25 (Environmental Control for Plants and Animals) which is currently under review by ASHRAE. The ISU and UNL teams determined the heat and moisture production rates of gestating sows in group pens at USDA MARC.

Teng Lim and Joseph Zulovich (Missouri) collaborated with other faculty from in-state and other states including Iowa, Nebraska, and Kansas to conduct regional coordination and leveraging of existing disaster preparedness and recovery resources. The grant is USDA National Institute of Food and Agriculture, Smith-Lever Funding, for 2018-2022.

Teng Lim and Joseph Zulovich (Missouri) are collaborating with Richard Stowell and Amy Schmidt (Nebraska), and other faculty from Arkansas, Ohio, and Colorado to work on an integrated USDA-NIFA project. The title of the project is Water and Nutrient Recycling: A Decision Tool and Synergistic Innovative Technology, and is for 2018-2023.

Teng Lim collaborated with faculty from Oklahoma, Kentucky, Colorado, Maryland, and agency personnel to form a team of expert panel, for producing recommendation and report on “Livestock and Poultry Mortality Management Best Management Practices”. The grant is provided by the U.S Environmental Protection Agency, Chesapeake Bay Program (CBP).

Joseph Zulovich collaborated with the ASABE PAFS 40 Facilities & Systems Sub-Committee, revising ASABE Standards. The group has progressed with the Design of Ventilation Systems for Livestock and Poultry (Standard number 270.6). Others involved are MN (Erin Cortus and Kevin Janni), KY (Morgan Hayes), IA (Brett Ramirez and Rich Gates) and many others. The team members will be working to get the revised 270 Standard information into the ASHRAE Handbook.

The Minnkota Agri-Builders and Suppliers Association brings together regional university and Extension personnel, builders and suppliers in the livestock and grain processing industries, and

government personnel who want to network and learn about advancements in the agricultural building and related fields. The Association allows the sharing of ideas and concerns in a non-competitive environment that helps the industry learn from one another and informs Extension and research needs moving forward. This is a long-standing, collaborative effort among University of Minnesota, South Dakota State University, Iowa State University and University of Nebraska-Lincoln. The 2022 Annual Meeting drew 35 attendees to learn about environmental sustainability initiatives in the livestock and concrete sectors, ongoing university research, and tour a dairy digester supplying biogas for the California market.

Several NCCC-09 members are shepherding a revision to the American Society of Agricultural and Biological Engineers (ASABE) Engineering Practice Standard ASAE EP270 Design of Ventilation Systems for Poultry and Livestock Shelters. The revision team is gathering more recent heat and moisture production data for livestock, and modernizing the descriptions of common ventilation systems and components. The multistate approach is crucial as ventilation practices must consider local climates and management practices.

Exposure to pathogenic dust is a health issue for workers inside swine barns and a potential health concern for people residing adjacent to swine facilities. Zifei Liu in Kansas State University is working on a project to determine the occupational and community health outcomes associated with swine production with an emphasis on respiratory health outcomes, using a standard quantitative microbial risk assessment (QMRA) approach. QMRA is a standard risk assessment framework that allows for quantitative scientific data to be interpreted in the context of estimated health risks associated with a system.

Another project is a team effort to support smart and safe prescribed burning for communities that use prescribed fires for land management.

iAMResponsibleTM Project. Engaged a nationwide team of agricultural production, engineering, food safety, and veterinary medicine extension specialists in delivering information and programming content about antimicrobial resistance (AMR)-related food safety; includes development and deployment of an outreach content database (housed in Air Table) for use by extension educators wishing to deliver local programming on AMR-related food safety.

Water and Nutrient Recycling- A Decision Tool and Synergistic Innovative Technology. As a learning network focused on animal agriculture and environmental stewardship, the Livestock & Poultry Environmental Learning Community (LPELC) is keenly interested in developing tools that assist livestock producers in selecting manure treatment technologies that optimize capabilities to recycle water and nutrients while enhancing overall sustainability of their operations. The University of Nebraska-Lincoln is utilizing the extension specialist expertise in water quality, manure management, and livestock production systems and the resources of the LPELC toward achieving the extension-focused objectives of the overall project.

Facilitating "Win-Win" Manure Utilization for Sustained Soil Health, Economic, and Environmental Benefits. Collaborating engineering extension faculty at UNL, Iowa State University, and the University of Minnesota continued working together beyond the life of an originally funded project (funded by North Central Region Sustainable Agriculture Research and Education Program) to deliver content related to communicating the value of manure. In addition to an online content library titled "Merits of Manure", the team refined and delivered a team learning activity titled the "Land Application Site Selection Exercise" to engage learners in making evidence-based decisions about land application of livestock manure based on economics, soil health, transportation, environmental impacts, and social impacts.

Tom Scherer, Extension Agricultural Engineer, continues to focus on water resources. There was interest in irrigation with drought conditions during 2021 and a very wet spring in 2022 lead to prevented planting and continued interest in subsurface drainage.

Ken Hellevang, Extension Agricultural Engineer, continues to provide education and technical assistance regionally on grain drying, handling, storage, structures, and disaster response. This is primarily done through news articles and webinars. Research is continuing on the allowable storage time of soybeans and how to manage soybeans killed by frost before maturity and in harvest of high moisture soybeans. These are problems particularly in northern states.

Outcomes & Accomplishments

Many participants use the Minnkota meeting for professional engineering professional development hours (PDHs).

The scope and overall context (hazard identification, exposure pathways, and health outcomes of interest) of the QMRA has been defined in order to bring fundamental knowledge and application for continuous improvement relating to environmental stewardship in the pork industry. The exposure assessment was undertaken to quantify the magnitude and frequency of exposure to reference pathogens via the identified exposure pathways and hazardous events in swine production.

Practical burning decision guidelines were developed to assist management of prescribed fires in the Flint Hills region, which was based on combined analysis of historical data including O3, weather variables, and daily burned area that were obtained from satellite observations. It can assist land managers to better plan their burning activities and enable the continuous practice of burning in a manner that minimize adverse air quality.

iAMResponsibleTM Project. Over 50 new pieces of outreach content were created during the reporting period for distribution on social media and added to the existing library of approximately 500 pieces of media and research related to AMR curated by the iAMR team and available to the public on the Livestock and Poultry Environmental Learning Community (LPELC) website. Engagement events for social media content totaled just over 4,000 during the period of July 2021 to June 2022. Results of social media surveys to assess audience knowledge and

attitudes toward AMR, food safety, and the iAMR Project indicate that the team has utilized social media effectively to build a recognized and trusted brand among medical professionals, educators, and AMR researchers worldwide and audience members indicated that they were motivated to change at least some personal behaviors to address growing AMR.

The iAMResponsibleTM Project team further expanded their online university course, AMR from a One Health Perspective, with emphasis on developing scientific communication skills in young STEM professionals from an extension approach. During the Spring of 2022, twenty-three students at six universities – University of Nebraska-Lincoln, North Carolina State University, University of Maryland, University of Minnesota, Washington State University, and Oklahoma State University – participated in the multi-institutional graduate course led by the University of Nebraska-Lincoln.

Water and Nutrient Recycling- A Decision Tool and Synergistic Innovative Technology. Provided feedback during biweekly meetings in support of expanding the decision-support tool being developed by the project team with technical and economic models; Developed graphics to help communicate project team objectives internally and to stakeholders; Developed two surveys – one for dairy producers and one for swine producers – to inform the project on manure management system characteristics, as well as levels of, motivations for, and barriers to adoption of treatment technology; Maintained communications with two commercial enterprises that are looking to implement new technology for recovering solids and phosphorus from manure on NE swine operations; and Explored options to treat and/or better manage runoff from cattle open lots and liquid manure in new beef confinement facilities, including:investigating methods for collecting and monitoring runoff from open feedlot pens, and recommending designs to incorporate in trials at the current research facility; and incorporating treatment technology in plans for facilities proposed for UNL's Beef Innovation Center.

Facilitating "Win-Win" Manure Utilization for Sustained Soil Health, Economic, and Environmental Benefits. Our manure value library (https://go.unl.edu/manurevaluelibrary), which contains over 350 recommended resources (and growing!) targeting educators and advisors, was promoted to members of the Livestock and Poultry Environmental Learning Community (LPELC) with publicized release of the library on the LPELC web site (https://lpelc.org/value-of-manure-library/). The library is organized by the benefits and barriers identified by our Stakeholder Advisory Committee (see Figure 7). Content is organized by 1) social media, 2) short news articles and web pages, 3) educational publications, 4) decision support tools; and 5) recommended research articles.

The "Land Application Site Selection Exercise"was delivered in Nebraska at ten locations statewide to approximately 100 persons as a component of the Nebraska Department of Environment and Energy-required Land Application Training for permitted animal feeding operation manure managers. The activity was delivered during a special session of the 2022

Waste to Worth Conference in Oregon, Ohio to peers interested in implementing the teaching method in their state or region.

Impact

Missouri faculty collaborated with others, to revise ASABE Standards (PAFS Sub-Committee) and form Expert committee to improve estimation of animal mortality impact for the Chesapeake Bay Program. The Extension team is also working with three surrounding states to organize practical resources for regional disaster preparedness and recovery resources. A multi-state effort is developing a decision-making tool for livestock waste nutrient and water recovery and mitigation technology considerations.

Over 90% of Minnkota attendees who completed the exit survey found the various presentations useful or very useful. One survey comment captured one of our primary goals: “Anything that can be done to encourage discussion and dialogue among [participants] is important."

Exposure to pathogenic dust is a health issue for workers inside swine barns and a potential health concern for people residing adjacent to swine facilities. As swine operations are becoming larger and more intensive, public concerns on community health are growing. Moreover, because many operations now have more than 10 employees, occupational health of workers has become more relevant. Results of our project will assist the US pork industry in the development of specific technology objectives and environmentally sustainable strategies, highlighting opportunities for potential change or innovation, and prioritizing research needs in both an epidemiological and industrial hygiene perspective.

Advanced knowledge and behaviors regarding the value of manure to improve resilience of cropping system soils through demonstrations, outreach efforts, and technical publications.

Approximately 1,100 extension educators, university faculty and professionals in animal agriculture and allied fields were reached through AMR-related professional conference outputs.

Advanced knowledge among food producers and consumers of the risks and mitigation practices associated with antimicrobial resistant bacteria and genes originating from agricultural production systems and potentially impacting food safety and human health.

Surveys of participants in one or more LPELC webinars (n=82 responses) who report advising approximately 4,300 agricultural producers annually revealed that *100% experienced improved knowledge of manure treatment and application practice impacts on AMR in soil and water; and 100% reported improved understanding of how manure management and conservation practices discussed mitigate the movement of antibiotics and resistance genes in the environment.*

In three years of offering, 56 students have participated in the multi-institutional graduate course led by the University of Nebraska-Lincoln titled, “AMR from a One Health Perspective” representing seven U.S. institutions and eight academic disciplines.

85% of course participants valued engagement with students from other institutions and disciplines and reported improved understanding of how AMR is perceived and addressed outside their field.

77% of course participants experienced an increased appreciation for the value of sharing scientific information using research-based methods.

Students commented that “this class is great for networking!”…“I didn’t really understand Extension before taking this course”…and “I liked the numerous aspects we got…on such a multidisciplinary issue.”

Instructors valued the integration of research and outreach highlighted in the course, appreciated their knowledge gain as an instructor (100%), committed to contributing AMR-related outreach content to the iAMResponsibleTM Project (67%), and reported plans to begin disseminating iAMResponsibleTM Project content (83%).

Institutions wishing to offer the course continues to rise, with at least ten institutions committed to offering the course in spring 2023.

New Facilities & Equipment

University of Missouri is expecting a $20K, 20-ft long educational mobile trailer for the USDA National Animal Disease Preparedness and Response Program (NADPRP) Project.

Iowa State University is expecting the Stanley L. Balloun Turkey Teaching and Research Facility to be operational in late 2022.

Fund Leveraging (Collaborative Grants)

Zifei Liu in Kansas State University is working with fire sensing and simulation faculty members in Kansas University, Georgia State University, and University of Missouri for fire smoke related researches in a NSF funded project. Zifei is also collaborating with researchers from Purdue University and North Carolina A&T State University in a project that aims to develop robust, low-cost, open-source climate-smart sensors for climate conscious livestock producers.

Other Relevant Efforts or Accomplishments

- Activities occurring in conjunction with ASHRAE include:
    - Long-term member of Plant and Animal Environment committee – TC 2.2
    - Working with Multi-Committee Task Group (MTG) evaluating minimum ventilation requirements for all types of facilities and assessing how to evaluate ventilation effectiveness.
    - Assisting with the development of a white paper addressing air change rate (ACR)
    - Assisted with the development of a work statement for a RAC proposal addressing indoor plant environments

    - Participated in three virtual ASHRAE meeting sessions – one for winter meeting and two for summer annual meeting
- Activities occurring in conjunction with National Frame Builders Association (NFBA) include:
    - Serving on editorial board to review and author of technical papers for NFBA's National Frame Builders Magazine.
    - Serving on Technical and Research Committee addressing technical issues and identifying research needs for the post-frame industry.
    - Helping develop a post-frame construction curriculum.
- Activities occurring in conjunction with Dairy Practices Council (DPC) include:
    - Serving as director for Task Force 1 which addresses on-farm dairy production issues through the development of written resources called Guidelines.
    - Serve as member of DPC Executive Board of Directors which includes planning for DPC Annual Conference.

- AMR Content Library: A repository of approximately 500 AMR-related scientific resources, primarily focused on agricultural AMR and AMR-related food safety, has been created that includes refereed research publications, graphical resources, videos, and short media articles. This database is intended to provide ready access to team members of AMR-related information for use in extension programs and publications nationwide. The database is available to the public at: https://lpelc.org/antimicrobial-resistance-resource-library/.
- AMR Webinar: In partnership with the LPELC, the project team delivered the third in an ongoing series of webinars on AMR impacts on agriculture aimed at agricultural producers and their advisors.
- AMR Podcast Series: In late 2021, the iAMResponsible team launched a podcast series (Tales of the Resistance), to discuss research findings on AMR in food production systems with general (non-expert audiences).
- AMR Online and Social Media Outlets:
    - Twitter: https://twitter.com/i_AMResponsible
    - Facebook: https://www.facebook.com/iAMResponsibleEDU
    - Instagram: https://www.instagram.com/iamresponsibleedu/
    - YouTube: https://www.youtube.com/channel/UC4cO1Gr80Y8skUWYk_try3g
    - Website: iamrproject.com

Outputs

Peer-Reviewed Publications, Abstracts, and Proceedings

Xu, Z., Sullivan, R., Zhou, J., Bromfield, C., Lim, T. T., Safranski, T. J., & Yan, Z. 2023. Detecting sow vulva size change around estrus using machine vision technology. Smart Agricultural Technology, 3, 100090. https://doi.org/https://doi.org/10.1016/j.atech.2022.100090

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Tanvir R. U, M. Ahmed, T.-T. Lim, Y. Li, and Z. Hu. 2022. Arrested methanogenesis: Principles, practices, and perspectives, Advances in Bioenergy, Elsevier. ISSN 2468-0125, https://doi.org/10.1016/bs.aibe.2022.04.001.

Lin, C.H., E.E. Wang, W.D. Walter, T.-T. Lim, and H.E. Garrett. 2021. Vegetative Environmental Buffers for Air Quality Benefits. Chapter 11. In: Garrett, H.E., Jose, S. and Gold, M.A. (eds). Agronomy Society of America, Madison, WI.

Schuft, A. N., Boelke, S. S., DeWitte, D., Martinson, K., & Cortus, E. Biosecurity Education for the Next Generation. Journal of Ag Health and Safety. [Accepted:2022]

Sharara, S., Koelsch, R. K., Cortus, E. L., Larson, R. A., Classen, J. J., & Janni, K. A. Addressing nutrient imbalance in animal agriculture systems. Transactions of the ASABE. [Accepted:2022]

Welles, J. S., Soriano, N. T. C., Dorbu, F. E., Pereira, G. M., Rubeck, L. M., Timmermans, E. L., … Cortus, E. L. 2021. Socio-Economic and Governance Conditions Corresponding to Change in Animal Agriculture: South Dakota Case Study. Sustainability 13(19). https://doi.org/10.3390/su131910682

Charlier, D., Wilson, M., Modderman, C., Cortus, E., Janni, K., Peterson, C., . . . Bender, J. B. Assessing occupational risks of manure applicators in the Upper Midwest. Journal of Agromedicine. Accepted

Bird, K. I.T., Nichols, V. A., Garay S., Nowatzke, M., Essary, C., Post, K. K., . . . Cortus, E. L. Means, motive, and opportunity: A method for understanding stakeholder agency within food-energy-water systems. Elementa. [Accepted]

Aguirre-Villegas, H. A., Cortus, E., Reinemann, D. J. The Role of Anaerobic Digestion and Solar PV to Achieve GHG Neutrality in a Farm Setting. Energies. [Accepted]

Haque, M.A.; Liu, Z.; Demilade, A.; Kumar, N.M. 2022. Assessing the Environmental Footprint of Distiller-Dried Grains with Soluble Diet as a Substitute for Standard Corn–Soybean for Swine Production in the United States of America. Sustainability, 14, 1161.

Demilade, A. and Liu, Z. 2022. Daily burned area mapping for prescribed rangeland burning in the Flint Hills region using MODIS data. In press. Transactions of ASABE.

Mware, N., M. C. Hall, S. Rajendran, J. E. Gilley, A. Schmidt, S. Bartelt-Hunt, Y. Zhang, and X. Li. 2022. Resistome and mobilome in surface runoff from manured soil as affected by setback distance. Journal of Hazardous Materials. https://doi:10.1016/j.jhazmat.2022.128278

Yost, J.L., A. M. Schmidt, R. Koelsch, and L. R. Schott. 2021. Impact of swine manure on soil health properties: A systematic review. Soil Science Society of America Journal. https://doi.org/10.1002/saj2.20359.

Zelt, M., Z. Staley, X. Li, B. Wang, D. Miller and A. M. Schmidt. 2021. Antibiotic Resistance in Manure-Amended Agricultural Soils. Nebraska Beef Cattle Report. https://beef.unl.edu/documents/2021-beef-report/mp110-2021-36.pdf

Conference Papers, Posters, and Presentations

Canter, T., Lim, T.-T., and J. A. Zulovich. 2021. Field Experience of Removing and Land Application of Dairy Lagoon Solids. In International Symposium on Animal Environment and Welfare. Rongchang, Chongqing, China

Bohl Bormann, N., Wilson, M., Cortus, E., Floren, J., Miller, R. O., and Gunderson, L. 2021. Differences in Manure Total Nitrogen Results Due to Total Kjeldahl Nitrogen and Nitrogen Combustion Methods [Abstract]. ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT. https://scisoc.confex.com/scisoc/2021am/meetingapp.cgi/Paper/134506

Cortus, E. L., Samuel, R. S., Yang, X., Thaler, R. C., and Hetchler, B. P. 2021. Evaluating Gas and Particulate Matter Emissions and Downwind Concentration Impacts using the EPI Air Filter Wall System. Paper 2100656. In 2021 ASABE Annual International Virtual Meeting, 11-14 July 2021. https://doi.org/10.13031/aim.2100656

Warmka, A., and Cortus, E. L. 2021. Fluorescing Gel Characteristics for Use in Biosecurity Research. Paper 2100516. In 2021 ASABE Annual International Virtual Meeting, 11-14 July 2021. https://doi.org/10.13031/aim.2100516

Charlier, D., Wilson, M., Modderman, C., Cortus, E., Janni, K., Peterson, C., . . . Bender, J. 2021. Assessing occupational risks of manure applicators in the Upper Midwest. Raising Safety: North American Agricultural Safety Summit 2021.

Schuft, A. E., Cortus, E., and Martinson, K. 2021. An online course to teach and encourage equine biosecurity practices vol. 100. Journal of Equine Veterinary Science. https://doi.org/10.1016/j.jevs.2021.103577 (Abstract)

Demilade, A. and Liu, Z. 2021. Identification of meteorological factors affecting the timing of prescribed burning in the Flint Hills. ASABE paper No. 2100194. St. Joseph, MI.: ASABE

A.M. Schmidt, M. Zelt, K. Nixon, D. Lansing, and A. King. 2022. I'm an expert…why aren't you listening to me?! Proceedings of the *2022 Waste-to-Worth Conference*, Oregon, OH, April 18-22, 2022.

A.M. Schmidt, M. Zelt, S. Lansing, R. Tikekar, M. Sharara, J. Harrison, and N. Noyes. 2022. Antimicrobial resistance from a One Health perspective: multi-disciplinary university instruction from extension professionals. Proceedings of the *2022 Waste-to-Worth Conference*, Oregon, OH, April 18-22, 2022.

Zelt, M., A. Patterson, J.C. Ramos Tanchez$_2$, and A.M. Schmidt. 2022. Impacts of social media on public awareness and behavior related to antimicrobial resistance. Proceedings of the *2022 Waste-to-Worth Conference*, Oregon, OH, April 18-22, 2022.

Ramos Tanchez, J.C., R. Stowell, A.M. Schmidt, M. Zelt, and L. Witt-Swanson. 2022. Manure treatment technology adoption by swine and dairy producers: Survey feedback. Proceedings of the *2022 Waste-to-Worth Conference*, Oregon, OH, April 18-22, 2022.

Oviedo, M.J., J. Iqbal, A. Yoder, B. Maharjan, and A.M. Schmidt. 2022. Evaluation of geospatial data for livestock operation location and estimation of manure nutrient utilization capacity in five Nebraska counties. Proceedings of the *2022 Waste-to-Worth Conference*, Oregon, OH, April 18-22, 2022.

K. Melgar Velis, M. Zelt, A. Ortiz Balsero$_1$, and A.M. Schmidt. 2022. Assessment of method of photo analysis for demonstrating soil quality. Proceedings of the *2022 Waste-to-Worth Conference*, Oregon, OH, April 18-22, 2022.

A.M. Schmidt, M. Zelt, L. Johnson, R. Koelsch, E. Cortus, M. Wilson, and D. Andersen. 2022. Perceptions of agricultural stakeholders on manure use benefits and barriers. Proceedings of the *2022 Waste-to-Worth Conference*, Oregon, OH, April 18-22, 2022.

A.M. Schmidt, M. Zelt, L. Johnson, R. Koelsch, E. Cortus, M. Wilson, and D. Andersen. 2022. Merits of Manure content library. Proceedings of the *2022 Waste-to-Worth Conference*, Oregon, OH, April 18-22, 2022.

Zelt, M., K. Melgar Velis, and A.M. Schmidt. 2022. Swine manure and cedar woodchip applications improve soil ecological indicators and moisture retention. Proceedings of the *2022 Waste-to-Worth Conference*, Oregon, OH, April 18-22, 2022.

Ramos Tanchez, J.C., M. Zelt, and A.M. Schmidt. 2021. AgSitePlanner: Resources and decision support tools for expansion of livestock production. Proceedings of the *2021 Annual International Meeting of the American Society of Agricultural and Biological Engineers*, Virtual Conference, St. Joseph, MI, July 11-14, 2021.

Extension and Outreach Presentations, Workshops, etc.

Zifei, L. 2021. Smoke Management for Prescribed Burning, November 17th, 2021. UAS Integration for Fire Operation Workshop.

Schmidt, A.M. 2022. *iAMResponsible…And so are you!* Invited Speaker. 2022 National Block & Bridle Convention, April 2, 2022.

Schmidt, A.M. 2022. *Antimicrobial Resistance from a One Health Perspective.* Invited Speaker. Veterinary Medicine 688 Lecture, April 11, 2022.

Schmidt, A.M. 2022. Accounting for Nutrients When Applying Manure. Nebraska Land Application Training, Multiple Sites, February 2022.

Schmidt, A.M. 2022. Valuing Manure as a Seller or a Buyer. Nebraska Center for Ag Profitability Webinar, January 13, 2022.

Schmidt, A.M. 2021. Maximizing Manure Value and Distribution. Nitrogen and Water Quality Management Field Day, Columbus, NE, December 9, 2021.

Schmidt, A.M. 2021. Assessing Soil Biological Quality Without a Lab. Soil Health Nexus Digital Café Webinar (Virtual), November 17, 2021.

Schmidt, A.M. 2021. Let's Talk Soil Health. Manure and Soil Health Field Day (Virtual), October 25, 2021.

Schmidt, A.M. 2022. *Nebraska Extension Resources for Supporting Responsible Manure Management in Nebraska.* Invited Speaker. Alliance for the Future of Agriculture in Nebraska County Officials Tour, April 6, 2022.

Schmidt, A.M. 2022. *Manure Management in Small Grains Systems.* Invited Speaker. Small Grains Conference, Lincoln, NE, March 3, 2022.

Schmidt, A.M. 2021. *When is Manure the Right Solution for Cropping Systems?* Invited Speaker. Certified Crop Advisors Training, December 3, 2021.

Schmidt, A.M. 2021. *Nebraska Extension Resources for Supporting Responsible Manure Management in Nebraska.* Invited Speaker. Alliance for the Future of Agriculture in Nebraska County Officials Tour, September 23, 2021.

Ramirez, B. C. 2022. *Ventilation workshop*. Hosted and sponsored by Swine Vet Center. Minneapolis, MN.

Ramirez, B. C. 2021. *Ventilation workshop*. Hosted and sponsored by United Animal Health. Olin, IA.

Ramirez, B. C. 2021. *Ventilation workshop*. Hosted and sponsored by JBS. Ottumwa, IA.

Ramirez, B. C. 2021. *Ventilation workshop series: 11 events*. Hosted and sponsored by Pipestone. Dubuque, Lamoni, and Sheldon, IA.

Ramirez, B. C. 2021. *Ventilation workshop*. Jul. 2021. Hosted and sponsored by Hanor Pork Production. Webster City, IA.

Ramirez, B. C. 2022. *Saving energy with proper ventilation*. JBS Annual Producer Meeting. Des Moines, IA.

Extension Publications, Trade Publications, Outreach Activities, etc.

Ni, J-Q., and T.-T. Lim. 2022. Manure characteristics, testing, and sampling. Purdue University Extension. https://www.extension.purdue.edu/extmedia/ABE/ABE-166-W.pdf

Lim, T.-T., T. Canter, and J. Zulovich. 2021. Lagoon Solids Removal and Solid Separation System Improvement at a Dairy Farm. University of Missouri Extension. https://extension.missouri.edu/publications/g3401

Canter, T., T.-T. Lim, and J. Zulovich. 2021. Nutrient recovery system for dairy farms: Dissolved air flotation and multi-disk press. University of Missouri Extension. https://extension.missouri.edu/publications/eq303

Lutt, A. We can learn a lot from poop. Lpelc.org. April 27, 2021. https://lpelc.org/we-can-learn-a-lot-from-poop/

Schmidt, A. IAMResponsible™…and so are you! Agriculture's role in addressing antimicrobial resistance. October 14, 2021. https://www.youtube.com/watch?v=PYJwHFqrao8&ab_channel=ExtensionMarathonCounty

Zelt, M., A. Schmidt, and A. Patterson. Highlights from the AMR from a One-Health Perspective course. December 6, 2021. https://lpelc.org/amr-from-a-one-health-perspective/

Zelt, M. and A. Patterson. Visual Glossary of Antimicrobial Resistance. September 9, 2021. https://lpelc.org/glossary-of-antimicrobial-resistance/

Zelt, M., H. Fowler, E. Okello, J. Moyle, and H. Grenier. Addressing Antimicrobial Resistance Through Livestock Management. August 23, 2021. https://lpelc.org/addressing-antimicrobial-resistance-through-livestock-management/

Zelt, M., and A.M. Schmidt. 2021. Capacity-building in One Health to Address Challenges Like AMR and COVID-19. LPELC.org, December 10, 2021.

Zelt, M., and A.M. Schmidt. 2021. Moving Downstream: Antimicrobial Resistance and Stormwater. LPELC.org, December 9, 2021.

Zelt, M., and A.M. Schmidt. 2021. Companion Animal Stewardship: One Health Solutions to Tackling Antimicrobial Resistance. LPELC.org, December 9, 2021.

Zelt, M., and A.M. Schmidt. 2021. Strategies to Improve Science Communication About Antimicrobial Resistance & Stewardship. LPELC.org, December 9, 2021.

Zelt, M., and A.M. Schmidt. 2021. Antimicrobial Resistance in Livestock Production. LPELC.org, December 9, 2021.

Zelt, M., and A.M. Schmidt. 2021. Clinical Implications of AMR. LPELC.org, December 9, 2021.

Zelt, M., and A.M. Schmidt. 2021. Antimicrobial Use and Resistance in Agriculture. LPELC.org, December 9, 2021.

Zelt, M., and A.M. Schmidt. 2021. AMR from a One Health Perspective. LPELC.org, December 6, 2021.

Zelt, M., and A.M. Schmidt. 2021. History of Public Attitudes Toward Microbial Diseases. LPELC.org, September 24, 2021.

Zelt, M., and A.M. Schmidt. 2021. Risk-Based Approach to Combatting Antimicrobial Resistance. LPELC.org, September 23, 2021.

Zelt, M., and A.M. Schmidt. 2021. Introduction to Antimicrobial Resistance. LPELC.org, September 22, 2021.

Zelt, M., and A.M. Schmidt. 2021. Glossary of Antimicrobial Resistance. LPELC.org, September 14, 2021.

Ramirez, B. C. 2022. Ventilation considerations for Prop 12 remodels.

Ramirez, B. C. 2022. Keep your hogs heat stress free. Written by Madelyn Ostendorf for Successful Farming.

Ramirez, B. C. 2022. Ventilation Webinar 3: Preparing for summer ventilation. PIC Technical Services Webinar.

Ramirez, B. C. 2022. Ventilation Webinar 2: Importance of FPM at inlet and static pressure. PIC Technical Services Webinar.

Ramirez, B. C. 2022. The positives and negatives of negative and positive pressure filtration Written by Sam Heuser for Farm Journal's Pork.

Ramirez, B. C. 2022. Ventilation Webinar 1: Importance of FPM at inlet and static pressure. PIC Technical Services Webinar.

Ramirez, B. C. 2021. Winter preparation, part 3: Intersection of air flow, humidity, and heating costs (Episode 104). PIC: The Squeal podcast.

Ramirez, B. C. 2021. Winter preparation, part 2: Updating your preparation checklist (Episode 103). PIC: The Squeal podcast.

Ramirez, B. C. 2021. Winter preparation, part 1: Early pig care considerations, ventilation, and managing health (Episode 102). PIC: The Squeal podcast

Ramirez, B. C. 2021. How does cage-free ventilation change in cold weather? Written by Meredith Johnson, Managing Editor, for Egg Industry Magazine.

Ramirez, B. C. 2021. Check hog buildings before 'tightening up' for winter. Written by Jeff DeYoung for Iowa Farmer Today.

Journal Editorship

Frontiers In Sustainable Food Systems, Special Topic Guest Editor (Dr. Amy Schmidt), The Impact of Government and Industry Practices on Animal Antimicrobial Use, Stewardship, and Resistance, 2021 – Present (Dr. Amy Millmier Schmidt)