Annual Report 2018

National Pork Board

Animal Science Committee

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Mission Statement

To invest Checkoff funds into research that provides solutions to challenges faced by U.S. pork producers.

Purpose

The purpose of this report is to centrally locate and summarize the research and programmatic activities of the National Pork Board's Animal Science Committee. It will provide committee members, producers, researchers and the public a reference resource and knowledge about the mission and priorities of the committee and the progress made to resolve constraints to profit and viability during 2018.

To view all the Checkoff-funded research, visit *pork.org/research*.

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Letter from the Chair

Dear Fellow Pork Producer:

It certainly has been an interesting year to be in the business of producing safe, wholesome pork for the world. Expansion within the industry and improved productivity has led to record numbers of pigs produced in the U.S. Yet, demand both domestically and internationally, remained very solid in 2018. The emergence and spread of African Swine Fever in China, placed renewed emphasis on foreign animal diseases. While these new threats are real, let us not lose sight of our existing domestic challenges to pork production.

To this end, the Animal Science Committee, in cooperation with the Welfare Committee, embarked on an effort to improve pig survivability. The vision for this effort is threefold:

- Coordinated research projects that will reveal best management practices for mitigating pig death loss
- Rigorous training for students involved in these research practices
- Outreach activities including workshops, symposia and websites where producers can gain first-hand knowledge about reducing pig mortality

While swine health and disease play a major role, genetics, facilities, nutrition and management also significantly contribute to pig mortality. Therefore, a "systems" approach to solving the issue is needed. In July the combined committees selected a consortium of researchers to address this issue. The consortium is led by Dr. Jason Ross at Iowa State and, over the next five years, 16 researchers and their students from three different institutions will work collectively on the effort.

The initial funding of $1 million for this effort was established by the Animal Science and Welfare Committees of the National Pork Board. The Foundation for Food and Agriculture Research (FFAR) agreed to partner with the NPB by contributing an additional $1 million in funding for the effort. This is a great way to leverage producer dollars into answers that will have real impact.

This coming year, the Animal Science and Welfare Committees are once again partnering with FFAR to invest in development of novel or adaption of existing technologies to identify and monitor indicators of pig health, welfare and productivity. While the committees have not yet selected projects for funding, there were 26 proposals submitted for consideration in this area. It will be interesting to see how technology may be used to tackle some of the issues we face in the production of pork.

Sincerely,

Dustin Kendall, PhD
Chair of Animal Science Committee
National Pork Board

Introduction

The Animal Science Committee continues to be committed to the wise investment of Checkoff funds in research that is critical to maintaining our position as the most efficient producer of low-cost, high-quality pork in the world. In this regard, the committee is dedicated to finding answers to issues that affect productivity and profitability; primarily driven by improved production efficiencies.

In this report, you will find an accounting of the programmatic and research activities of the Animal Science Committee. In the table at right is a listing of specific programs under each of these areas.

Program Activities	Research Activities
Pork Industry Scholarship	Feed Cost Mitigation
Pork Industry Leadership	Impact of Seasonality
Industry Productivity Analysis	Sow Lifetime Productivity

Improving pig survivability became the highest priority research area for the Committee in 2018. In cooperation with the Welfare committee a request for proposals entitled "A Systems-Approach to Enhancing Pig Health, Wellbeing and Productivity" was developed and released. Together these committees set aside $1 million in 2018 monies to fund this research, training and outreach effort over the next 5 years. The Foundation for Food and Agriculture Research agreed that this is a critical issue and contributed an additional $1 million in funding support for this effort. This coordinated research, training and outreach effort represents a novel approach to funding and allows the committee to be more strategic in how they invest their available dollars. More importantly, if successful, this effort will fundamentally change the way we raise pigs for pork production in the U.S.

Feed efficiency remains a priority research area in 2018 because feed is the number one cost of production representing approximately 65% of all production costs. Even with the projected reduction in corn prices for 2018, feed will remain the single largest cost for producing pork. In 2017, it was the last year of a seven-year program to conduct research that will result in a reduction of feed cost. This research has led to novel insights into use of enzymes to enhance nutrient uplift from high fiber feedstuffs, improved feed-processing technologies, improved animal performance and better understanding of the available nutrients in alternative feed ingredients. Alone these are small changes in swine nutrition, however, collectively they have the potential to make a significant difference on producer bottom line because even a small change in feed efficiency has a large impact on cost of production. During the summer research meeting, the committee voted to continue work in this area, dedicated $200,000 in 2019 monies to this effort, and established new priorities for this area of research to account for completed research work.

The Animal Science Committee also continued to support the sow lifetime productivity effort. The two primary projects conducted in this area over the past seven years are largely complete so the support was primarily used to mine the large data sets generated by this research and in dissemination of the information. Dr. George Foxcroft of the University of Alberta and Dr. Clay Lents of the US-Meat Animal Research Center were the primary investigators on these projects. They presented the results of their projects at a number of meetings including the Midwest Section Animal Science Meeting, the World Pork Expo, the Reproduction Workshop and the Leman Conference. This effort is largely complete and will sunset in 2019.

Chris Hostetler, Ph.D.
Director of Animal Science, National Pork Board

2018 NPB Animal Science Committee

Name	Role	State
Dr. Dustin Kendall	Chair	NC
Dr. Dan Hamilton	Vice-chair	TN
Dr. Roger Arentson	Member	MN
Dr. Nathan Augspurger	Member	IN
Dr. Bart Borg	Member	IA
Mr. Wayne Cast	Member	MO
Dr. Paul Cline	Member	MN
Mrs. Valerie Duttlinger	Member	IN
Mr. Gregg Eckardt	Member	KS
Dr. Justin Fix	Member	IL
Mr. Gene Gourley	Member	IA
Dr. Kent Gray	Member	NC

Name	Role	State
Dr. Blaine Hanson	Member	IA
Mr. Nick Holden	Member	MN
Dr. Zack Rambo	Member	MN
Dr. Clint Schwab	Member	IL
Ms. Heather Wilt	Member	IA
Mr. Terry O'Neil	Board Representative	NE
Dr. Joe Cassady	Advisor	SD
Dr. Maynard Hogberg	Advisor	IA
Dr. Clay Lents	Advisor	NE
Dr. Ken Stalder	Advisor	IA
Dr. Mike Tokach	Advisor	KS

Program Effort

The Animal Science Committee has developed a key program designed to identify and develop the next generation of leaders in the pork industry. This ongoing program is critical for the continued success of the industry and is critical for meeting labor demands. In addition, the Animal Science Committee is dedicated to annually establishing industry-wide benchmarks of the some key productivity indicators. This information is critical for producers to be able to identify areas in which they can make improvements in productivity for their individual enterprises. Analysis of this data is also important for identifying and targeting research in areas that are likely to have the greatest impact on productivity.

1. NPB Scholarship Program

The purpose of the National Pork Board's Pork Industry Scholarship Program is to support the efforts of individuals who intend to seek an advanced degree by enrolling in either graduate school or veterinary college. In this way, the committee identifies and supports individuals with the ability and training to serve as the next generation of leaders for the industry. This scholarship is open to college juniors and seniors, majoring in a variety of disciplines, who have a demonstrated dedication to working in pork production.

A selection committee that includes members of the Animal Science Committee, academia and allied industry representatives evaluates applicants. Selection committee members review and score each application independently and rank the applicants based on the following criteria:

- Scholastic record
- Youth and industry leadership activities
- Interest/involvement in the swine industry
- Graduate degree selected and/or prospective career path

This year's top scholarship recipients are Madison Wensley and Amanda Anderson, who will receive a $5,000- and $3,500-scholarship, respectively. Wensley, a senior at Michigan State University, is majoring in animal science. She plans to continue her academic career by pursuing a masters of science degree in swine nutrition at Kansas State University. Ultimately, she would like to provide pig farmers with the tools they need to improve feed management practices. Anderson, a senior at Iowa State University, is majoring in animal science. She plans to pursue a doctorate of veterinary medicine at Iowa State University in the fall. The other award recipients will receive $2,000 each.

2018 NPB Pork Industry Scholarship recipients			
Applicant	**City, State**	**Institution**	**Major**
Abner, Victoria	Howe, TX	Texas A&M	Animal Science
Anderson, Amanda	Ames, IA	Iowa State University	Animal Science
Anderson, Madison	Bend, OR	Dordt College	General Agriculture
Batson, Kelsey	Princeton, MO	University of Missouri-Columbia	Animal Science
Beam, Joshua	Elverson, PA	Penn State	Animal Science
Boyd, William	Chesapeake VA	Virginia Polytechnic	Animal Science
Bryan, Erin	Urbana, IL	University of Illinois	Animal Science
Creager, Chloe	Olpe, KS	Kansas State University	Animal Science
Everett, Hunter	Mebane, NC	North Carolina State University	Animal Science
Gibbs, Evan	Cascade, IA	Iowa State University	Agricultural Studies
Hopple, Piper	Clyde, OH	The Ohio State University	Animal Science
Leddy, Kiera	Stockholm, SD	Oklahoma State University	Ag Communications
Lowery, Katelyn	Clayton, NC	North Carolina State University	Animal Science
Meeker, Meg	Emden, IL	University of Illinois	Ag Leadership
Strathman, Sara	Brodhead, WI	University of Wisconsin Platteville	Animal Science
Wensley, Madison	Parma, MI	Michigan State	Animal Science
Whitaker, Whitney	Templeton, CA	Kansas State University	Animal Science
Wikner, Ben	Farmersburg, IA	Iowa State University	Agricultural Studies
Wolfe, Zoe	Raleigh, NC	North Carolina State University	Animal Science
Wonderly, Morgan	Bakersfield, CA	Cal Polytechnic Institute	Animal Science
Zimmerman, Luke	Forrest, IL	University of Illinois	Animal Science
Keegan Vander Molen	Pella, IA	Oklahoma State University	Animal Science

During the summer of 2017, Ms. Hannah Price, the National Pork Board's Science and Technology intern, conducted a survey of scholarship recipients. The purpose of this survey was to determine if recipients of this scholarship are still active in the pork production industry and to update the existing database with new contact information. The highlights of that poll are as follows:

- There were 49 respondents who received scholarships between 2010 and 2016
- 50% were working on or had already received their MS degree
- 28% were working on or has already received their PhD degree
- 28% were working on or had already received their DVM degree
- Over 69% were employed in a segment of agriculture
- Over 55% were employed in the swine industry

2. Industry Productivity Analysis

Benchmarking of key productivity indicators is an important tool to assess continual improvement. Both producers and scientists can better understand performance and pork industry trends through use of production benchmarks. However, limited benchmarking data is publically available for producers to use in making comparisons. Therefore, the objective of this work is to quantify U.S. production benchmarks and trends for grow-finish and sow traits from a large, commercially available database.

A data management company provided the data for this project. This data set represents approximately 35 percent of U.S. sows and their offspring. Currently, the database contains data from 2005 through 2017, however; only data from the years 2012 through 2017 were included in the 2018 analysis. Updates to the database occur each March when the data from the previous year becomes available. Each record represents a farm's production for one month for grow-finish and sow traits. Grow-finish traits are analyzed for three stages of production; nursery, finishing and wean-to-finish. Sow key productivity indicators include piglets per mated female per year, litters per mated female per year, total number born, number born alive, number weaned, pre-weaning mortality, weaning age, weaning weight, replacement rate, culling rate, sow mortality, lactation feed intake and gestation feed intake.

Dr. Ken Stalder conducted the analysis for 2018 and the report was completed and released at the World Pork Expo in June. Both the full report and the summarized report are available on *www.pork.org/animalscience.*

At right are selected results from that analysis.

Table 2. Average sow productivity 2012 - 2017	2012	2013	2014	2015	2016	2017
Pigs/Mated Sow/Year	23.9	23.7	22.2	23.4	23.6	23.9
Litters/Mated Sow/Year	2.31	2.30	2.26	2.27	2.28	2.30
Total Born	13.4	13.6	13.5	13.5	13.7	13.9
Stillborn and Mummies	1.17	1.14	1.21	1.35	1.32	1.37
Number Born Alive	12.3	12.4	12.3	12.1	12.4	12.6
Number Weaned	10.3	10.2	9.7	10.0	10.2	10.3
Pre-weaning Mortality %	15.5	17.3	20.5	17.4	17.3	17.8
Weaning Weight (lbs.)	13.2	13.4	13.6	13.9	13.9	14.0
Weaning Age (d)	21.5	21.9	21.7	22.0	22.1	22.0

Table 3. Average of key measurements during the nursery phase 2012 - 2017	2012	2013	2014	2015	2016	2017
Percent Mortality	3.80	3.87	5.47	5.22	4.58	4.77
Exit Weight (lbs.)	50.7	50.9	51.8	53.5	51.5	52.0
Days in Nursery	46.0	45.4	46.4	48.1	45.2	47.2
Average Daily Gain (lbs.)	0.82	0.83	0.83	0.82	0.84	0.82
Feed Conversion	1.48	1.48	1.51	1.54	1.53	1.54

Table 4. Average of key measurements during the grow-finish phase 2012 - 2017	2012	2013	2014	2015	2016	2017
Percent Mortality	5.03	5.04	5.78	5.53	5.34	5.19
Finishing Weight (lbs.)	269.2	272.1	279.7	277.4	272.8	272.8
Days in Finisher	121.5	122.8	124.1	121.4	119.2	118.5
Average Daily Gain (lbs.)	1.81	1.81	1.85	1.85	1.86	1.86
Feed Conversion	2.68	2.66	2.70	2.69	2.69	2.71

Research Effort

The Animal Science Committee has a commitment to wisely investing Checkoff funds into research that provides solutions to problems experienced at the farm level. The committee strives to achieve a unique balance between basic science, which investigates the underlying, biological mechanism of a problem, and applied research, which has direct, on-farm application. While the committee recognizes the importance of research conducted in small, carefully controlled trials, the committee strives to fund proposals that include research conducted and validated through field trials.

4. Funded Projects

FEED EFFICIENCY RESEARCH: *The committee selected the projects listed in this section from all proposals submitted in response to the request for proposals related to High Feed Cost Mitigation. This research tactic is an extension and expansion of the research conducted through the Nutritional Efficiency Consortium and the High Feed Cost Mitigation research that was conducted between 2011 and 2017. The Animal Science Committee developed the High Feed Cost Mitigation initiative to deliver on the following outcomes:*

1) *Reduce total feed cost (feed cost standardized for start and end weight)*
2) *Improve caloric efficiency of growth (calories per pound of gain, standardized for weight)*
3) *Reduce the variation in feed cost due to inaccurate ingredient values for available nutrients and nutrient diversion caused by inflammatory disease*

A subcommittee of the Animal Science Committee was given responsibility to update the research priorities for this area of research. The Animal Science Committee approved the suggestion revision and slight change of focus. The research priorities of this request for proposals are as follows:

1) Synthetic amino acid use
2) Enzyme technologies
3) Novel technologies or approaches to improve energy and/or amino acid utilization
4) Optimal feeding strategies during times of disease challenge

Table 5. Projects identified for funding in 2018 in the area of Feed Efficiency

ID	Investigator	Title
18-036	Urriola	Effects of supplementing transition sow diets with 3 levels of zinc on pre-wean mortality and lifetime productivity of pigs under commercial rearing conditions
18-086	van Heugten	Targeted use of mega-doses of phytase in late finishing pigs to improve overall growth performance and profits
18-119	Nick Gabler	Optimizing nutritional strategies to improve the lifetime performance of health compromised pigs

18-036 (Urriola): Effects of supplementing transition sow diets with 3 levels of zinc on pre-wean mortality and lifetime productivity of pigs under commercial rearing conditions

The objective of this project is to increase preweaning survival and subsequent lifetime productivity (market weight, days to market, percent lean) of low birth weight pigs. Specifically, we will be feed late gestating sows diets with incremental level of zinc from zinc sulfate. The hypothesis is that dietary zinc intake may trigger signaling pathways of intrauterine development resulting in decreased IUGR, improved fetal maturation, and consequently, decreased variation in intra-litter birth weight, decreased preweaning mortality, and improved market weight of pigs from sows fed diets supplemented with zinc during transition from gestation to lactation.

18-086 (van Heugten) Targeted use of mega-doses of phytase in late finishing pigs to improve overall growth performance and profits

The goal of this project is to improve growth rate, feed efficiency, and net return on investment through the strategic application of mega-doses (above super-dosing levels that have been used in previous studies) of the enzyme phytase. We hypothesize that supplementation of mega-doses of phytase will result in the near complete destruction of the anti-nutrient phytate, thereby providing a cost effective means to promoting body weight gain and reducing feed cost relative to gain, leading to improved efficiency of pig production. We propose that mega-doses of phytase will be more effective at a lower overall cost when applied strategically during the final feeding phase of the finishing period. Specifically, our objectives are:

1. Determine the impact mega-dose inclusion levels of phytase and timing of supplementation on growth rate, feed efficiency, carcass characteristics, and economic metrics of production in pigs housed under the rigors of commercial production.
2. Determine and validate the impact of mega-doses of phytase in diets for finishing pigs throughout finishing or during the final phase of production on production performance and economic metrics in a large production flow.

18-119 (Gabler): Optimizing nutritional strategies to improve the lifetime performance of health compromised pigs

Recently, there has been an increase in the use of non-fermentable fiber in nursery pig diets. The concept of reducing dietary energy for nursery pigs to stimulate feed intake has gained attention outside of the U.S. In addition, the use of exogenous protease and carbohydrase enzymes in pig diets have anecdotally been reported to reduce mortalities and morbidity. Therefore, our objectives are to determine and compare dietary synthetic amino acid and exogenous enzyme use in nursery pigs divergent in health status. We also plan to validate our recent lysine:energy ratio findings (NPB# 16-062) in poor health nursery-grower pigs. Importantly, we will evaluate how nursery-grower pig diet by health interactions impact lifetime productivity (i.e. wean-market performance). Specifically in two turns of commercial Maschhoffs Pork Group nursery pigs, we aim to:

1. Optimize AA and energy utilization to improve performance and reduce mortality of PRRSV+ nursery-grower pigs.
    a. Does increasing amino acid to energy ratios to 110% of requirement improve growth performance and reduce mortality in nursery-grower pigs?
    b. Does amino acid source (soybean meal or synthetic amino acid) impact performance and mortality differently?
    c. Can feed intake and pig performance be improved under reduced energy and exogenous enzyme usage?
2. Evaluate the impact of diet and PRRSV vaccine on lifetime performance and health of nursery-grower pigs.
    d. Does increasing amino acid to energy ratio profiles of the diet improve growth performance and vaccine response?
    e. Can diets with increased non-fermentable fiber and exogenous enzymes improve performance upon challenge with vaccine and/or live PRRSV?

A SYSTEMS-APPROACH TO ENHANCING PIG HEALTH, WELLBEING AND PRODUCTIVITY: *In the U.S., approximately 35% of pigs that are born are never marketed due to losses across the lifespan. In addition, the current annualized sow mortality is approximately 12% for the U.S. herd. Furthermore, trend analysis indicates mortality rates across all phases of production are increasing over time. Collectively, these numbers indicate a major need to focus on enhancing pig health, wellbeing and productivity throughout all life stages with the goal of improving whole-herd pig livability.*

Table 6. Projects identified for funding in 2015 in the area of A Systems-Approach to Enhancing Pig Health, Welfare and Productivity

ID	Investigator	Title
18-147	Ross	An integrated approach to improve whole herd pig survivability

18-147 (Ross): An integrated approach to improve whole herd pig survivability

In response to this proposal request, Dr. Ross assembled a unique, interdisciplinary team that includes research, extension and veterinary faculty from Iowa State University, Kansas State University and Purdue University. This core team will operate in synergy with U.S. swine industry partners and collaborators. Furthermore, the team will operate closely with active guidance from a diverse advisory board, accomplish the overarching objective to identify causative factors contributing to swine mortality in commercial production and to develop and disseminate strategies and information that can be utilized to maximize pig survivability with the goal of reducing overall mortality nationally by 1 percentage point or more per year of the project. To achieve this audacious goal, our team will provide nation-wide leadership to the following specific objectives:

1. Specific Objective 1: Evaluation of the management attitudes and economics associated with improving survivability in U.S. swine production.
2. Specific Objective 2: Identification of putative mortality causes on U.S. sow farms with the development and implementation of targeted strategies to maximize survivability.
3. Specific Objective 3: Reducing wean to finish mortality through the implementation of management strategies founded upon ongoing production research.
4. Specific Objective 4: Develop nationally effective and sustainable extension, outreach and education resources and strategies to enable adoption and implementation of strategies that will reduce mortality in pork production

SOW PELVIC ORGAN PROLAPSE: *The Animal Science Committee selected the following proposal from all proposals submitted in response to a targeted call designed to address the increased incidence of sow pelvic organ prolapse. The Animal Science Committee is conducting this research in collaboration with the Welfare and Swine Health Committees because over the past several years, the incidence of pelvic organ prolapse in the U.S. sow heard has increased dramatically. In some instances, pelvic organ prolapse may make up as much as 20 percent of the sow mortality. Estimations of the economic impact of current level of pelvic organ prolapse exceed $30M annually. Using a Sow Survival Working Group, the committee identified the following areas as research priorities relative to sow survival as affected by pelvic organ prolapse. The goal of the research in sow survivability is to discover the root cause of the increased incidence of pelvic organ prolapse in the U.S. sow herd.*

Research Priorities:

1. *Epidemiologic study of female pelvic organ prolapse*
    a. *Establish relationship with 6 to 7 production companies who are willing to share pertinent production data/information and allow personnel access to sow farms.*
    b. *Imbed personnel within these farms to collect the production data as well as conduct post mortem of sows that perish due to pelvic organ prolapse*
2. *Establish a common repository for data / information generated from vet diagnostic laboratory submission of body tissue and fluids of sows following prolapse.*
    a. *Establish a common tissue and fluid submission form that can be used by the industry*
    b. *Dissemination plan for making the presence of this repository known among swine veterinarians, consultants, nutritionists and pork producers.*

Table 7. Projects identified for funding in 2018 in the area of Sow Pelvic Organ Prolapse

ID	Investigator	Title
17-224	Ross	Identification of putative factors contributing to pelvic organ prolapse in sows

17-224 (Ross): Identification of putative factors contributing to pelvic organ prolapse in sows

The central objective of the IPIC team is to coordinately work with industry partners to establish a fundamental understanding of potential contributing sow pelvic organ prolapse factors. This central objective will be accomplished by the following specific objectives:

1. Establish a network of industry partners and sow farm managers (SFM) that will enable our team to seamlessly collect data on severely affected, moderately affected, and unaffected sow farms from varying geographic locations and production systems.
2. Develop an intensive herd and individual sow survey tool to objectively collect sow farm data and conduct statistical analysis to identify potential contributing factors to sow POP.
3. Establish a POP-associated communication and advisory network of producers, allied industry, university faculty and staff.
4. Establish an accessible repository of data, samples and information related to sow POP for use by the scientific communities interested in developing, providing, and evaluating mitigation strategies and solutions.

5. Progress Reports

Progress reports are an important part of the research planning process. Not only do they provide documentation of progress for a given project, but the Animal Science Committee may use preliminary data for planning future research direction. Researchers submitted the projects in this section in response to request for proposals in the areas of High Feed Cost Mitigation, Mitigation of the Impact of Seasonality and Sow Lifetime Productivity.

Table 8. Projects for which progress reports received in 2018

ID	Investigator	Title
17-036	Urriola	Strategies to modify the fiber structure and increase digestible energy content in corn distillers dried grains with solubles
17-046	Hoff	Design and Assessment of a Novel Cooling Control Algorithm and System for Swine Heat Stress Alleviation
17-090	Boler	Projecting changes in pig growth, pork quality, eating experience, and muscle physiology due to increasing live and carcass weights
17-106	van Heguten	Improving pig performance and economic return by application of ultra-high doses of phytase in finishing pigs
17-166	Ellis	Moderating body temperature decline in low birth weight piglets in the early post-natal period to improve survival and enhance animal welfare
17-224	Ross	Identification of putative factors contributing to pelvic organ prolapse in sows
18-036	Urriola	Effects of supplementing transition sow diets with 3 levels of zinc on pre-wean mortality and lifetime productivity of pigs under commercial rearing conditions

17-036 (Urriola) Strategies to modify the fiber structure and increase digestible energy content in corn distillers dried grains with solubles

Objectives: The overall objective of this project is to increase energy uplift from low energy feedstuffs, by characterizing ingredients according to the digestibility of fiber, studying the structure of fiber, and developing degradation procedures. Specifically, we will enhance:

1. Understanding of the relationship between crystallinity of DDGS and relative to in vivo fiber and energy digestibility.
2. Understanding of the fiber structural changes of DDGS before and after ammonia fiber expansion (AFEX) pre-treatment, as well as in vitro and in vivo digestion.
3. Energy uplift in corn DDGS by combining exogenous carbohydrases with fiber pre-treatment to improve digestibility in the small and large intestine as well as digestibility of nutrients (protein, starch, fat and cellulose, non-cellulose polysaccharides) using in vitro and in vivo methods.

Progress: The final steps in the project are in progress and is to evaluate the impact of ammonia expansion pretreatment of DDGS of in vitro digestibility and crystalline structure of DDGS. We are currently collecting sources of DDGS that will be pretreated with AFEX. The final in vitro assay will be run at the end of March and the final report will be delivered on schedule. There haven't been any serious setback or delays in the project nor are additional funds needed to complete the stated objectives.

17-046 (Hoff) Design and Assessment of a Novel Cooling Control Algorithm and System for Swine Heat Stress Alleviation

Objectives: The original objectives of this research project were to:

1. Develop a real-time control algorithm that maximizes the latent heat loss capability of pigs by automatically optimizing cooling equipment (e.g., sprinklers, evaporative coolers, or both) selection and operation based on dry-bulb temperature, relative humidity, and airspeed inside and outside the building.
2. Specifically for sprinkler systems, develop a control logic that dynamically changes the 'off' interval based on time required to evaporate water from the animal's skin from dry-bulb temperature, relative humidity, and airspeed feedback in the animal occupied zone.
3. Integrate and implement the control systems described in objectives 1 and 2 in a commercial facility to evaluate: (i) the performance of the new controllers and (ii) the effectiveness of sprinklers compared to evaporative cool cells at reducing heat stress conditions for grow-finish pigs.

Progress: Objective 1 Progress: The real-time control algorithm has been developed, all sensor and computing needs installed on-site at our cooperator farm, and all equipment modifications required for this research project have been installed.

Objective 2 Progress: The control logic required for sprinkler control systems has been developed and installed on our control equipment at the cooperator's farm.

Objective 3 Progress: All equipment additions, equipment modifications, sensing requirements, and control logic have been installed and prepared to accomplish objective 3. However, the combination of project start-date and the time required to modify and/or install required equipment prevented ample time to complete implementation of the control system. The plan, in consultation with our cooperating producer, is to start with actual barn control and pig weight monitoring in May, 2018.

17-090 (Boler) Projecting changes in pig growth, pork quality, eating experience, and muscle physiology due to increasing live and carcass weights

Objectives: The PRIMARY objective of this research was to determine the space allowance needed and evaluate the carcass quality of pigs with increased live weights that might be expected in the next 50 years. To accomplish our overall goal, we proposed five specific objectives:

- Objective 1: Compare k-value space allowances of market weight pigs representative of current industry weights with those that are representative of projected carcass weights for the near and distant future.
- Objective 2: Compare temperature decline of hams and loins from pigs that are representative of current industry carcass weights with carcasses that are representative of projected carcass weights for the near and distant future.
- Objective 3: Compare fresh loin quality (muscle pH, color, marbling, firmness, and predicted tenderness) of loins from pigs representative of current industry carcass weights with carcasses that are representative of projected carcass weights for the near and distant future.
- Objective 4: Determine how increased carcass size affects eating experience and purchasing preferences of consumers.
- Objective 5: Compare muscle physiology, hypertrophy, and fiber types of pigs that are representative of current industry carcass weights with carcasses that are representative of projected carcass weights for the near and distant future.

Progress: All pigs for this project have been slaughtered and loins have been sent to US Meat Animal Research Center and Kansas State for further evaluation.

- Objective 1: All the pigs have been raised and slaughtered. Data are currently being reviewed and summarized by the folks at Kansas State University
- Objective 2: Temperature recorders were placed in the hams, loins, and open air during carcass chilling at the plant. Those data are currently being reviewed
- Objective 3: Fresh Loin quality and shear force data were evaluated at US MARC. Chops for sensory analysis will be shipped to the University of Illinois next week. Sensory analysis will be conducted over the summer.
- Objective 4: Consumer test panels were completed by Kansas State University. Those data are currently being summarized.
- Objective 5: Samples from posterior end of 60 loins have been excised and frozen in liquid nitrogen-cooled isopentane. Muscle histochemistry analysis will be completed this summer.

17-106 (van Heugten) Improving pig performance and economic return by application of ultra-high doses of phytase in finishing pigs

Objectives: The goal of this project is to improve the efficiency of utilization of feed ingredients in swine through the strategic application of ultra-high levels (above super-dosing levels that have been used previously) of the enzyme phytase. We hypothesize that supplementation of super-doses of phytase will result in the near complete destruction of the anti-nutrient phytate, thereby providing a cost effective means to promoting growth and reducing feed cost of gain. We further propose that super-doses of phytase may be a more cost effective means to promoting growth than supplemental dietary fat or growth promotants, some of which cannot be used in the future. Specifically, our objectives are to:

1. Determine the impact ultra-high inclusion levels of phytase on growth rate, feed cost per unit of gain, carcass characteristics, and economic metrics of production.
2. Determine the impact of ultra-high levels of phytase in diets with or without supplemental fat on growth rate, feed cost per unit of gain, carcass characteristics, and economic metrics of production.

Progress: All the animal work for this study has been completed. We are currently compiling and verifying all the data for statistical analysis. We are on target to finish all aspects of this study in April, 2018. Preliminary analysis indicates that the addition of fat decreased feed intake and improved feed efficiency and this response was not improved when phytase was supplemented to the fat-added diet. Phytase supplementation to the control diet improved daily gain, reduced feed intake and improved feed efficiency during the last phase of the finishing phase before the first cut was made, which resulted in improved feed efficiency for the overall period. This last phase of the finisher represents a challenge in that performance declines, presumably due to more crowded conditions compared to earlier finisher phases. The improved performance during the final phase of production suggests the possibility for targeted supplementation of phytase, which would be more cost-effective than continuous administration.

17-166 (Ellis) Moderating body temperature decline in low birth weight piglets in the early post-natal period to improve survival and enhance animal welfare

Objectives: This research has 3 major objectives:

1. Define body temperature changes and the effect of birth weight on body temperature changes in neo-natal piglets in the 24 hour period after birth in typical commercial farrowing facilities.
2. Evaluate the impact of intervention strategies (warming boxes, drying, oxygen chambers) singularly and in combination on postnatal body temperature changes.
3. Determine the effect of the optimum approach to minimizing piglet body temperature decline (chosen on the basis of effectiveness, ease of application, and cost) on pre-weaning mortality.

Progress: Objectives 1 and 2 have been partially completed (approximately 75% of the proposed animal work completed). The studies that will complete these objectives are in progress or are being planned and will be completed before the end of the project. The study that is addressing Objective 3 has just been started and it is anticipated that it will also be completed within the proposed timeline for this project. In terms of meeting the 3 objectives stated above, the project is progressing as planned. There have been some changes to the approach used (described below), however, we anticipate that the overall project will be completed and a final report submitted within the timeline outlined in the original proposal (i.e., by December 1st, 2018).

17-224 (Ross) Identification of putative factors contributing to pelvic organ prolapse in sows

Objectives:

- Specific Objective #1: Establish a network of industry partners and sow farm managers (SFM) that will enable our team to seamlessly collect data on severely affected, moderately affected, and unaffected sow farms from varying geographic locations and production systems.
- Specific Objective #2: Develop an intensive herd and individual sow survey tool to objectively collect sow farm data and conduct statistical analysis to identify potential contributing factors to sow POP.
- Specific Objective #3: Establish a POP-associated communication and advisory network of producers, allied industry, university faculty and staff.
- Specific Objective #4: Establish an accessible repository of data, samples and information related to sow POP for use by the scientific communities interested in developing, providing, and evaluating mitigation strategies and solutions.

Progress:

- Specific Objective #1: We have created a vast network of industry partners that includes contributions from 104 sow farms across 15 states. This contribution represents 13 larger production systems in the U.S. in addition to many independent sow farms.
- Specific Objective #2: We have developed and employed both herd and individual sow survey tools. This has resulted in a vast amount of collected data for which we are currently optimizing statistical models and evaluating the data. Much of the data is still being curated and the identification of the best statistical analysis is being tested and determined
- Specific Objective #3: We have been actively engaging the industry in open forums to provide updates and seek input. The following is a brief summary of when/where we have sought such feedback. We have also conducted individual consultations with many of our industry partners throughout the project period and will continue to do so. The following are examples of when we have distributing information and had open discussions.

Completed Outreach/Communication/Information Seeking Efforts

2-14-18: NPB Animal Science Committee Meeting, Des Moines, IA
6-5-18: Pre-World Pork Expo Nutritionist Round Table Meeting, Des Moines, IA
6-6-18: World Pork Expo, Des Moines, IA
6-12-18: Webinar will all of the sow farm managers and industry collaborators on the project.
6-28-18: Iowa State University Swine Day 2018, Ames, IA
7-9-18: National Pork Industry Conference, Wisconsin Dells, WI

Upcoming Outreach/Communication/Information Seeking Efforts

7-16-18: Missouri Pork Swine Health Symposium, Sedalia, MO
7-26-18: NPB Animal Science Committee Meeting, Chicago, IA
7-31-18: Iowa Farm Bureau Swine Advisory Committee Meeting, Ames
8-28-18: NBP Webinar
8-28-18: Carthage Annual Swine Conference, Macomb, IL
11-29-18: National Swine Improvement Federation, Nashville, TN

- Specific Objective #4: We currently distribute weekly updates to participants and other stakeholders. These are also posted on our webpage at www.ipic.iastate.edu. As the data becomes more curated, and the statistical model is finalized, additional data will be distributed and posted.

18-036 (Urriola) Effects of supplementing transition sow diets with 3 levels of zinc on pre-wean mortality and lifetime productivity of pigs under commercial rearing conditions

Objectives: The objective of this project is to increase preweaning survival and subsequent lifetime productivity (market weight, days to market, percent lean) of low birth weight pigs. Specifically, we will be feed late gestating sows diets with incremental level of zinc from zinc sulfate.

Progress: The project is on-task and on-time. We identified the research farm, fed sows the respective treatment diets, collected farrowing and litter performance data and identified a cohort of piglet. For this cohort of piglets, we are following thought market.

6. Final Reports

Principal investigators submit final reports at the conclusion of research projects and are designed to present the results and findings of the project. Following review and approval, the industry summary of the project is posted online at www.pork.org/research. Additionally, the National Pork Board Communications Department publishes the Research Reviews Newsletter quarterly to highlight research results. Unless otherwise expedited, the full report of the project is published online one year after approval of the final report. This moratorium allows the principle investigator to publish the results as a peer-reviewed article in an appropriate scientific journal.

Table 9. Projects for which final reports received in 2018

ID	Investigator	Title
15-139	Zhou	Genome wide identification and annotation of functional regulatory regions in livestock species
15-204 (Part 2)	Gabler	Development and Validation of a Standardized Scientific Protocol Evaluating Antibiotic Alternatives in Growing Pigs – Part 2
16-010	Patience	Improving the economic efficiency of fat utilization in pig diets by better quantifying the energy value of fat sources based on their chemical composition
16-056	Cortus	Modeling Conductive Heat Transfer Through and Around Grow-Finish Pigs
16-062	Gabler	Determining the optimal dietary lysine:energy ratios for health challenged grow-finish pigs
17-036	Urriola	Strategies to modify the fiber structure and increase digestible energy content in corn distillers dried grains with solubles
17-106	van Heugten	Improving pig performance and economic return by the application of ultra-high doses of phytase in finishing pigs
17-116	Ellis	Effects of body weight and research conditions on the determination of the productive energy content of corn germ meal fed to growing-finishing pigs

15-139 (Zhou) Dr. Huaijun Zhou Genome wide identification and annotation of functional regulatory regions in livestock species

Summary: The objectives of this study were to identify previously unknown regions in the pig genome that act to regulate genes, and therefore play a role in the traits the pigs exhibit. Eight tissues from two adult male Yorkshire pigs were used for this study to profile a wide range of biological functions important to the industry. Biological assays were performed on these tissues to identify DNA-protein interactions that have been shown to be associated with promoters, enhancers, and insulators, which are important regulatory regions of the genome that exist outside of genes. A machine learning algorithm was used to integrate the data from these assays into predictions of regulatory elements for each tissue in the study. The results showed similarity with previous done in human and mouse, which supports the accuracy of the predictions. Identifying these regions will allow researchers to better understand the genetic basis for complex traits such as feed efficiency and disease resistance, which will in turn allow breeders to create new genetic lines of pigs to improve production efficiency, animal welfare, and food safety.

Key Findings:

1. Identify novel regulatory elements of genes that are potentially associated with economically important traits such as growth rate, feed efficiency and immune function.
2. Functions of regulatory elements annotated on the genes provide novel targets for genetic selection and breeding.
3. Assist in filtering SNPs on identification potential causative mutations associated with economically important traits.

15-204 (2) (Gabler) Development and Validation of a Standardized Scientific Protocol Evaluating Antibiotic Alternatives in Growing Pigs – Part 2

Summary:

Heightened interest in reducing antibiotic usage in pork production leaves producers looking for effective alternatives to antibiotic growth promoters (AGPs) in swine diets. While there are a substantial number of alternative products available, inconsistencies in existing literature make drawing conclusions about products and making comparisons across studies difficult. Therefore, the objectives of this study were: 1) to develop a protocol defining essential study components that can be used in studies evaluating antibiotic alternatives; 2) to evaluate the effects of specific AGP alternatives on nursery pig growth performance 3) to evaluate the effect of two different group sizes on growth performance and efficacy of AGP alternatives. To achieve these objectives, an experiment was conducted in a commercial research facility using 1,300 pigs weaned at 21 d of age in a 6-week nursery study. The four dietary treatments were: a negative control diet (NC), a positive control diet (PC; NC + antibiotics), a combination of zinc oxide and a dietary acidifier (ZA; NC + ZnO + acid), and a combination of a bacillus-based direct-fed-microbial and resistant potato starch (DR; NC+DFM+RS). Pigs were housed in groups of 31 (large pens) or 11 (small pens). Pens were modified so that floor space per pig was 0.41 m^2 (4.4 ft^2) and 0.42 m^2 (4.5 ft^2) per pig in large pens and small pens, respectively. Data were analyzed using a 4x2 factorial design with four levels of diet and two levels of group size. Pen was considered the experimental unit; with 60 pens total: 15 pens per dietary treatment, 32 replicates of large pens and 28 replicates of small pens. Pigs were weighed by pen and feed disappearance recorded to calculate ADG, ADFI, and G:F using pig days. Over the course of the project the pigs experienced two naturally occurring health challenges (acute diarrhea and septicemia in week 1 and PRRSV in week 4), which impacted performance and health during the study. Summary of results:

1. There was a significant interaction between diet and group size for ADG; the PC diet improved ADG by 27% in large pens and by 14% in small pens, the zinc/acid diet improved ADG by 8% only in large pens and had no effect in small pens. Small pens had higher ADG than large pens when fed the NC or DFM/RS diet.
2. There was a significant interaction between diet and group size for ADFI; the PC diet improved ADFI by 18% in large pens and by 9% in small pens, the zinc/acid diet improved ADFI by 8% in large pens but had no effect in small pens.
3. Small pens had greater G:F than large pens, and pens fed the PC diet had greater G:F than pens fed the NC, zinc/acid, or DFM/RS diets.
4. Pigs fed the PC diet required 40% less individual medical treatments than pigs on the NC diet, and the zinc/acid diet was intermediate of the NC and PC.
5. Depending on the performance variable, the interaction between diet and group size suggests group size should be an important consideration in design of future studies.

In order to make progress towards identifying effective AGP alternatives as rapidly as possible, it will be important for studies evaluating alternative products to include as much information as possible on a consistent basis. Recommended study components and information to report should include:

1. Genetic background of pigs used in the study
2. Vaccination and medication program
3. Characterization of health status
4. Report of mortality and morbidity
5. Report number of pigs treated, according to treatment, and details on the treatment regime and type
6. Diet formulation must include a negative control
7. Diet analysis to verify inclusion of test ingredients
8. Clear description of experimental design (pigs per pen, replications per treatment, blocking, etc.)
9. Description of study environment (time of year, temperature, pen specifications, barn design, etc.)

16-010 (Patience) Improving the economic efficiency of fat utilization in pig diets by better quantifying the energy value of fat sources based on their chemical composition

Summary: The overall objective of this project was to provide pork producers with accurate energy values for various dietary fat sources based on their chemical composition (free fatty acid levels, MIU content, and degree of unsaturation). Our hypothesis was dietary fat sources that had low free fatty acid levels and were highly unsaturated would have the greatest energy value compared to the other dietary fat sources. To test our hypothesis and accomplish the project objective we selected 14 dietary fat sources that were diverse in their chemical composition. A total of 120 Genetiporc 6.0 × Genetiporc F25 (PIC, Inc., Hendersonville, TN) individually housed barrows were studied for 56 d. These barrows were randomly allotted to 1 of 15 dietary treatments. Each experimental diet included 95% of a corn-soybean meal basal diet plus 5% either: corn starch or 1 of 14 dietary fat sources. The 14 dietary fat sources were: animal-vegetable blend, canola oil, 2 sources of choice white grease, coconut oil, 2 sources of corn oil, fish oil, flaxseed oil, palm oil, poultry fat, 2 sources of soybean oil, and tallow. Pigs were limit-fed experimental diets from d 0 to 10 and d 46 to 56 providing a 7 d adaption for fecal collection on d 7 to 10 and d 53 to 56. At 13 kg BW, the average energy content of the 14 sources was 8.42 Mcal of DE/kg, 8.26 Mcal of ME/kg, and 7.27 Mcal of NE/kg, respectively. At 50 kg BW, the average energy content was 8.45 Mcal of DE/kg, 8.28 Mcal of ME/kg, and 7.29 Mcal of NE/kg, respectively. At 13 kg BW, variation of dietary fat DE content was explained by: DE (Mcal/kg) = 9.363 + [0.097 × (FFA, %)] – [0.016 × Omega-6:Omega-3] – [1.240 × (arachidic acid, %)] – [5.054 × (insoluble impurities, %)] + [0.014 × (palmitic acid, %)] (P = 0.008; R2 = 0.82). At 50 kg BW, variation of dietary fat DE content was explained by: DE (Mcal/kg) = 8.357 + [0.189 × U:S] – [0.195 × (FFA, %)] – [6.768 × (behenic acid, %)] + [0.024 × (PUFA, %)] (P = 0.002; R2 = 0.81). In summary, the chemical composition of dietary fat explained a large degree of the variation observed in the energy content of dietary fat sources. The Powles et al. (1995) equation accurately predicted the average DE content from the 14 sources (8.43 Mcal/kg), but underestimated the DE content of medium chain SFA sources and the negative impact of increased FFA level to a large degree. Further research is needed to validate if the equations generated herein are more precise in predicting dietary fat DE variation among sources. This validation was done in a commercial scale research facility in collaboration with Hanor Co. Using choice white grease and corn oil it was found in Experiment 2 that the equation generated in Experiment 1 in 50 kg pigs had less prediction error (0.11) and bias (0.33) than the equation reported by Powles et al. (1995). These regression equations were generated using apparent total tract digestibility of fat, but the novelty of this experiment was to investigate the impact endogenous losses of fat (ELF) had on the energy value of dietary fat sources. Endogenous losses of fat, is the amount of fat that is present in the feces of non-dietary origin. An additional 8 barrows (average initial BW of 9.9 ± 0.6 kg) were utilized to determine ELF. Estimated ELF at 9 kg BW was 4.17 g/kg of DM intake (P<0.001). Estimated ELF at 38 kg BW was 6.67 g/kg of DM intake (P=0.002). Adding 5% dietary fat regardless of source compared to

pigs fed 5% corn starch increased the ATTD and STTD of AEE at both fecal collection time points (P<0.001). At 13 kg BW, the STTD of AEE was the greatest in barrows fed CANO-, CWGA-, and FISH-based diets and was the least in pigs fed PALM- and TAL-based diets (P<0.001). The average STTD of AEE among the 14 dietary fat sources at 13 kg BW was 93.7% and the range was 3.20%. At 50 kg BW, ATTD and STTD of AEE was the greatest in pigs fed a CANO-based diet and the least in pigs fed a CORA-based diet (P<0.001). The average of STTD of AEE among the 14 dietary fat sources at 50 kg BW was 96.8% and the range was 4.22%. On average ELF accounted for 43.1% and 68.0% of the fecal AEE both fecal collection points, respectively. The substantial proportion of AEE contained in feces that is of ELF origin and not of dietary origin implies that the current estimates of the DE content of dietary fat are underestimated. Not correcting for ELF, resulted in underestimating dietary fat DE content by 0.42 and 0.60 Mcal/kg at 13 and 50 kg of BW, respectively. In conclusion, the DE content of dietary fat can be predicted by the dietary fat source's chemical composition. However, further work is needed on determining the NE content of dietary fat sources.

16-056 (Cortus) Modeling Conductive Heat Transfer Through and Around Grow-Finish Pigs

Summary: As pig genetics and feeding programs advance, the heat production and environmental needs of pigs also change. Grow-finish pigs are especially susceptible to hot weather conditions that our existing ventilation systems cannot completely mitigate. There are various ways to further cool pigs using evaporation, convection and conduction, but each heat transfer method also requires additional resource inputs in the form of water or energy, which have associated costs.

The long-term goal of this research is to understand the effects of floor temperature control on conductive heat transfer through the skin of the pig, swine performance, and management implications of utilizing this technology. An initial knowledge gap we set out to answer is "With modern genetics and leaner pigs, how has the tissue resistance of the animals changed?" Specifically, the objectives were to: (1) Evaluate the postural (resting, standing) effects on heat flux and tissue thermal resistance; (2) Refine existing animal growth models to accommodate conductive heat transfer and activity, for modern pigs; and (3) Develop a monitoring methodology to measure the postural effects of floor tempering in group-housed animals.

Heat flux (flow of heat energy per unit area and time) measurements were collected from twelve individually-housed active barrows in the average (±standard deviation) weight ranges of 95.6±15.5 kg (210±34 lb) and 111±13.9 kg (245±31 lb), and referred to as Trials 1 and 2, respectively. Heat flux measurements were collected every minute from the right and left sides and rumps of the pigs over a six hour period. An overhead video camera system recorded pig behavior and positioning within a pen throughout the trials.

The average measured heat flux from the side of a 50 kg pig was 131 W/m^2, and the heat flux decreased 2.64 (SE 0.83) W/m^2 for every 10 kg (22 lb) increase in pig mass, up to 120 kg (265 lb). Fat and thicker skin and muscle tissue provides more resistance to heat flow, thus decreasing the rate of heat flow for a given area. The heat flux measurements were collected from a shaved area, so the variable impact of the pig's coat was not considered.

Tissue resistance is related to both pig mass/size and ambient temperature conditions. In the limited ambient temperature window of 20°C to 25°C, the tissue resistance (coat not included) for the barrows in these trials was less than tissue resistance values prescribed in the early 1990s. Tissue resistance values estimated for these project pigs suggest a minimum and maximum tissue resistance of 0.0015 and 0.014°C m^2/W for ambient temperatures of 39°C and 0°C, respectively.

Behavior monitoring provides insight into how environment influences positioning and activity, which in turn affects feed conversion. Video cameras and game cameras were used in this project, though not simultaneously. Our experience showed that the camera positioning and picture frequency were more influential than the technology used. Daily patterns of feeder occupancy and number of pigs lying on the

solid floor are suitable variables to measure with time lapse or motion detection technology available in relatively inexpensive game cameras.

Heat production and flux or transfer to the environment are affected by many factors including nutritional plane, growth rate, internal temperature, environmental temperature, evaporation from the skin and respiratory tract, airflow rate, surface temperatures, and body position. This study captured heat flux data from active grow-finish pigs. In the course of detecting heat flux patterns and conditions based on the lying or standing position, the influence of other environmental factors like manure on the skin surface or air gaps were also evident. As animal and environmental models progress, including conduction along with convection and evaporation (planned and unplanned) will add more complexity, but will ultimately help us better evaluate an animal's response to varying environments and management strategies to promote efficient production and animal welfare in all conditions.

Key Findings:

1. The average measured heat flux from the side of a 50 kg (110 lb) pig was 131 W/m^2, and the heat flux decreased linearly to 113 W/m^2 for a 120 kg (265 lb) pig.
2. Tissue resistance estimates were 0.023 to 0.034°C m^2/W for 40 to 130 kg (88 to 287 lb) pigs, respectively, in the ambient temperature conditions of 22.5°C (72.5°F).
3. Daily patterns of feeder occupancy and number of pigs lying on the solid floor are suitable variables to measure with time lapse or motion detection technology available in relatively inexpensive game cameras.

16-062 (Gabler) Determining the optimal dietary lysine:energy ratios for health challenged grow-finish pigs

Summary: When pigs become health challenged with a virus like Porcine Reproductive and Respiratory Syndrome (PRRS), production efficiency and pig wellbeing is reduced that can have a larger economic burden on the U.S. swine industry. How to best feed and manage these health challenged pig flows is poorly understood. Interestingly, the optimum dietary requirements for energy and protein as well as amino acids have not been determined for such health challenged pigs. Therefore, two experiments were conducted to evaluate the effect of increasing SID Lys:ME (g SID Lys per Mcal ME) on growth performance during a PRRSV challenge. In Exp. 1,379 barrows (51.3 ± 0.3 kg BW) were allotted to one of six diets (1.87 to 3.41 Lys:ME) for a 35-d growth study. In Exp. 2,389 barrows (29.2 ± 0.23 kg BW) were allotted to one of six diets (2.39 to 3.91 Lys:ME) for a 49-d growth study. These isocaloric diets represented 80 to 130% of NRC SID Lys requirement. After the 35 to 49-d growth study, all pigs were fed a common diet until they reached a target market weight of ~127 kg. Our results from this project showed:

1. There were no difference in PRRS serology due to altered Lys:ME diets.
2. Breakpoint analysis showed that the optimal Lys:ME for ADG and G:F was increased up to 136% and 130%, respectively, in PRRSV infected 50 kg BW pigs (Exp. 1) compared to healthy controls depending on the breakpoint model used (one slope verses quadratic).
3. In 25 kg BW pigs (Exp. 2) the optimal Lys:ME for ADG increased up to 107% as determined by breakpoint analysis; however, optimal Lys:ME for G:F was decreased up to 25% in PRRSV infected pigs.
4. In the 50 kg pigs, the predicted requirement for ADG and G:F in PRRSV pigs using a quadratic model were above the highest Lys:ME diet. This was similar for G:F in control pigs in the 25 kg BW pigs. Therefore, further studies should be conducted to more accurately determine the Lys:ME requirement.
5. No difference in carcass characteristics were reported.
6. Overall, increasing Lys:ME 110-130% above the NRC (2012) requirement increased growth performance and feed efficiency in PRRSV infected pigs, and the response was similar between natural and experimental PRRSV infection.

17-036 (Urriola) Strategies to modify the fiber structure and increase digestible energy content in corn distillers dried grains with solubles

Summary: The aims of this project were 1) to develop a new method for quantification of the feeding value of corn DDGS, and 2) to increase extraction of nutrients from corn DDGS (a low energy feedstuffs). We used an in vitro digestibility assay that was developed in NPB project #13-014. We introduced modifications to the procedure that allowed us to understand what the characteristics of fiber are that are responsible for low digestible and metabolizable energy (DE and ME) in DDGS. We used 15 sources of DDGS of known DE and ME and that we have preserved at – 20 °C (NPB project #11-136). We measured fermentability of neutral detergent fiber (NDF) after incubating DDGS with fecal inocula for 8, 12, and 72 hours. We observed that a significant portion of NDF (21.6%) was degraded after 8 hours of incubation; while it took another 72 hours to degrade 68% of NDF. In addition, the lower content of undigestible fiber in DDGS (uNDFom8), the greater apparent total tract digestibility (ATTD) of gross energy (R2 = 0.881) and ether extract (R2 = 0.382). These two characteristics of fNDFom8 made it a good predictor of the DE (R2 = 0.93) and ME (R2 = 0.92) content among the 15 sources of DDGS. Subsequently, we used x-ray diffraction to determine the relationship between crystalline configuration of fiber in DDGS and ATTD of NDF. We observed that DDGS with low (44.5%) ATTD of NDF had lower crystallinity index (9.2%) than 12.2% in DDGS with high ATTD of NDF (57.3%). These observations suggest that the differences in digestibility of fiber among sources of DDGS appears to be related to crystalline configuration of fiber. This crystalline structure is more resistant to degradation in the large intestine of pigs. Therefore, for the second objective we used ammonia fiber expansion (AFEX) to degrade the unfermentable portion of fiber in DDGS from two sources (A and B). We measured in vitro digestibility of dry matter and energy during fermentation of the non-treated and treated DDGS with and without enzymes. We observed that pretreatment of DDGS increased the digestibility of dry matter and energy, it also increased in vitro DE from 3,579 to 4,502 kcal/kg DM in DDGS A and from 3,699 to 4,225 kcal/kg DM. The effect of adding enzymes was negligible compared with AFEX.

Key Findings:

1. Digestibility of fiber differs among sources of corn DDGS and the difference in digestibility of fiber appears to be due to crystalline configuration of fiber.
2. The greater content of undigestible fiber in DDGS, the less digestibility of gross energy, protein, and lipids. Consequently, the greater content of undigestible fiber in DDGS, the less DE and ME in DDGS.
3. Ammonia expansion is an effective technology for increasing the energy value in corn DDGS

17-106 (van Heugten) Improving pig performance and economic return by the application of ultra-high doses of phytase in finishing pigs

Summary: This project specifically evaluated the impact of ultra-high doses of phytase on pork production parameters. Past research efforts have demonstrated positive effects of phytase supplementation at approximately 1,500 to 3,000 FTU/kg, but higher inclusion levels have not been adequately tested in a commercial production environment. The cost of phytase has decreased substantially; therefore, inclusion of ultra-high levels of phytase (beyond those required for P release) becomes economically feasible. In the present study with 2,150 pigs, we demonstrated that mega-dosing of phytase (3,000, 4,500, or 6,000 FTU/kg) linearly improved daily gain and feed efficiency and that this improvement was most dramatic during the final finishing phase (95 to 125 kg of body weight), improving feed efficiency from 3.76 to 3.41 (9.3% improvement). The final finishing phase represents a period of increased stress related to decreasing floor space per unit of pig body weight, resulting in a relatively profound reduction in pig performance. These data suggest that a targeted application of mega-doses of phytase during the final phase of production may be economically attractive compared to supplementation of phytase for the entire growth period.

Key Findings:

1. Supplementation of fat improved daily body weight gain and feed efficiency, with the largest effect being observed during the last feeding phase before the first marketing cut.
2. Supplementation of phytase at up to 6,000 FTU/kg improved daily gain and feed efficiency, especially during the final feeding phase before marketing.
3. Supplementation of phytase (3,000 FTU/kg) to diets with added fat (4% choice white grease) did not impact performance of pigs.
4. Supplemental phytase reduced the number of viable pigs (representing mortalities, light, and cull pigs) and this potential impact of phytase needs to be further evaluated.
5. Collectively, data indicate that mega-doses of phytase during the final phase of production may be economically attractive compared to feeding phytase for the entire growth period

17-116 (Ellis) Effects of body weight and research conditions on the determination of the productive energy content of corn germ meal fed to growing-finishing pigs

Summary: Corn germ meal (CGM), a co-product of the corn wet milling industry, is an ingredient that could be used to reduce the cost of swine diets. Efficient use of any ingredient requires an accurate estimate of energy content and metabolizable energy (ME) is the standard energy measurement that is used in diet formulation in the US. However, there are few published estimates of the ME content of CGM. In addition, for ingredients high in fiber, such as CGM, using the ME system overestimates the energy available to the animal for production. An approach that has been advocated to overcome the problem with using ME is to determine the productive energy (PE) of ingredients such as CGM. This is estimated from the growth performance, in particular feed and energy efficiency, of pigs fed a diet including the test ingredient with that of pigs fed a reference diet based on a standard ingredient (e.g., a corn-soybean meal based diet). Determination of PE is relatively easy to carry out, can be conducted on commercial as well as research units, and does not require specialized facilities or equipment. However, the appropriate methodology to determine PE has not been investigated and the optimum approach to estimate PE has not been established. Therefore, the objectives of this research were to estimate the PE of CGM based on growth studies conducted at either a university research unit or a commercial production facility across various weight ranges in the growing-finishing period. In addition, these estimates of PE were compared with direct measurement of the ME of CGM using a standard metabolism study.

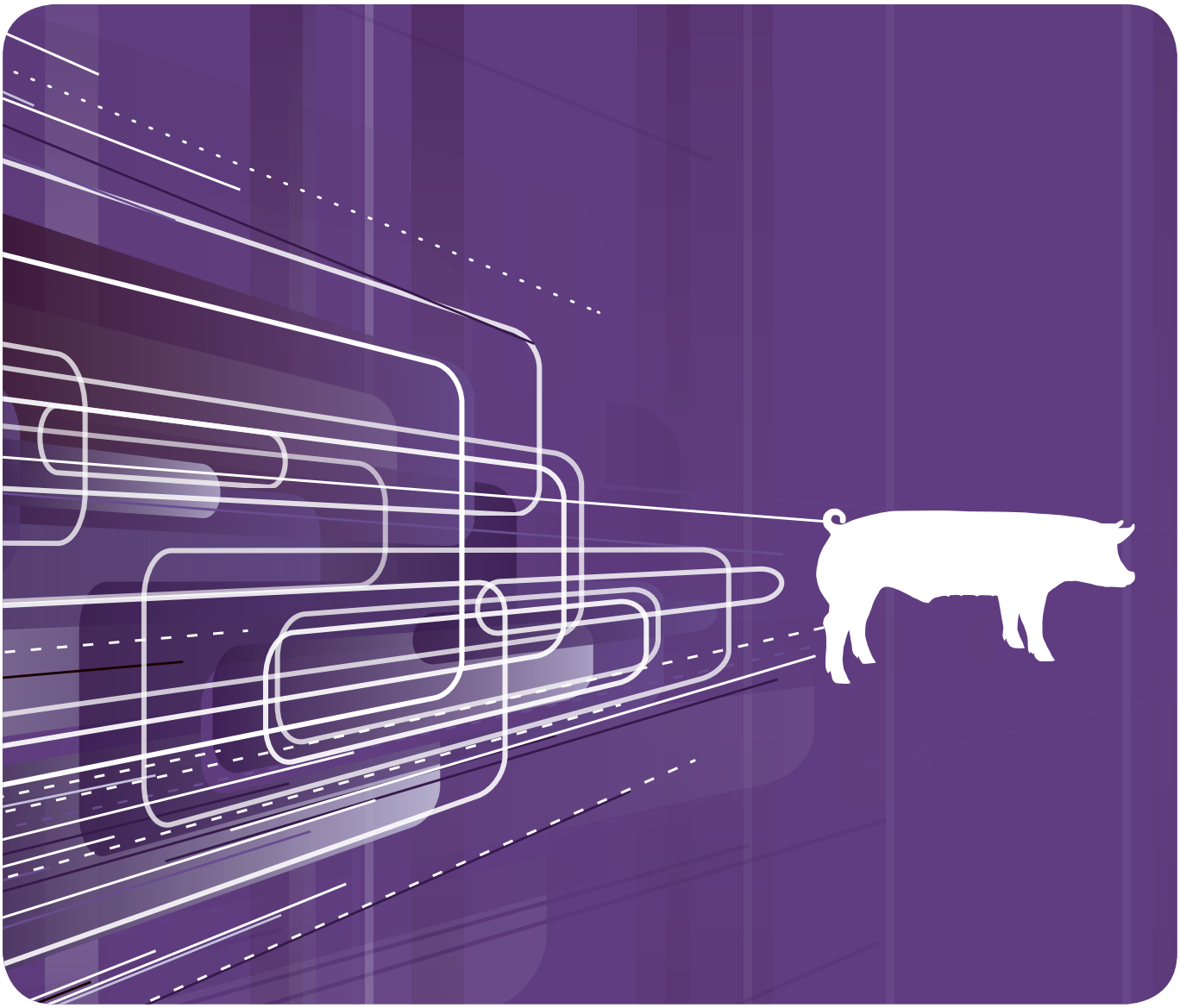
Four experiments were conducted; 2 growth performance evaluation studies (at either a Commercial or University research site), and 2 metabolism studies to measure the ME content of ingredients and diets used in the growth studies. Three diets were compared [a Control diet based on corn and soybean meal and 2 diets containing 20% CGM (with and without added fat)] across 4 growth periods [Early Growing (64 to 141 lb live weight), Late Growing (141 to 211 lb live weight), Finishing (141 to 280 lb live weight), and Growing-Finishing (64 to 280 lb live weight)]. A total of 3,672 and 576 barrows and gilts housed in mixed-sex groups of 34 and 4 were used in the Commercial and University experiments, respectively, giving 12 replicates per diet for each growing period at each site. The CGM used was from a single source and a single diet phase was used in each growth period. The ME value of CGM used to formulate diets, based on previous research, was 2,548 kcal/kg. Two standard metabolism studies were carried out to directly measure the ME content of corn and CGM and also of the 3 diets that were use in the Early Growing period of the growth study, respectively.

The growth performance of pigs at the University site was more variable than at the Commercial site which was most likely the result of the larger group sizes and total numbers of animals used at the Commercial site. In addition, estimates of the PE of CGM were much more variable for the 3 diets and growth periods at the University site. Also, the PE of CGM estimated in the Finishing period at both sites was greater than estimates from the other growth periods. The ME of corn and CGM measured directly in metabolism studies were similar to estimates published by NRC (2012); however, the estimate of ME of CGM was considerably greater than the PE estimated from the growth studies. The ME of the Control diet used in the Early Growing period measured in the metabolism study was similar to the formulated value for this diet. However, the ME values for the 2 CGM diets used in the Early Growing period determined in the metabolism study were greater than the formulated values.

The results of this research suggest that the most appropriate approach to estimate PE would be using large-scale, controlled research studies carried out under commercial conditions rather than relatively small-scale studies under university conditions. Also, this research suggests that PE could be accurately determined over a relatively short period early in the growing period rather than over the entire growing-finishing period. Finally, the direct measurement of ME of CGM and of diets containing CGM from metabolism studies confirmed that this approach generally overestimates the energy available to the pig for growth which emphasizes the potential benefit of the use of the PE approach.

Notes:

Notes:



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