

NCERA-219 Annual Meeting

October 25 through 27, 2023

Attendees: **Gary Apgar**, Southern Illinois University-Carbondale; **Lee Johnston**, University of Minnesota; **Merlin Lindemann**, University of Kentucky; **Brian Richert**, Purdue University; **Ryan Samuel**, South Dakota State University; **Marcia Shannon**, University of Missouri-Columbia; **Jeff Wiegert**, Texas A&M University

Absent: **Andrea Arruda**, Ohio State University; **Richard Gates**, Iowa State University; **Bob Goodband**, Kansas State University; **Benny Mote**, University of Nebraska-Lincoln; **Brett Ramirez**, Iowa State University; **Bob Thaler**, South Dakota State University

Wednesday, October 25, 2023

3:30pm – Meeting called to order and Chair Jeff Wiegert welcomed the group, outlined the agenda, and set the meeting goals to generate collaborative opportunities.

4:00pm – Station Reports were provided by Merlin Lindemann (Kentucky) and Brian Richert (Purdue).

5:45pm – Meeting adjourned and Day 1 concluded.

Thursday, October 26, 2023

8:00am – Meeting called to order and “Welcome to Waseca” provided by Jason Stenzel, Director of Operations at the Southern Research & Outreach Center. Mr. Stenzel provided valuable insight into the farm operations and answered committee member questions about how the Center addresses the challenges that are commonplace at academic research farms (e.g., staffing, budgeting, balancing research endeavors against profitable production agriculture, etc.).

9:15am – Swine Facilities Tour provided by Hayford Manu, Researcher and Swine Farm Manager at the Southern Research & Outreach Center. Dr. Manu showcased the facilities and research capabilities, described how the farm manages research projects, and demonstrated innovative technologies, such as a squeeze-lift system for trimming overgrown claws and hooves.

12:30pm – Lunch at SROC

1:00pm – Station Reports were provided by Gary Apgar (Southern Illinois), Lee Johnston (Minnesota), Ryan Samuel (South Dakota State), Marcia Shannon (Missouri), and Jeff Wiegert (Texas A&M)

3:00pm – Collaborative research and outreach education ideas were discussed, focusing on industry challenges and priorities (e.g., sustainability of swine production, pig welfare, image and trust of pork production, etc.), including:

- Feed wastage on contract farms: Feed leftover in feeders and bins after closeout often ends up in manure pit; could there be strategies to reduce feed wastage through better feed purchasing or pig marketing or opportunities to reuse/reclaim this feed for other purposes.
- Water access following periods of water deprivation: Pigs that are dehydrated due to water line issues (freezing, etc.) face physiological challenges when water access is restored; what is the best way to resupply water to dehydrated pigs to promote health and water.

4:00pm – Ernie Hansen and Morgan Hart, Hubbard Feeds, provided an overview of their research barns and a presentation on fiber feeding young pigs. Their insights and the discussion that was generated was valuable to steer committee discussion on collaborative efforts.

6:00pm – Meeting Adjourned and Day 2 Concluded

Friday, October 27, 2023

8:00am – Collaborative research planning continued, focusing on sources of funding: including RFPs from the National Pork Board (Swine Educators & Outreach Professionals) and the United Soybean Board.

10:00am – Discussion was given to future meeting times and locations. It was decided that scheduling this committee meeting to follow the National Pork Board’s Swine Educators & Outreach Professionals conference would be repeatable and dependable, and therefore allow more committee members to be able to plan to attend.

10:15am – Discussion was given to extend membership invitations to swine production faculty whose programs would fit with the committee: Dr. Beth Hines, Penn State University, and David Rosero, Iowa State University. Jeff Wiegert will reach out to extend invitations.

10:25am – Election of new Chair: Bob Goodband (Kansas State University) was nominated.

10:30am – Adjourn

Respectfully Submitted,

Jeff Wiegert

Southern Illinois University Carbondale
Station Report
10/26/23

Reporting unit:

In 2020 the newly formed School of Agriculture was merged under the newly formed College of Agriculture Life and Physical Sciences (a combination of the College of Science, and Agricultural Sciences). The School includes ANS and Crop Soil and Environmental Sciences, the primary users of the university farms.

Faculty:

New position in ANS focused in physiology/genetics/applied research. Hope to advertise soon, it is in DEI for review.

Dr. Erin Perry – hired as an equine nutritionist, has focused on companion animal/service animal research looking at decontamination protocols, treat palatability, etc. Also has conducted multiple equine palatability studies with flavors.

Dr. Eduardo Gastal – Hired as an equine reproductive physiologist, continues publishing heavily in the area of equine follicular development and hosting short courses to Amish and students related to estrus and breeding techniques.

Dr. Puthenpurauil Sasidharannair (Dr. Jay) – Hired 2 years ago as a ruminant nutritionist, has great farm support, many cows, purchased feedlot animals and 5 ruminally fistulated steers.

Dr. Amer Abughazalleh – Dairy nutritionist, microbiology specialist. Dairy was depopulated in ~2009, and no more cows. He has focused on environmental outputs using in vitro digesters.

Dr. Apgar – We have no swine, and is actively working on ensuring faculty oversight at the farms matches the responsibilities of said position. We've enjoyed donated pregnant sows and feed from the Maschhoff's for the last three years, but the current market has changed this situation.

University of Minnesota Station Report
NCERA-219 Committee Meeting
University of Minnesota
10/26/23

Research Projects

Integrating hybrid rye as a winter annual crop into organic pig production

PI's: Li, Johnston, Tallaksen, Lazarus, Wilson, Cox

This project is designed to evaluate the use of hybrid rye in a certified organic pig production system. We are evaluating agronomic, nutrient cycling, pig performance, pork quality, economic, and management system aspects of using hybrid rye to reduce feed costs in organic pig production. This is a three-year project initiated in the fall of 2021. Rye is grown at WCROC for this project and production facilities have been modified and certified for organic pig production. Consumer taste panel work revealed that replacing 50% of corn with hybrid rye in growing-finishing diets had no impact on consumer acceptability of pork.

Funding: USDA OREI grant and KWS

Utilization of computer vision as a means to understanding the etiology of tail biting outbreaks in growing-finishing pigs

PI's: Li, Johnston, Mote (UNL), Schmidt (UNL)

This three-year project utilizes the advanced computer vision platform (NUtrack System) to understand the complex etiology of tail biting and provide early recognition of tail biting outbreaks in pigs. Our objectives are: 1) Utilize an advanced computer vision platform to identify changes in postures and activities associated with tail biting outbreaks (TBO) to predict and prevent TBO through early intervention; 2) Characterize behavioral patterns of tail biters and victimized pigs for early identification of these pigs; 3) Evaluate social positions of pigs involved with tail biting and their roles in the development of TBO; 4) Assess stress and immune status of individual pigs that may predispose them to tail biting events; and 5) Visually identify tail biting events from processed video to develop AI and machine learning programs that will be capable of autonomously identifying tail biting events and associated pigs. Two experiments have been completed at the University of Minnesota and a third experiment is underway at University of Nebraska-Lincoln.

Funding: USDA NIFA

Effects of a phytogetic feed additive fed during lactation on sow and litter performance

PI's: Johnston and Manu

The purpose of this study was to investigate the impact of a phytogetic feed additive on sow and litter performance. Six cohort groups of sows (N=250) were used in this experiment. Dietary treatments were: 1) a corn-soybean meal diet (Control); 2) Control containing 150 ppm of a phytogetic feed additive (Low); and 3) Control + 200 ppm of a phytogetic feed additive (High). The feed additive contained a proprietary formulation of turmeric, capsicum, and black pepper

oleoresins (Fytera[®] Care, Selko USA, Indianapolis, IN). Average daily feed intake of sows, sow body weight, wean-to-estrus interval, and the proportion of sows expressing estrus by d 14 postweaning were not significantly different across treatments. Dietary treatments did not affect litter size, litter weight, or litter weight gain. The percentage of piglet mortality before cross-fostering tended to be lower ($P = 0.056$) for High-fed sows compared with Control sows. However, piglet mortality after cross-fostering was not affected by diet.

Funding: Selko USA

Sire line progeny evaluation

PI's: Johnston, Manu, Urriola, Cox

This sire line progeny evaluation involves 480 mixed sex progeny from two different sire lines. Sows were mated with semen from two terminal boar lines to produce pigs for evaluation in the SROC wean-to-finish unit. Growth performance, carcass characteristics, and pork quality are being evaluated. Pigs will be harvested early in January 2024.

Funding: Topigs Norsvin

Effects of feeding elevated dietary zinc to gestating sows on piglet survival

PI's: Johnston, Urriola, Gomez, Ryu

Feeding elevated dietary zinc (~600 ppm) seems to improve intrapartum and/or postnatal survival of piglets. Timing of zinc supplementation seems to be important with greatest beneficial effects observed in late gestation. However, early gestation supplementation needs to be explored. In this latest study conducted on a commercial sow farm, we evaluated sow and litter performance, plasma concentrations of Zn, Fe, and Cu of sows and piglets, liver mineral concentrations of piglets, gene expression in whole blood, and microbiome populations in sows and piglets.

Funding: USDA AFRI and National Pork Board

Publications:

Hammers, K. L., P. E. Urriola, M. Schwartz, M. Ryu, A. Gomez, and L. J. Johnston. 2022. Timing of dietary zinc additions during gestation for improved piglet survival. *J. Anim. Sci.* 100(Suppl. 2):56-57. <https://doi.org/10.1093/jas/skac064.090>

Sustainability of feeding systems

PI's: Shurson, Urriola, et al.

This overarching project aims at understanding the sustainability of swine feeding programs related to life cycle analysis from many different aspects. Numerous indicators of sustainability are evaluated including the transmission of foreign animal diseases through feed ingredients, feeds and feed supply chains.

Funding: Internal funds, commodity funds

Publications:

Yang, Z., P. E. Urriola, L. J. Johnston, and G. C. Shurson. 2023. A systems approach to evaluate nitrogen utilization efficiency and environmental impacts of growing-finishing swine feeding programs in U. S. pork production systems. *J. Anim. Sci.*
<https://doi.org/10.1093/jas/skad188>

*Education/Demonstration Projects***SowBridge**

PI's: Schieck-Boelke, Johnston, et al.

Short monthly programs (30 min + Q&A) are delivered over the noon period via Zoom. The program has grown to include fifteen collaborating institutions: MN, IA, SD, NE, OH, IN, IL, KS, NC, WY, PA, TX, ND, MO, and MI. The program for 2023 is underway and the program for 2024 is under development. The 2023 series is the fifteenth edition of SowBridge.

PQAPlus and TQA Producer Training

PI's: Schieck, DeWitte, and Johnston

Our group of advisors in cooperation with the MN Pork Board provides monthly training sessions to certify producers in the Pork Quality Assurance Plus and Transport Quality Assurance programs that are administrated by the National Pork Board. We also provide services for Site Assessments in the PQA+ program.

*Personnel/Facility Update***Faculty positions**

Swine faculty at the University of Minnesota in the College of Ag continue at a steady level over the past few years. Swine faculty include: Johnston (Nutrition/Mgt; Anim. Sci.), Urriola (Nutrition; Anim. Sci.), Shurson (Nutrition; Anim. Sci.), Baidoo (Nutrition; Anim. Sci.), Li (Welfare; Anim. Sci.), Lazarus (Economics; Applied Economics), Gomez (Microbiome; Anim. Sci.), Saqui-Salces (Gut physiology; Anim. Sci.), Cortus (Housing; Biosystems Engineering), Wilson (Manure mgt.; Soils), Chen (Metabolomics; Food Sci.), and others with passing involvement.

New positions

The Department of Animal Science has filled one beef position in the Beef Production Systems area and is negotiating with a candidate in the Ruminant Nutrition & Management – Beef area. We hired a Dairy genetics assistant professor that started in January, 2023.

Dr. Pedro Urriola accepted the **Assistant Professor of Livestock Sustainability** position in late summer and began his new appointment in September. This position is an AGRETT position

funded directly by the Minnesota Legislature. (AGRETT = Agricultural Research Education and Technology Transfer)

The longtime Poultry Extension Specialist in Turkeys (Sally Noll) retired in early 2023. Discussions are ongoing but the position is a top priority for the Department of Animal Science.

Facilities

Research and Outreach Centers are experiencing budget challenges as a result of many factors. The new Associate Dean overseeing ROC's is working hard to drive balanced budgets at ROC's. This is not an easy task.

The College of Food, Agricultural and Natural Resource Sciences (CFANS) is advancing a large facilities project named FAARM (Future of Animal Agricultural Research in Minnesota). This facility will initially include dairy facilities, cropland, turkey facilities and ultimately swine facilities. The fate of FAARM will surely dictate the future of ROC livestock facilities. This project is a partnership of CFANS, Riverland Community College, Hormel Foundation, and industry donors (yet to be named).

University of Kentucky

Swine Nutrition Research

NCERA-219, MN

October 26-27, 2023

~~Personnel~~

Research:

Nutrition: Merlin Lindemann, Sunday A. Adedokun

Digestive Physiology: open position

Microbiology: Melissa Newman

Kelly

Extension: open position

Graduate students in swine/poultry nutrition: *PhD*: Richard Adefioye (Obafemi Awolowo University, Nigeria).

Meats: Gregg Rentfrow

Research Specialist: Ashton

~~Research Facilities~~

The UK Swine Research Unit is at the C. O. Little Agricultural Research Center located between Versailles and Frankfort, approximately 15 miles west of Lexington. The three-site production facility (Headquarters-Breeding-Gestation-Farrowing; Nursery; Grow-Finish) accommodates up to 120 sows as part of the production herd, utilizes all AI (PIC purchased boar semen), and about 3-week weaning. At full capacity, it can finish about one-half of the pigs that are farrowed.

Research space for nursery pigs, grow-finish pigs, metabolism crates for pigs, and battery cages for chicks are available on campus in the W. P. Garrigus Building.

W. P. Garrigus Building – the office building that has housed the Department of Animal and Food Sciences, along with another building that houses several college departments and the college administration, and a series of greenhouses, will be razed by 2026 to give more space to the UK Hospital complex. Plans are being discussed on a fast-track pace for a new office building.

~~Research Activity in Swine Nutrition~~

~~Weanling Pig Research~~

- **Additional Iron Injection.** The multistate paper involving pigs from 7 universities from the NCCC-042 and S1081 committees has been submitted for publication.
- See animal byproduct research with sows below.

~~Growing-Finishing Pig Research~~

- **NCCC-042 Collaborative studies in pigs.** Our station contributed to the study determining the AME of bakery meal from different sources. Secondly, the study on standardized ileal amino acid digestibility of 11 bakery meal products in growing pigs was

conducted, contributed to, and published.

- **Standardized ileal amino acid digestibility.**
 - a. Standardized ileal amino acid digestibility of SBM produced from soybeans cultivated in Kentucky was evaluated in 25 kg and 50 kg pigs. Work is in the process of summarization.
 - b. The effect of increasing levels of supplemental enzyme (phytase and pectinase) supplementation on standardized ileal amino acid digestibility of corn-SBM-based diets was evaluated in cannulated growing pigs. Lab work is ongoing.
 - c. Standardized ileal amino acid digestibility of regular corn and mycotoxin-contaminated corn with and without the addition of Fumzyme (a DSM product) was evaluated in cannulated growing pigs. Lab work is currently ongoing.

~~Sow Research~~

- **S-1081 multistate new objectives for 2023-2028** - Objective 1: Examination of supplemental histidine on the lactation performance of sows, Objective 2: Biomarkers related to sow metabolic status, piglet vigor, and reproductive potential, and Objective 3: Effect of a sensory additive during lactation on sow feed intake and reproductive performance. Project was approved in September 2023. We will participate first on Objective 1.
- **Rendered Animal Protein Byproducts in Sow Diets.** Feeding animal byproducts (PBM or MBM) up to 5% of the diet in nursery and grower pigs were evaluated previously and indicated that they are an acceptable option as a feed ingredient. Both animal byproducts performed well when started in the nursery diets immediately at weaning but less so when started 7 days postweaning, implying that these products need to be added in the first nursery diet rather than the later nursery diet. In choice/preference studies, pigs demonstrated a preference for the animal byproduct-free diets when given a choice, but pigs definitely preferred either PBM or MBM over the SDPP when given that choice. In dose-related nursery studies, the 2-3% inclusion rate of the byproducts resulted in the greatest ADG, generally as a result of increased ADFI. These byproducts are now being evaluated in lactation diets at an inclusion rate of 3%. As a follow-up to the sow study, weaned piglets are being fed diets with 0 or 3% of the byproducts, making a 2x2 factorial of sow diet and nursery diet.

Texas A&M University / Texas A&M AgriLife Agency
Swine Programs
NCERA-219 Committee Meeting; Waseca, MN; Oct. 25 to 27, 2023

Personnel

Active Swine Personnel

- Management: Jeff Wiegert
- Reproduction: Rebecca Poole, Fuller Bazer, Greg Johnson
- Nutrition: Guoyao Wu
- Current Swine Graduate Students: Kyle Hickman-Brown, Brooke McAnally, Olivia Ognibene, Matt Stuehr, Joe Cain, Arianna Lopez

Administrative Changes

- Vice Chancellor and Dean: Jeff Savell (June 2022)
- Director of Texas A&M AgriLife Research: Cliff Lamb (March 2022)
- Head of the Department of Animal Science: Clay Mathis (October 2023)
- Interim Associate Head of Extension: Andy Herring (October 2023)

New Hires (within 2023)

- Equine Science: Erica Macon (August 2023)
- Precision Technology (Dept. of Poultry Science): Ziteng “Tim” Xu (August 2023)
- Extension Livestock Predation Specialist: Bill Constanzo (July 2023)
- Extension Beef Specialist – South Texas: Karl Harborth (June 2023)
- Vet Science Certificate Program Manager: David Sessum (March 2023)
- Extension Livestock Sustainability Specialist: Jacquelyn Prestegaard-Wilson (January 2023)
- Swine Unit Manager: Ed Savage (January 2023)

New Positions (varying stages of planning, advertisement, or hiring)

- Precision Gene Editing
- Instructor and Rodeo Team Coach
- Extension Meats Specialist

Swine Facilities

The Animal Science Swine Unit is located ~5 miles from Texas A&M University campus and was depopulated in 2018 before repopulation with commercial genetics in 2020. The unit consists of two barns: 1. A partially slatted naturally ventilated barn housing both growing pigs and breeding sows (~35 sows, group housed), and 2. A mechanically ventilated barn with farrowing (10 crates) and nursery (16 pens) rooms. Sows are bred to farrow in batch according to research and teaching needs. Additional barns are present on site that can be modified for experimental animal housing.

The Nutrition and Physiology Center, located next to the Swine Unit, contains rooms for individual animal housing, surgery/necropsy rooms, and a dedicated animal recovery space.

A new Meat Science and Technology Center will be built approximately 10 miles from campus. The facility will replace the current on-campus Meat Center and is planned to be equipped with meat coolers,

research laboratories, and teaching and demonstration areas in a 75,000 sq ft space. Projected completion date is 2028.

Ongoing Swine Research

Swine Reproductive Microbiome

Microbiomes of cyclic and pregnant gilts at various gestational ages

PIs: Poole, Wiegert

Project summary: The objectives of the study are to 1. Characterize the microbiome of reproductive and placental tissues of cyclic and pregnant gilts, 2. Evaluate shifts in the microbiome throughout the reproductive tract and with advancing gestational age, and 3. Correlate microbial shifts with blood progesterone concentrations. Results in pregnant gilts show distinct microbiome clustering (β -diversity) within the reproductive tract, notably: decreasing microbial diversity with greater proximity to the fetus. Bacteria of the genera *Lactobacillus* are the most prevalent in placental tissue and fluids and appear positively correlated with circulating progesterone ($r = 0.70$). Additionally, the microbial communities of reproductive tissues in early gestation (day 15 to 18 post-breeding) are different than the microbial communities of reproductive tissues in late gestation (days 60 to 90 post breeding). A greater number of cyclic gilts are needed, and these studies are ongoing. Future studies will focus on modulating the reproductive and therefore fetal microbiomes through nutritional interventions.

Funding: Internal TAMU funds; USPCE Swine Research & Education Experience

Hickman-Brown, K.J., M.S. Smith, B.E. McAnally, J.W. Cain, H. Seo, F.W. Bazer, G.A. Johnson, J.G. Wiegert, and R.K. Poole. 2023. The microbiome of reproductive tissues and amniotic and allantoic fluid of pregnant gilts during mid- and late-gestation. *J Anim Sci.* 101 (Suppl. 1):14-15. <https://doi.org/10.1093/jas/skad068.017>

Stockland, E.L., K.J. Hickman-Brown, M.S. Smith, B.E. McAnally, J.W. Cain, H. Seo, F.W. Bazer, G.A. Johnson, J.G. Wiegert, and R.K. Poole. 2023. Relationship between progesterone and reproductive tract microbiota in pregnant gilts. *J Anim Sci.* 101 (Suppl. 1):117-118. <https://doi.org/10.1093/jas/skad068.140>

Poole, R.K., D.R. Soffa, B.E. McAnally, M.S. Smith, K.J. Hickman-Brown, and E.L. Stockland. 2023. Reproductive microbiomes in domestic livestock: Insights utilizing 16s rRNA gene amplicon community sequencing. *Animals.* 13(3):485. <https://doi.org/10.3390%2Fani13030485>

Hickman-Brown, K.J., M.S. Smith, B.E. McAnally, J.W. Cain, H. Seo, F.W. Bazer, G.A. Johnson, V. Palanisamy, S. Chitlapilly Dass, J.G. Wiegert, R.K. Poole. Bacterial community diversity in reproductive tissues and fetal fluids of pregnant gilts. Accepted for the 2023 American Society of Animal Science Annual Meeting.

Maternal versus environmental contributions to the piglet pioneer microbiome

PIs: Wiegert, Poole

Project Summary: The objective was to quantify various maternal and environmental contributors to the piglet's pioneer microbiome. Sterile swabs were used to collect samples from the disinfected farrowing crate before and after gilt introduction, from multiple locations of the dam at farrowing, and from the piglets at repeated times between birth and weaning. Multiple regression analysis indicated that the dam's birth canal explains greater than 50% of the variation in the piglet microbiome at birth, which in turn explains 15.6% of the variation in the microbiome at 10 days of age. Nearly 60% of the variation in the

piglet microbiome at weaning is explained by the microbiome at 10 days of age. In this study, the microbiomes of the dam's rectum, of colostrum, and of the farrowing crate at farrowing were not associated with the piglet microbiome from birth to weaning. Bioinformatic analysis is ongoing.

Funding: Internal TAMU funds

Eldridge, L.K., K.J. Hickman-Brown, B.E. McAnally, M.S. Smith, R.K. Poole, and J.G. Wiegert. 2023. Maternal versus environmental contributions to the piglet pioneer microbiome. *J Anim Sci.* 101 (Suppl. 1):69-70. <https://doi.org/10.1093/jas/skad068.082>

Boar semen and reproductive tract microbiome

PIs: Poole, Wiegert

Project Summary: Extended semen doses were obtained from commercial boar studs of the same genetic company and evaluated 1. Over the shelf-life of the extender, 2. Between studs of known “above average” and “below average” fertility, and 3. Between single-sire and pooled-sire composition. The microbiome communities of semen doses change over the shelf life of the extender and differ between studs. No major differences were detected between single-sire and pooled-sire doses. From this, pre-pubertal and post-pubertal boars were dissected to evaluate reproductive tract microbiomes. In the pre-pubertal boar, the relative abundance of bacteria in the preputial diverticulum appeared dominated by genera of known gastrointestinal origin, and this location was different from the rest of the tract. In the pubertal boar, the preputial diverticulum was again different from reproductive organs, yet greater differences in bacteria relative abundance were observed between individual organs, such as the testes, epididymis, and seminal vesicles. Ongoing work from this project includes bioinformatics analysis and evaluation of the expression and localization of toll-like receptors within boar tissues.

Funding: Internal TAMU funds; USPCE Swine Research & Education Experience

McAnally, B.E., M.S. Smith, J.G. Wiegert, V. Palanisamy, S. Chitlapilly Dass, and R.K. Poole. 2023. Characterization of boar semen microbiome and association with sperm quality parameters. *J Anim Sci.* 101:skad243. <https://doi.org/10.1093/jas/skad243>

McAnally, B.E., D.R. Soffa, M.S. Smith, K.J. Hickman-Brown, E.L. Stockland, C. Stenhouse, J.G. Wiegert, G. Wu, R.K. Poole. Expression of toll-like receptors in the boar reproductive tract prior to puberty attainment. Accepted as Late-Break Abstract for the 2023 Society for the Study of Reproduction Annual Meeting.

McAnally, B.E., D.R. Soffa, M.S. Smith, K.J. Hickman-Brown, E.L. Stockland, J.G. Wiegert, G. Wu, R.K. Poole. Characterization of boar reproductive tract microbiome prior to puberty attainment. Accepted for the 2023 American Society of Animal Science Annual Meeting.

Swine Nutrition

Dietary glycine enhances post-weaning growth and meat quality of IUGR pigs

PI: Wu

Project Summary: Pigs with intrauterine growth restriction (IUGR) have suboptimum growth performance and impaired synthesis of glycine (the most abundant amino acid in the body). Conventional corn- and soybean meal-based diets for postweaning pigs contain relatively low amounts of glycine and may not provide sufficient glycine to meet requirements for IUGR pigs. At weaning, IUGR or normal birth weight (NBW) pigs were assigned randomly to one of two nutritional groups: supplementation of a

corn-soybean meal-based diet with either 1% glycine plus 0.19% cornstarch or 1.19% L-alanine (isonitrogenous control) until slaughter at 188 d of age. Neither IUGR nor glycine supplementation affected ($P > 0.05$) feed intakes of pigs per kg BW. The final BW, gain:feed ratio, carcass dressing percentages, and four-lean-cuts percentages of IUGR pigs were 13.4 kg, 4.4%, 2%, and 15% lower ($P < 0.05$) for IUGR pigs than NBW pigs, respectively. Compared with pigs in the alanine group, dietary glycine supplementation increased ($P < 0.05$) final BW, gain:feed ratio, and meat a* value (a redness score) by 3.8 kg, 11%, and 10%, respectively, while reducing ($P < 0.05$) backfat thickness by 18%. Thus, supplementing 1% of glycine to a corn-soybean meal-based diet improves the growth performance, feed efficiency, and meat quality of IUGR pigs.

Funding Source: USDA AFRI

He, W., E.A. Posey, C.C. Steele, J.W. Savell, F.W. Bazer, and G. Wu. 2023. Dietary glycine supplementation enhances post-weaning growth and meat quality of pigs with intrauterine growth restriction. *J Anim Sci* 101:skad354. <https://doi.org/10.1093/jas/skad354>

Basic Swine Reproductive Physiology

Metabolic pathways and hormone communication of the porcine conceptus, uterus, and placenta

PIs: Johnson, Wu, Bazer

Project summary: Conceptus elongation and early placentation involve growth and remodeling that requires proliferation and migration of cells. This demands conceptuses expend energy prior to establishment of a placenta connection and when they are dependent upon components of histotroph secreted or transported into the uterine lumen from the uterus. Glucose and fructose, as well as many amino acids (including arginine, aspartate, glutamine, glutamate, glycine, methionine and serine) increase in the uterine lumen during the peri-implantation period. Glucose and fructose enter cells via their transporters, SLC2A, SLC2A3 and SLC2A8, and amino acids enter the cells via specific transporters that are expressed by the conceptus trophectoderm. However, porcine conceptuses develop rapidly through extensive cellular proliferation and migration as they elongate, resulting in increased metabolic demands. Therefore, coordination of multiple metabolic biosynthetic pathways is an essential aspect of conceptus development. Oxidative metabolism primarily occurs through the TCA cycle and the electron transport chain, but proliferating and migrating cells, like the trophectoderm of pigs, enhance aerobic glycolysis. The glycolytic intermediates from glucose can then be shunted into the pentose phosphate pathway and one-carbon metabolism for the de novo synthesis of nucleotides. A result of aerobic glycolysis is limited availability of pyruvate for maintaining the TCA cycle, and trophectoderm cells likely replenish TCA cycle metabolites primarily through glutaminolysis to convert glutamine into TCA cycle intermediates. The synthesis of ATP, nucleotides, amino acids, and fatty acids through these biosynthetic pathways is essential to support elongation, migration, hormone synthesis, implantation and early placental development of conceptuses.

Funding Source: USDA NIFA

Johnson, G.A., H. Seo, F.W. Bazer, G. Wu, A.C. Kramer, B.A. McLendon, and J.W. Cain. 2023. Metabolic pathways utilized by the porcine conceptus, uterus, and placenta. *Mol Reprod Dev.* 90(7):673-683. <https://doi.org/10.1002/mrd.23570>

Cain, J.W., H. Seo, K. Bumgardner, C. Lefevre, R.C. Burghardt, F.W. Bazer, and G.A. Johnson. 2023. Pig conceptuses release extracellular vesicles containing IFNG for paracrine communication with the endometrium. Presented at Society for the Study of Reproduction.

Creatine metabolism in porcine conceptus

PIs: Bazer, Johnson, Wu

Project summary: In pigs, the majority of embryonic mortality occurs during two periods of pregnancy. The first is between Days 14 and 25 when free-floating conceptuses (embryos and associated placental membranes) elongate and attach to the uterus, and the second is between Days 50 and 70 when the uterine-placental interface undergoes extensive folding and develops mature areolae to maximize hemotrophic and histotrophic support for the fetuses. Both periods involve extensive cell proliferation and migration that require energy in the form of adenosine triphosphate (ATP). We hypothesize that insufficient ATP production in conceptus and uterine tissues may contribute to conceptus loss in pigs. Creatine is an organic compound commonly stored in the muscle as phosphocreatine (PCr) for ATP production. One method of ATP production is through the creatine (Cr)-creatine kinase (CK)-PCr pathway. In a reversible reaction, CK catalyzes the conversion of intracellular pools of PCr to Cr and ATP. However, the expression of factors involved in creatine metabolism for the production of ATP has not been examined in conceptus and uterine tissues throughout gestation in pigs. Enzymes and a transporter of importance in this pathway include arginine:glycine amidinotransferase (AGAT), S-adenosylmethionine-dependent guanidinoacetate N-methyltransferase (GAMT), solute carrier family 6 member 8 (SLC6A8), muscle-type creatine kinase (CKM), and brain-type creatine kinase (CKB). In the present study, we performed real-time qPCR to quantify mRNA expression for enzymes and the transporter involved in the creatine metabolic pathway in conceptus/placental and uterine/endometrial tissues from Days 10, 12, 15, 18, 20, 24, 30, 40, 60, and 90 of gestation. qPCR established increases of AGAT, GAMT, CKM, CKB, and SLC6A8 mRNAs in elongating conceptuses by Day 15 of the peri-implantation period, and a further increase in AGAT mRNA in the chorioallantois on Day 90 of gestation. Immunofluorescence staining of the uterine-placental interface from Days 15, 16, 20, and 25 of gestation corroborated qPCR results, with the expression of GAMT, CKM, and CKB proteins appearing to increase in conceptus trophoblast cells on Day 15. Endometrial AGAT and CKM mRNAs increased on Day 15, CKB increased again on Day 30, and AGAT, GAMT, and SLC6A8 showed significant increases on Days 40, 60, and 90 of gestation. Collectively, these findings indicate that the Cr-CK-PCr pathway could play a role in establishing sufficient energy stores to support cell proliferation and migration required for the key events of conceptus elongation, implantation, and remodeling of the uterine-placental interface to form folds and areolae during gestation in pigs.

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Sah, N., K.M. Halloran, R.M. Moses, M. Newton, H. Seo, G.A. Johnson, G. Wu, and F.W. Bazer. 2023. Day of gestation and fetal sex influence creatine metabolism at the porcine uterine-placental interface. *Presented at Society for the Study of Reproduction.*