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pork checkoff **Research REVIEW**

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Welcome to this issue of *Research REVIEW* brought to you by Pork Checkoff. The purpose of this e-newsletter is to give you a user-friendly way to learn more about research funded by the Pork Checkoff, what it means to the industry, and where to go if you want more information. We hope you find this publication useful. Feel free to forward to others. Archived issues are found [here](#).

ANIMAL SCIENCE

Includes pork quality, reproduction, nutrition and genetics

ANIMAL WELL-BEING

Includes animal assessment, handling and transportation, sow housing, euthanasia and animal space requirements

ENVIRONMENT

Includes manure management, air quality, water quality, water use/conservation and carbon footprint

HUMAN NUTRITION

Includes dietary nutrition, food preparation technology and ingredient health implications

PORK SAFETY

Includes pre- and post-harvest safety issues, pathogens and intervention technologies

PUBLIC HEALTH

Includes antibiotic use and resistance, disease transmission, risk assessment and worker health and safety

SWINE HEALTH

Includes domestic and foreign swine diseases, swine ID, biosecurity, disease surveillance and emergency preparedness

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RESEARCHER SPOTLIGHT:

Dr. Suzanne Millman
Associate Professor of Animal Welfare, Iowa State University

What is your current role at Iowa State? How did your career bring you to ISU?

I serve as associate professor of animal welfare in Iowa State's College of Veterinary Medicine. I chose to come here when this new position was announced to build a program in the heart of animal agriculture production.

How long have you been involved in livestock and swine industry research?

My research career with swine began in 1987 as undergraduate student in Canada, when I was hired as a technician for applied ethologist Dr. Frank Hurnik. He was exploring ways of fostering runt pigs on a robotic sow and I worked for several years as the "pig mama" for that project. He was a wonderful mentor and inspired my love of pigs and research.

What Pork Checkoff-funded research are you most proud of and why?

My interest gravitates toward the welfare of the vulnerable individuals in the swine herd—those animals that fail to thrive within the husbandry system. I am most proud of the collaborative research projects that provided guidance on how to recognize and care for those individual pigs, including humane euthanasia.

How do pork producers and others benefit from your research?

My research helps producers and veterinarians in the design of evidence-based standard operating procedures, particularly in the sensitive topic of ill and injured pigs. Similarly, I benefit from frank conversations with swine producers and veterinarians as such dialogue informs my research questions and helps me design projects that have relevance at the farm level for pigs and producers.

Why do you think it's important for pork producers to continue to fund swine research?

In my area of animal welfare, there is a great deal of public interest and rapidly expanding scientific knowledge. To address risks of poor decision-making based on emotion or tradition, there is a critical need for producers to work with scientists to identify research priorities and support projects that are likely to yield results that can strengthen production practices.

What else would you like producers to know?

Looking forward, the emergence of the Common Swine Industry Audit provides an opportunity for the industry to consolidate and interpret data on a number of animal welfare issues. As a researcher, I see exciting potential for the swine industry to use this data to determine prevalence norms at the individual farm and industry levels. Also to identify risk factors for particular animal welfare challenges and to evaluate interventions designed to prevent or treat these problems. It will be interesting to see how producers choose to use this information to strengthen their husbandry practices.

To view some of Dr. Millman's work, click [here](#).



Study Name: Understanding the Biology of Seasonal Infertility to Develop Mitigation Strategies

Principal Researcher: Dr. Jason Ross, Iowa State University

Key Points:

- Seasonal infertility in commercial pork production systems was not strongly correlated with heat stress during the wean-to-estrus interval.
- However, heat stress during other production phases, such as late gestation and/or lactation could influence reproductive ability.
- The physiological response to heat stress is repeatable in gilts that went more than four months between heat stress exposures.
- Heat stress affected a range of ovarian pathways to compromise reproduction, which could have implications for pregnancy maintenance and litter size. It does not affect the response to Matrix.

Summary: Seasonal infertility accounts for an estimated \$1 billion in annual revenue losses to the swine industry. Heat stress is a predictable event (particularly seasonal infertility) for which mitigation strategies are dramatically lacking. Defining the biological underpinnings contributing to reduced reproductive ability during seasonal infertility is the first and urgently needed step in developing mitigation strategies. Collectively, this project advanced the understanding of seasonal infertility and the role of heat stress on several areas and it will have immediate and long-term value to U.S. pork producers. The data provides a foundation for future experiments that will identify valuable markers for reproductive success during seasonal infertility, allowing the development of mitigation strategies. We also expect to enhance the basic understanding of the detrimental effects that heat stress has on porcine oocyte development which is foundational for future applied swine management and production practices.

[To learn more, click here.](#) 

Study Name: Effects of Prewaning Factors on Sow Lifetime Productivity

Principal Researcher: Dr. Mark Knauer, North Carolina State University

Key Points:

- Cross-fostered gilts were 2.45 percent less likely to farrow litters of their own.
- Increasing weaning age by one day increased a gilt's subsequent reproduction by 0.185 piglets per year.
- Greater piglet birth weight increased the proportion of gilts that farrowed a litter.
- Greater piglet preweaning growth improved the proportion of gilts that farrowed a litter as well as lifetime reproductive throughput.

Summary: The objective was to associate preweaning factors in gilt multiplication with the subsequent lifetime productivity in commercial sow herds. Sows were farrowed at two multiplication farms in North Carolina between May and December 2013. Prewaning data was collected on 12,943 gilts and their birth litters, including total number born, number nursed, number weaned, litter sex ratio, cross-foster status, weaning age, birth dam parity and individual traits such as birth weight, weaning weight and preweaning average daily gain. Gilts were traced from finishing facilities to commercial sow farms in eastern North Carolina. Of the 12,934 gilts individually tagged at birth, 6,249 entered a commercial sow farm. When including all gilts tagged at birth in the analysis, a lower litter size at birth, gilts not cross-fostered, greater piglet birth weight, piglet weaning weight and preweaning average daily gain were associated with increased ability to remain to parity 1. Yet only a lower litter size at birth tended to increase the ability to remain to parity 4. When including all gilts that were delivered to commercial sow farms, a greater weaning age, weaning weight and preweaning average daily gain were associated with more total pigs farrowed through four parities. Similarly, when including all gilts that were delivered to the sow farms, a greater weaning age, weaning weight and preweaning average daily gain were associated with more total pigs produced per day of herd life through four parities. Results suggest gilt multiplication farms should not cross-foster gilts, increase weaning age to 25 days, increase piglet birth weight and preweaning average daily gain to enhance subsequent sow lifetime productivity.

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Study Name: Assessment of Swine Marketed at Buying Stations and Development of Transport Guidelines

Principal Researcher: Dr. Suzanne Millman, Iowa State University

Key Points:

- Study confirms that pigs marketed through buying stations may face greater welfare risks.
- Compromised pigs made up 1.6 percent of the total, of which 69 percent were euthanized on site.
- Breeding stock comprised 72 percent of pigs sold at buying stations and faced greater risk of fatigue, abscesses and emaciation than market pigs.

Summary: Pigs marketed through buying stations may face higher risks of becoming fatigued or non-ambulatory during transport and marketing. This study examined health and welfare concerns within pigs marketed through buying stations, with the goal of developing guidelines for transport fitness and on-farm euthanasia. The goal was to identify prevalence of animal welfare outcomes and potential risk factors. Data collection was performed from March through October in 2014. We assessed animal welfare on 7,105 pigs as they were unloaded from 122 trailer loads at 15 commercial buying stations in the Midwest and eastern United States. Compromised pigs were defined as pigs that were segregated from cohorts due to health and welfare concerns. They were followed through the buying station to determine the animal's final outcome: 1) rested and recovered, 2) euthanized or 3) died. The prevalence of dead, non-ambulatory and fatigued pigs on arrival was 0.04 percent, 0.2 percent and 15.6 percent, respectively. For all pigs entering the buying station the most common animal welfare outcomes, in order, were abscesses, lameness, emaciation, hernias, severe skin lesions and vulva wounds. Hernias were more prevalent in market pigs than breeding pigs; there was no difference in lameness prevalence between the two pig groups. Tail biting and prolapses were rarely observed. More research is needed to determine the responses of these at-risk pigs to transport and mixing stressors.

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Study Name: Influence of Timing and Method of Land Application on the Fate and Transport of Manure Constituents in Runoff

Principal Researcher: Dr. Xu Li, University of Nebraska

Key Points:

- Manure application method did not significantly impact nitrogen transport, but did impact dissolved and total phosphorus in runoff.
- Antimicrobial levels were higher in runoff from broadcast plots than from injected plots.
- Land application timing relative to rainfall significantly impacted nearly all levels of manure constituents in runoff.

Summary: The objective was to determine how the timing and method of swine manure application may impact the movement of manure constituents in runoff. These included nutrients, antimicrobials, antimicrobial-resistant bacteria and antimicrobial-resistance genes. Swine manure slurry from a commercial farm was broadcast on or injected into plots by a commercial manure applicator. Three simulated rainfall events were initiated at 1 day, 1 week, 2 weeks or 3 weeks after the manure application. This allowed us to study the impacts of the application method and timing relative to rainfall on the movement of manure constituents in runoff. Results show that manure application method had no significant impact on nitrogen transport but did impact dissolved and total phosphorus in runoff. Chlortetracycline, lincomycin and tiamulin levels were higher in runoff from broadcast plots than from injected plots. Other than *E. coli*, the two application methods did not have significantly different levels of microbial constituents in runoff. However, land application timing relative to rainfall significantly impacted levels of nearly all manure constituents in runoff; longer intervals led to reduced load in runoff. The one exception was the antimicrobial resistance gene tet(X), whose relative abundance in runoff increased with longer time between application and rainfall. These findings show how the movement of different manure constituents in runoff may be affected by land-application strategies, highlighting the complexity in designing best management practices.

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Study Name: Effect of Macronutrient Composition of Breakfast on Satiety and Cognitive Function in Students

Principal Researcher: Dr. Christine Emilien, Iowa State University

Key Points:

- Plasma glucose and insulin levels were lower following the high–protein/low–carbohydrate breakfast.
- Participants were less happy when they missed breakfast, but there were no other statistically significant effects of breakfast on mood or cognitive performance.
- Due to a range of limitations associated with this topic, more study is needed.

Summary: It's believed that breakfast is an important meal due to its effect on appetite control and cognitive performance, yet little evidence exists to support this hypothesis. This study investigated the effect of changing the macronutrient content of breakfast on appetite and food intake. The no–breakfast treatment had a marked effect on appetite before lunch. Moreover, participants consumed more energy at lunch following the no–breakfast treatment. There was no difference in appetite before lunch or food intake at lunch following any treatment when breakfast was eaten. However, food intake over the entire test day was lowest for the no–breakfast treatment. Plasma glucose and insulin were lower following the high–protein/low–carbohydrate treatment compared to the low–protein/high–carbohydrate (no animal protein treatment). Participants were less happy when they missed breakfast, but there were no other statistically significant effects of breakfast on mood or cognitive performance. Due to the common perception that breakfast is an important meal for weight management and cognitive performance, more research is needed to determine the importance of breakfast as part of a healthy diet.

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Study Name: Equations to Predict the Iodine Value of Swine Carcass Fat

Principal Researcher: Dr. John Gonzalez, Kansas State University

Key Points:

- A diet's essential fatty acids (C 18:2 and C 18:3) content can be used to predict iodine value (IV) in back, belly and jowl fat.
- Equations using appropriate factors to estimate carcass fat IV will let producers feed pigs to avoid discounts associated with high IV.
- Backfat thickness exhibited the greatest influence on predicting IV of three distinct fat areas.

Summary: The study objectives were twofold. 1) Analyze existing data to develop predictive equations to determine the IV of three economically relevant adipose depots (areas) in finishing pigs. Equations would be developed using parameters such as dietary IV product, withdrawal period, carcass characteristics, etc. 2) Validate the equations in a live–hog finishing trial. In addition to examining the direct dietary effect on IV in fat depots, molecular analyses were conducted to investigate the biological mechanisms that govern or explain the phenotypic responses. Overall, adding fat to swine diets throughout finishing increased average daily gain and improved feed efficiency. However, the added fat increased backfat, which tended to reduce the carcass fat–free–lean index. Feeding tallow can improve rate of gain and feed efficiency without impacting IV. Feeding soybean oil can improve gain and feed efficiency, but it negatively impacts fatty acid composition and IV. This negative impact can be improved through a withdrawal strategy, but IV levels exceeded controls even after a 42–day withdrawal. The jowl was the least responsive to withdrawal periods, indicating a differential response between adipose depots. This is supported by past studies and should be a standard location and procedure to assess IV in pig carcasses.

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Study Name: Prebiotic Intervention to Reduce Carriage of Zoonotic Pathogens on the Farm and to the Abattoir

Principal Researcher: Dr. Robin Anderson, USDA, Agricultural Research Service

Key Points:

- The pig gut can be colonized with foodborne and disease–causing bacteria such as *Salmonella*, *E. coli* and

Campylobacter.

- Thymol, a natural product, exhibits potent antimicrobial activity against those bacteria, making it an attractive antibiotic alternative.
- However, when fed to swine Thymol is absorbed rapidly and isn't delivered to the lower gastrointestinal tract where the bacteria reside.
- More study is needed to overcome absorption challenges

Summary: Because thymol is very rapidly absorbed in the pig's stomach and small intestine, it's not delivered to the cecum and large intestine where *Salmonella*, *E. coli* and *Campylobacter* primarily reside. To make thymol more resistant to absorption, we used a conjugated form referred to as thymol-beta-D-glucopyranoside (beta-D-thymol). Conceptually, once the beta-D-thymol arrives to the cecum and intestine, gut bacteria there can degrade the protective bond and thus liberate free thymol, making it available to kill *Salmonella*, *E. coli* and *Campylobacter*. The study's objective was to determine if beta-D-thymol could be fed to reduce gut concentrations of *Salmonella*, *E. coli* and *Campylobacter*. Results from live-animal studies were not successfully achieved significant reductions in cecal and rectal concentrations of the three bacteria, possibly because hydrolysis and absorption of beta-D-thymol and free thymol in the small intestine may still have been rapid enough to preclude delivery to the cecum and large intestine. It's also possible that uptake and internal compartmentalization of beta-D-thymol by gut bacteria, or its chemical attraction to fats and oils, may sequester the beta-D-thymol thus preventing the release of free thymol. Comparing antimicrobial resistance profiles between *E. coli* isolates or multi-drug resistant *Salmonella* strains didn't support a hypothesis that exposure to beta-D-thymol or thymol may co-select for antimicrobial resistance. Research is underway to try to overcome obstacles preventing efficacious activity of beta-D-thymol in the pig's lower gastrointestinal tract.

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Study Name: Evaluation of a Shipping Model to Investigate PEDV Introduction into the U.S.

Principal Researcher: Dr. Scott Dee, Pipestone Veterinary Services

Key Points:

- Porcine epidemic diarrhea virus (PEDV) can survive in specific feed ingredients based on a shipping simulation from China to the United States.
- Contaminated feed ingredients could serve as transboundary risk factors for PEDV.
- The study introduced a model that could enhance further research and continue to validate mitigation protocols, among other strategies.

Summary: This study describes a model developed to evaluate the transboundary risk of PEDV-contaminated swine feed ingredients and the effect of two mitigation strategies during a simulated transport event from China to the United States. The imported ingredients were inoculated with PEDV. Control ingredients and treatments (ingredients plus a liquid antimicrobial (LA) or a 2 percent custom medium-chain fatty acid blend (MCFA)) were tested. The model ran for 37 days, simulating transport of cargo from Beijing, China to Des Moines, Iowa, from Dec. 23, 2012 to Jan. 28, 2013. Historical temperature and percent relative humidity data were programmed into an environmental chamber which stored all containers. Across the control (non-treated) ingredients viable PEDV was detected in soybean meal (organic and conventional), Vitamin D, lysine hydrochloride and choline chloride. In contrast, viable PEDV was not detected in any samples treated with LA or MCFA. This is proof of concept suggesting that contaminated feed ingredients could serve as transboundary risk factors for PEDV, along with the identification of effective mitigation options.

[To learn more, click here.](#) 

Study Name: PEDV Contamination, Quantification and Survival in Fomites and the Effect of Disinfectants

Principal Researcher: Dr. Montse Torremorell, University of Minnesota

Key Points:

- Porcine epidemic diarrhea virus (PEDV) was viable at 4°C (39.2°F) for 10 to 15 days in variety of common materials.
- At room temperature PEDV survivability dropped to 2 days for all materials.

- Transmissible gastroenteritis virus (TGEV) was the most sensitive and porcine delta coronavirus (PDCoV) the least sensitive to disinfectants tested.

Summary: This study was designed to assess the survivability of PEDV in fomites and determine the efficacy of four commonly used disinfectants against the three swine enteric coronaviruses; PEDV, PDCoV and TGEV. The fomites tested included Styrofoam, nitrile disposable gloves, cardboard, aluminum foil, cloth and Tyvek coveralls. Survivability was evaluated for 15 days at both room temperature and 4°C. The disinfectants tested were: Synergize, Virkon-S, DC&R and Tek-Trol. The virucidal evaluation of disinfectants was done by two tests—the suspension test and surface test. The results showed that PEDV could be viable at 4°C for 10 days in nitrile gloves, cardboard, aluminum foil and cloth, while it remained viable for 15 days in Styrofoam and Tyvek coveralls. In contrast, at room temperature survivability was significantly reduced to 2 days for all the materials. In addition, the results on disinfectants showed that TGEV was the most sensitive and PDCoV was the least sensitive to the disinfectants tested. For PEDV, DC&R was the most effective killing the virus within 30 seconds in both tests.

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Porcine Epidemic Diarrhea Virus (PEDV) Information

The National Pork Board has Checkoff-funded research underway right now to help find solutions to PEDV. To get the latest research updates and resources, go to www.pork.org/pedv.



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