Feed Efficiency in Swine: A Survey of Current Knowledge[1]

J.R. Flohr, M.D. Tokach, J. M. DeRouchey, J.F. Patience[2], R. D. Goodband, S. S. Dritz[3], J. L. Nelssen

Summary

Pork producers and advisers to the swine industry were surveyed about their knowledge of feed efficiency. The questionnaire was designed to accomplish three objectives: (a) determine the level of knowledge related to feed efficiency topics, (b) identify production practices being used that influence feed efficiency, and (c) identify information gaps or areas requiring additional knowledge to further improve feed efficiency.

Producer responses imply that they are unfamiliar with information behind the effects of fat inclusion, particle size reduction, feed additives, and thermal environment on feed efficiency. Many were not sure which energy system to use for evaluating dietary energy. Consultants and individuals in academia had the highest percentage of correct answers for the knowledge questions, but less than half identified the correct response when asked how reducing particle size affects feed efficiency, and very few correctly answered the question on how thermal environment affects feed efficiency. This result suggests the need for more information and education in these two topic areas.

Respondents who classified themselves as "Other" frequently replied "Not sure" to many of the knowledge-based questions, and also to several production practice questions, which may be due to the great diversity of occupations within the group. When responses were sorted by years of experience, a majority of individuals with less experience, specifically those with 0 to 5 years, had higher percentages of "Not sure" responses, which may be related to their unfamiliarity to specific industry practices and the knowledge behind those practices.

A majority of participants used or recommended using feed additives to improve feed efficiency; however, they indicated that they don't use other production practices such as fine-grinding cereal grains below 400 μm or pelleting finishing diets because of economic or system constraints or because these processing technologies are not available in their feed mills.

Extension education about current knowledge and production practices that are already proven should be expanded to provide this information in an easy-to-access format for the swine industry. Ultimately, successful dissemination of this information should help producers and swine operations lower input costs by improving the efficiency of their feed utilization.

Key words: feed efficiency, swine survey, swine industry

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[2] Department of Animal Sciences, Iowa State University, Des Moines, IA.

[3] Food Animal Health and Management Center, College of Veterinary Medicine, Kansas State University.

Introduction

Feed represents the largest input expense for U.S. pork producers, usually totaling more than 60% of the total cost of production. Increased non-feed use for the U.S. corn crop has led to distinct rises in prices, and crop supply fluctuation adds to the variability in ingredient costs. Nationwide, whole-herd feed conversion (lb feed/lb pork) is approximately 3 to 1. Improving feed efficiency by one unit change (e.g., 3.00 to 2.99) represents approximately 140,000 tons of feed annually, or feed cost savings of ~$28 million dollars. Efforts to fully adopt existing knowledge to optimize feed efficiency by the U.S. pork industry will improve the long-term competitiveness of the U.S. pork industry and the sustainability of food supplies.

This survey was developed to identify the current state of knowledge and the production practices used in the swine industry. The questionnaire was designed to accomplish three objectives: (1) determine the industry level of knowledge related to feed efficiency topics, (2) identify production practices being used that influence feed efficiency, and (3) identify information gaps or areas requiring additional knowledge to further improve feed efficiency. Conclusions drawn from this study will be used to assemble extension education programs to rapidly disseminate information to producers and industry workers on current and innovative information that may improve feed efficiency and to aid in future research initiatives.

Procedures

The procedures for this survey were approved by the Kansas State University Committee for Research Involving Human Subjects. The survey was web-based and created using the Axio Survey Creation Tool (https://online.ksu.edu/Survey/).

The subjects of this survey were individuals with their primary occupation in the swine industry. Most participants were from the United States, but international responses were received. The survey was made available via the internet from November 1, 2011, through March 1, 2012. Subjects targeted for the questionnaire were asked to participate through press releases advertised in popular press magazines including National Hog Farmer (www.nationalhogfarmer.com), Pork Magazine (www.porknetwork.com), and Feedstuffs Weekly Newspaper for Agribusiness (www.Feedstuffs.com). Emails with the press release were distributed to digital subscribers of those magazines, producer and allied industry email address lists used by K-State Swine Research and Extension, and individuals who registered for the International Conference on Feed Efficiency in Swine that was held November, 2011, in Omaha, NE. A link to the survey website was available on K-State's Swine Research and Extension website (www.KSUswine.org).

Individuals who participated in the survey were not required to answer all questions; therefore, results were summarized based on responses to individual questions. Total responses for individual questions ranged from 123 to 205.

Two demographic questions were asked to identify the population of respondents and to summarize the answers received for questions within the survey. The first was designed to allow respondents to categorize themselves by the segment of the swine industry that they represented as a primary occupation (pork producer, consultant to the swine industry, education, or other; Table 1). Out of 205 individuals who

responded to the first question, the largest percentage, 33%, identified themselves as consultants to the swine industry. An additional 28% identified themselves as producers, and 23% categorized themselves as "Other." Respondents who identified themselves as "Other" were asked to describe their role in the swine industry. A majority of those individuals said they were graduate students, media reporters/editors, feed manufacturers, meat packers, technical support representatives for production systems, and pharmaceutical/vaccine sales representatives. The second question was designed to categorize participants by their number of years of experience working in the swine industry (0 to 5 years, 5 to 10 years, 10 to 20 years, 20+ years; Table 2). The greatest majority (53%) of individuals responded that they have more than 20 years of swine industry experience, and 21% had 10 to 20 years of experience.

After establishing demographics of the sampled population, a series of knowledge-based, production practice, and discovery questions were asked to help achieve the objectives of the survey. Knowledge and production practice questions were delivered in a multiple-choice format, and possible answers included "Not sure" and "Other" options. Several production practice questions also branched into sub-questions depending on how respondents answered the main question. Branching sub-questions allowed for further data collection to better understand reasoning behind production practices utilized in the field, which will help extension educators identify critical control points within production systems as they pertain to feed efficiency. The discovery questions were designed so respondents could rank a predetermined topic area priority list from 1 to 10. To summarize the discovery questions, the average rank of each topic area was used to determine an overall ranking from the highest to lowest priority for future research and emphasis.

Results and Discussion

Defining Feed Efficiency

Survey respondents were asked to define feed efficiency as it relates to swine production; in response, 71% answered that feed efficiency is the amount of feed needed for one unit of live animal weight gain, and 15% answered with the amount of feed needed to gain one unit of carcass weight (Table 3). Both of these answers were considered correct, because feed efficiency can be defined on a live weight or carcass weight basis.

Dietary Energy

Individuals were asked to distinguish which dietary energy system they utilize when formulating diets. A total of 129 individuals responded (Table 4); 52% answered that they utilize ME, and 23% responded that they use NE. Based on demographics, 34% of producers (32) and 58% of respondents with 0 to 5 years of experience (12) were not sure. Participants were also asked how much of an improvement in feed efficiency can be expected by increasing dietary fat by 1% (Table 11; Question 1). In total, 138 respondents answered, with 41% answering correctly (2%), 30% answered incorrectly, and 27% responding "Not sure" (Table 12; Question 1). Of the producers who responded to this question (39), 31% answered correctly, whereas 44% answered "Not sure." In contrast, 63% of consultants answered this question correctly, but only 17% of respondents in the "Other" category for profession answered correctly (Table 13; Question 1). When responses are sorted by years of experience, 58% of respondents with

less than 5 years and 47% of individuals with 5 to 10 years of experience answered "Not sure" (Table 14; Question 1).

Grinding/Particle Size

A total of 164 respondents answered the question asking what cereal grain particle size is used or recommended for swine diets (Table 5). Most respondents (73%) indicated below 700 μm, but only 4% of respondents grind or recommend grinding grain below 400 μm, and 19% were not sure. A total of 45% of individuals who categorized their profession as "Other" (33) and 53% of individuals with 0 to 5 years of experience (17) responded "Not sure." If respondents answered with a particle size greater than 400 μm, they were asked a branched question to determine why they do not grind to a finer particle size. The most common reason (35% of responses) was that flowability or handling characteristics cause problems in the feeding system. Participants were also asked how much of an improvement in feed efficiency can result from decreasing the particle size of grain by 100 μm (Table 11; Question 2). In total, 160 individuals answered, 36% answered correctly (1.1 to 1.4%,) 31% answered "Not sure," and 30% answered incorrectly (Table 12; Question 2). Of the producers who responded to this question (44), only 27% answered correctly (Table 13; Question 2), and only 25% of individuals with less than 5 years of experience (12) answered the question correctly (Table 14; Question 2).

Pelleting

Participants were asked if they feed pelleted or recommend pelleting finishing diets. A total of 151 individuals answered, 59% replied "No," and 41% replied "Yes" (Table 6). Interestingly, 70% of individuals categorized as "Other" answered "Yes," whereas most producers, consultants, and academic participants answered "No." Individuals who answered "No" were then asked why they do not pellet or recommend pelleting finishing diets, and respondents could check all answers that applied. A total of 148 responses were returned; 29% indicated pelleting was too expensive or that it was not available at their local feed mill. These were clearly the most common reasons why individuals do not feed pelleted finishing diets. When asked how much of an improvement can be expected from feeding high-quality pellets (Table 11; Question 3), 70% of responses (157) answered correctly, with 2 to 6% (Table 12; Question 3). This result represented correct responses from 70% of producers (44), 80% of consultants (56), 62% of those in academia (26), and 52% of individuals who categorized themselves as "Other" (31; Table 13; Question 3). Additionally, 60% or more within each age category answered correctly, indicating a high knowledge level across the industry about pelleting diets for swine (Table 14; Question 3).

Extrusion/Expanding Processing

Extrusion and expanding are used in human food preparation, in pet food, and aquaculture products. Although it has not been used frequently for swine feed, improvements in pellet quality, and thus feed efficiency, have been seen when used for swine diets. Participants were asked if they recommend or use extrusion or expanding processing in any of their swine diets. A total of 147 respondents answered, with 93% of respondents answering no and only 7% answering "Yes" (Table 7). Participants were sent to branched questions depending on their response; if they answered yes, they were asked why they recommend using extruding or expanding technology. Eleven responses were received, and 55% of those said it was to improve feed efficiency and 27% said it was

to improve pelleting quality. Respondents who answered no were asked why they do not recommend using extruding or expanding processing and were allowed to check all reasons that applied; 176 responses were returned, with 45% indicating their current mill does not have extrusion/expanding technology and 23% indicating they are not familiar with extruding/expanding technologies.

Feed Additives

Participants were asked several questions to better identify the use of feed additives and their effects on feed efficiency. The first question asked individuals if they use or recommend using copper sulfate in the nursery; 69% of 134 respondents answered yes and 31% said no (Table 8). When results are sorted by demographic segments of the industry, 66% of producers (35), 84% of consultants (51), 58% of individuals in academia (24), and 54% of individuals categorized as "Other" (24) use or recommend using growth-promoting levels of copper sulfate in the nursery. Also, 68% of individuals with 10 to 20 years (31) and 80% with 20 or more years of experience recommend or use growth-promoting levels of copper sulfate, but 58% with 0 to 5 (12), and 56% with 5 to 10 (16) did not recommend or use growth-promoting levels in the nursery. A branched question asked those who answered "Yes" what percentage benefit in feed efficiency they expected from copper; those who answered "No" were asked why they did not recommend or use copper sulfate. Of the individuals who answered "Yes," 30% believed there was a 2% improvement in feed efficiency, but 20% were not sure. On the other hand, for those who answered "No," 48% were not sure why they do not use or recommend its use, and 29% said they did not recommend or use growth-promoting levels of copper sulfate because of environmental reasons.

Similarly, individuals were asked if they feed or recommend feeding growth-promoting levels of antibiotics in nursery diets. A total of 134 individuals answered, with 73% saying "Yes" and 23% saying "No" (Table 9). Demographics showed that 50% or more individuals in each industry segment or age category replied "Yes." Respondents were again asked branched questions depending on their answers. If they answered "Yes," they were asked what percentage improvement in feed efficiency they expected from its use. A total of 96 responses were received; 21% of those responded that they expected a 3% improvement, 20% responded "Not sure," 16% answered 4%, and 15% answered 5%. If survey takers answered "No," they were asked why they don't use or recommend using growth-promoting levels of antibiotics in nursery diets. Forty-two responses were returned, with 33% saying it was because the potential of development of antibiotic resistance and 26% answering "Other." The most common responses for individuals who answered "Other" were that they used antibiotics only to treat unhealthy pigs and did not feed growth-promotion levels of antibiotics.

Finally, individuals were asked if they use or recommend using Paylean in late finishing. A total of 132 answered, with 70% saying "Yes" and 30% saying "No" (Table 10). Individuals were then asked branched questions. If they said "Yes," they were asked what initial dosage they utilized; 66% of the 92 respondents answered 4.5 g/ton, and 26% answered 6.75 g/ton. They were also asked whether they utilize a step-up program or a constant level; 67% said they feed a constant level, and 33% said they use a step-up program. The step-up program was defined as feeding a lower dosage for a period of time followed by a higher dosage until pigs were marketed. If respondents said no, they were asked why they did not. Forty total responses were received, with 40% answer-

ing "Other," and 28% answering "Not sure" (Table 24). The most common reasons for individuals who replied with "Other" were that they had a niche market or special incentive not to utilize Paylean. A knowledge-based question was also asked (Table 11; Question 4) about the expected improvement in feed efficiency associated with the use of Paylean. A total of 132 participants answered the question, with 49% answering correctly (5 to 15%), 24% answering incorrectly, and 22% responding "Not sure" (Table 12; Question 4). Within respective segments of the swine industry, 30% of producers and 38% of individuals categorized as "Other" responded "Not sure" (Table 13; Question 4). Meanwhile, less than half with 5 to 10 years and 20 or more years of experience answered the question correctly (Table 14; Question 4).

Sow Efficiency

Respondents were asked approximately how much sow feed should be needed per pig weaned (Table 11; Question 5). A total of 128 individuals answered, with 51% answering correctly (70 to 100 pounds), 26% answering "Not sure," and 22% answering incorrectly (Table 12; Question 5). Although more than half of the total responses were correct, only 21% of individuals in academia (24) and 41% categorized as "Other" (22) answered correctly (Table 13; Question 5). Based on years of experience in the swine industry, only 27% with less than 5 years (11) and 43% with 5 to 10 years (14) had correct answers (Table 14; Question 5).

Thermal Environment

Individuals were also asked what feed efficiency would be for finishing pigs who initially have feed conversion rates of 2.80 if the temperature is dropped 4°F below their respective thermo-neutral zone (Table 11; Question 6). A total of 139 individuals responded; 22% answered correctly (2.88), 45% answered incorrectly, and 30% responded "Not sure" (Table 12; Question 6). Only 8% of individuals categorized as "Other" (24), 24% of consultants (51), 25% in academia, (24), and 25% of producers (40) answered correctly (Table 13; Question 6). Based on years of experience, only 33% with less than 5 years, 12% with 5 to 10 years, 9% with 10 to 20 years, and 27% with 20 or more years answered the question correctly (Table 14; Question 6).

Future Discovery for Feed Efficiency

Three discovery questions (Table 15) were asked to determine industry opinions on topic areas and their relationship to feed efficiency. When asked which topic areas would provide the largest opportunity to improve feed efficiency in the U.S. swine industry, total responses gave the top three areas as health, genetics, and feed processing (Table 16). By industry segment, producers, consultants, and those categorized as "Other" also ranked the top three areas as health, genetics, and feed processing, but academia ranked them as health, genetics, and dietary energy. Based on years of experience, participants with 0 to 5 years ranked health, feed processing, and environment; those with 5 to 10 years ranked health, genetics, and digestive tract microbiology; those with 10 to 20 years ranked health, genetics, and dietary energy; and those with 20 or more years ranked health, genetics, and feed processing as the most important topics.

Individuals were then asked to rank topic areas according to future research needs. Total responses suggest the most important areas were health, genetics, and dietary energy (Table 17). Producers ranked health, genetics, and dietary energy as the most

important, but consultants and individuals categorized as "Other" ranked health, dietary energy, and digestive tract microbiology as the most important areas. Individuals in academia ranked alternative feed ingredients, amino acids, and health as the most important. By years of experience, those with 0 to 5 years ranked pelleting, dietary energy, and feed additives (other than antibiotics); those with 5 to 10 years ranked health, dietary energy, and digestive tract microbiology; and respondents with 10 to 20 years ranked dietary energy, digestive tract microbiology, and health as the most important.

The final question asked survey respondents to rank topics based on their own knowledge of the topic. Overall, individuals believed they were most knowledgeable on particle size, amino acids, and antibiotics (Tables 17 and 18). The three topic areas that individuals were the least knowledgeable in were extruding/expanding, digestive tract microbiology, and feed additives (other than antibiotics). Producers answered that they were the most knowledgeable in health, genetics, and particle size but knew the least about extruding/expanding, digestive tract microbiology, and feed additives (other than antibiotics). Consultants and those in academia answered that they were the most knowledgeable about particle size, pelleting, and amino acids but need information on extrusion/expanding, digestive tract microbiology, health, and feed additives (other than antibiotics). Participants categorized as "Other" suggested they were the most knowledgeable in antibiotics, amino acids, and dietary energy but need more information on digestive tract microbiology, health, and extrusion/expanding. Individuals with 0 to 5 years of experience believed they were most knowledgeable on alternative feed ingredients, feed additives (other than antibiotics) and health but need more information in antibiotics, extrusion/expanding, and genetics. Those with 5 to 10 years of experience answered that they were knowledgeable about amino acids, alternative feed ingredients, and particle size but need more information on extrusion/expanding, pelleting, and digestive tract microbiology. Participants with 10 to 20 years said they were most knowledgeable in amino acids, antibiotics, and dietary energy but less knowledgeable in genetics, digestive tract microbiology, and extrusion/expanding. Those with 20 or more years believed they were the most knowledgeable in particle size, pelleting, and antibiotics but needed more information on extruding/expanding, digestive tract microbiology, and feed additives (other than antibiotics).

Conclusion

Results from this survey suggest gaps in information and knowledge of feed efficiency across demographic segments of the industry. Most individuals were familiar with the advantages in feed efficiency associated with pelleting swine diets, and a large percentage of the industry utilizes or recommends using feed additives. Although knowledge of the benefits from pelleting is high, more access to affordable pellets is required to increase adoption of pelleting within the industry.

Producer responses imply that they are unfamiliar with information behind the effects of fat inclusion, particle size reduction, feed additives, and thermal environment on feed efficiency, and many were not sure which energy system to use for evaluating dietary energy.

Consultants and individuals in academia had the highest percentage of correct answers for the knowledge questions, but less than half identified the correct response when asked how reducing particle size affects feed efficiency, and very few correctly answered the question about thermal environment effects associated with feed efficiency, which suggests the need for more information and education on the two topic areas.

Respondents who classified themselves as "Other" frequently replied "Not sure" to many of the knowledge-based questions and to several production practice questions. This result may be due to the great diversity in occupation within the group.

When responses were sorted by years of experience, a majority of individuals with less experience, specifically those with 0 to 5 years, had higher percentages of "Not sure" responses, which may be related to their unfamiliarity to specific industry practices and the knowledge behind those practices.

Regardless of demographics, responses suggest that grinding cereal grains to finer particle sizes is limited mainly because of more difficult handling in feeding systems and because pelleting finishing diets is not as prevalent because it is not available in many feed mills or is not affordable. A majority of respondents believe that topics for future research and the biggest areas of opportunity to improve feed efficiency include genetics, health, feed processing, and dietary energy. Additionally, the topic areas where most of the participants were the least knowledgeable were expanding/extruding technologies, digestive tract microbiology, and feed additives (other than antibiotics).

Many individuals still define feed efficiency on a live weight basis, even though a majority of the industry market animals on a carcass weight basis; therefore, the development and implementation of tools to monitor feed efficiency on a carcass weight basis should be more clearly explained to producers and advisors. This idea can then be communicated to help individual farms and systems better recognize efficiency measurements and make decisions on specific practices to improve feed efficiency.

Extension education on current knowledge and production practices that are already proven should be expanded to provide this information in an easy-to-access format for the swine industry. Ultimately, successful dissemination will help producers and swine operations lower input costs by improving the efficiency of feed utilization.

Table 1. Demographics depicting segments of the swine industry[1,2]

Possible answers	Responses	% of total
Pork producer	57	28%
Consultant to the swine industry	67	33%
Academia	33	16%
Other[3]	48	23%
Total	205	100%

[1] The question was, "What segment of the swine industry do you represent as a primary occupation?"
[2] This question was asked in a multiple-choice format.
[3] Respondents who identified themselves as "Other" were asked to describe their role in the swine industry; a majority of those individuals recognized themselves as graduate students, related media reporters/editors, feed manufacturers, meat packers, technical support representatives for production systems, and pharmaceutical/vaccine sales representatives.

Table 2. Demographics based on years of experience in the swine industry[1,2]

Possible answers	Responses	% of total
0 to 5 years	23	12%
5 to 10 years	28	15%
10 to 20 years	40	21%
20+ years	101	53%
Total	192	100%

[1] The question was, "How many years of experience do you have working in the swine industry?"
[2] This question was asked in a multiple-choice format.

Table 3. Definition of feed efficiency as it relates to swine production[1,2]

Possible answers	Responses	% of total
Amount of feed needed for one unit of live animal weight gain	132	71%
Amount of feed needed for one unit of carcass weight gain	28	15%
Residual feed intake	9	5%
Not sure	6	3%
Other	12	6%
Total	187	100%

[1] The question was, "In your own words, please define feed efficiency with regards to swine production, or what do you use to determine feed efficiency?"
[2] This question was asked in a multiple-choice format.

Table 4. Utilization of energy systems for diet formulation[1,2]

Possible answers	Responses	% of total
Gross energy	0	0%
Digestible energy	8	6%
Metabolizable energy[3,4]	67	52%
Net energy	30	23%
Not sure[5]	21	16%
Other	3	2%
Total	129	100%

[1] The question was, "When evaluating dietary energy, what energy system do you use or recommend using?"
[2] This question was asked in a multiple-choice format.
[3] By segment, 56% of consultants (50), 54% of academia (24), and 61% of "Other" (23) answered metabolizable energy.
[4] Based on years of experience, 50% with 5 to 10 (14), 55% of 10 to 20 (29), and 54% with 20 or more years of experience answered metabolizable energy.
[5] A total of 34% of producers (32) and 58% of individuals with 0 to 5 years of experience answered "Not sure."

Table 5. Particle sizes utilized by the swine industry[1,2]

Possible answers[3]	Responses	% of total
Greater than 800 µm	1	1%
700–800 µm	13	8%
600–700 µm	49	30%
500–600 µm	39	24%
400–500 µm	24	15%
Less than 400 µm	7	4%
Not sure[4]	31	19%
Total	164	100%

[1] The question was, "What is the current particle size that you recommend or use in finishing diets?"
[2] This question was asked in a multiple-choice format.
[3] Individuals who answered with micron sizes larger than 400 µm were asked a branched question, "Why do you not grind to a finer particle size?" 35% of responses were that flowability or handling characteristics cause problems in feeding system, 18% were that ulcer rates are too high, 15% were that current mill cannot grind to a smaller particle size, and 14% were that production rate in feed mill is slowed too much.
[4] Based on demographics, 45% of individuals categorized as "Other" and 53% of individuals with 0 to 5 years of experience (17) answered "Not sure."

Table 6. Production practices on pelleting finishing diets[1,2]

Possible answers	Responses	% of total[3]
Yes	62	41%
No[4]	89	59%
Total	151	100%

[1] The question was, "Do you currently pellet, or recommend pelleting finishing diets?"
[2] This question was asked in a multiple-choice format.
[3] In total, 77% of producers (43), 55% of consultants (53), and 72% of academia answered no; 70% of individuals identified in the "Other" segment answered yes. Based on years of experience, 50% or more of each category answered no.
[4] If respondents answered no, they were asked a branched question, "Why do you not pellet finishing diets?" 29% of responses were either that it was too expensive or that pelleting capabilities were not available at their local mill. These were clearly the most common reasons why individuals do not pellet finishing diets.

Table 7. Utilization of extruding/expanding technologies[1,2]

Possible answers	Responses	% of total
Yes[3]	10	7%
No[4]	137	93%
Total	147	100%

[1] The question was, "Currently, do you use or recommend any expanding or extrusion processing in rations?"
[2] This question was asked in a multiple-choice format.
[3] Individuals who answered yes were asked a branch question, "Why do you use these technologies?" 55% of responses were to improve feed efficiency, and 27% said to improve pelleting quality.
[4] Individuals who answered no were asked a branch question, "Why do you not use these technologies? 45% of responses were that their mills did not have extrusion/expanding technology, and 23% were that they were not familiar with extrusion/expanding technology.

Table 8. Use of growth promoting levels of copper sulfate in the nursery[1,2]

Possible answers	Responses	% of total[3]
Yes[4]	93	69%
No[5]	41	31%
Total	134	100%

[1] The question was, "Currently, do you feed or recommend feeding growth promoting levels of copper sulfate in the nursery?"
[2] This question was asked in a multiple-choice format.
[3] By industry segment; 66% of producers (35), 84% of consultants (51), 58% of individuals in academia (24), and 54% of individuals categorized as "Other" (24) answered yes. Based on years of experience, 58% with 0 to 5 (12), and 56% with 5 to 10 years (16) answered no whereas, 68% with 10 to 20 (31) and 80% with 20 or more years (75) answered yes.
[4] Individuals who answered yes were asked a branch question: What benefit in feed efficiency do you expect from its inclusion in nursery diets? 30% of responses were "2%," and 20% of responses were "Not sure."
[5] Individuals who answered no were asked a branch question, "Why do you not use growth promoting level of copper sulfate in the nursery?" 48% of responses were "Not sure," and 29% were because of environmental reasons.

Table 9. Use of growth-promoting levels of antibiotics in the nursery[1,2]

Possible answers	Responses	% of total
Yes[3]	98	73%
No[4]	36	27%
Total	134	100%

[1] The question was, "Currently, do you feed or recommend feeding growth promoting levels of antibiotics in the nursery?"
[2] This question was asked in a multiple-choice format.
[3] Individuals who answered yes were asked a branch question, "What benefit in feed efficiency do you expect from its inclusion in nursery diets?" 21% responded with "3%," 20% answered "Not sure," 16% answered "4%," and 15% answered "5% or more."
[4] Individuals who answered no were asked a branch question, "Why do you not use growth promoting level of antibiotics in the nursery?" 33% of responses were to avoid development of antibiotic resistance and 26% were "Other." The most common response for individuals who answered "Other" was because they used antibiotics only to treat sick animals and not for growth promotion.

Table 10. Industry use of Paylean[1,2]

Possible answers	Responses	% of total
Yes[3,4]	92	70%
No[5]	40	30%
Total	132	100%

[1] The question was, "Currently, do you feed or recommend feeding Paylean as a growth promoter in late finishing?"
[2] This question was asked in a multiple-choice format.
[3] Individuals who answered yes were asked a branch question, "What initial level of Paylean do you utilize?" 66% responded "4.5 g/ton," and 26% answered "6.75g/ton."
[4] Individuals who answered "Yes" were asked a second branched question, "Do you utilize a step-up program or do you feed a constant level?" 67% answered that they feed or recommend feeding a constant level, and 33% fed or recommend feeding a step-up program.
[5] Individuals who answered no were asked a branch question, "Why do you not use Paylean in late finishing?" 40% of responses were "Other." The most common response for individuals who answered "Other" was because they had a niche market or special incentive not to utilize Paylean.

Table 11. Knowledge-based questions[1,2]

1	By adding 1% fat to a diet, feed efficiency is improved by approximately?
2	By decreasing particle size of a cereal grain by 100 microns, feed efficiency improves by approximately how much?
3	Although variable, feeding high quality pellets should affect feed efficiency by?
4	How much of an improvement do you expect in feed efficiency from the inclusion of Paylean?
5	In your opinion, approximately how much sow feed should be required per pig weaned?
6	If the ambient temperature of a finishing barn is at thermo-neutrality and pigs average a feed efficiency of 2.8, what is the estimated feed efficiency after the temperature drops to 4 degrees Fahrenheit below the thermo-neutral zone?

[1] All knowledge-based questions were asked in a multiple-choice format with several available responses including a "Not sure" or "Other" option.
[2] Answers considered correct by the investigators were 2%, 1.1 to 1.4%, 2 to 6%, 2.88, 70 to 100 lb, and 5 to 15% for questions 1, 2, 3, 4, 5, and 6, respectively.

Table 12. Total responses for knowledge-based questions[1]

Question	Respondents	Correct,%	Incorrect,%[2]	Not sure,%	Other,%
1	138	41	30	27	3
2	160	36	30	31	3
3	157	70	12	17	1
4	132	49	24	22	5
5	128	51	22	26	1
6	139	22	45	30	3

[1] All knowledge-based questions were asked in a multiple-choice format with several available responses, including a "Not sure" or "Other" option.
[2] Incorrect responses represent all responses received other than the correct answers, or responses of "Not sure" or "Other."

Table 13. Responses on knowledge questions based on segment of the industry[1]

	Producers			Consultants			Academia			Other[2]		
Question	Responses	Correct	Not sure	Responses	Correct	Not sure	Responses	Correct	Not sure	Responses	Correct	Not sure
1	39	31%	44%	51	63%	10%	24	33%	25%	24	17%	38%
2	44	27%	36%	57	46%	12%	28	36%	46%	31	32%	45%
3	44	70%	18%	56	80%	7%	26	62%	35%	31	52%	19%
4	33	36%	30%	51	67%	10%	24	38%	21%	24	42%	38%
5	32	50%	38%	50	70%	12%	24	21%	29%	22	41%	36%
6	40	25%	42%	51	24%	20%	24	25%	25%	24	8%	38%

[1] All knowledge-based questions were asked in a multiple-choice format with several available responses including a "Not sure" or "Other" option.
[2] Respondents who identified themselves as "Other" were asked to describe their role in the swine industry; a majority of those individuals recognized themselves as graduate students, related media reporters/editors, feed manufacturers, meat packers, technical support representatives for production systems, and pharmaceutical/vaccine sales representatives.

Table 14. Responses to knowledge questions based on years of experience[1]

	0 to 5 years			5 to 10 years			10 to 20 years			20+ years		
Question	Responses	Correct	Not sure	Responses	Correct	Not sure	Responses	Correct	Not sure	Responses	Correct	Not sure
1	12	33%	58%	17	29%	47%	32	42%	22%	77	48%	19%
2	16	25%	44%	21	48%	33%	36	39%	33%	87	34%	28%
3	16	56%	31%	20	60%	10%	36	61%	25%	85	76%	13%
4	12	50%	42%	15	40%	27%	30	53%	30%	75	49%	15%
5	11	27%	64%	14	43%	43%	29	52%	24%	74	55%	18%
6	12	33%	50%	17	12%	41%	32	9%	47%	78	27%	18%

[1] All knowledge-based questions were asked in a multiple-choice format with several available responses including a "Not sure" or "Other" option.

Table 15. Discovery questions[1]

1	Which areas provide the most opportunity for improvement in feed efficiency by the U.S. Swine Industry? (1 = important; 10 = not important)
2	Please rank the following items on the need for future research as it pertains to feed efficiency. (1 = important; 10 = not important)
3	Please rank your level of knowledge on the following areas as they pertain to feed efficiency. (1 = knowledgeable; 10 = need more education)

[1] Discovery questions were asked in a ranking format where topics areas were provided and individuals were asked to rank the topics on a numerical scale from 1 to 10 based on the priority.

Table 16. Priority rankings by demographic segments for discovery question 1[1]

	Total	Industry segment				Years of experience			
Topic	responses	Producers	Consultants	Academia	Other	0 to5	5 to 10	10 to 20	20+
Alternative feed ingredients	8.1	8.1	8.0	7.6	8.7	6.4	9.2	7.6	8.2
Amino acids	6.2	6.2	6.6	5.4	6.2	8.1	7.1	5.6	6.0
Antibiotics	7.7	8.3	7.4	7.5	7.9	7.0	8.0	7.8	7.7
Dietary energy	4.6	4.3	4.4	4.9	5.4	5.1	5.3	4.3	4.6
Digestive tract microbiology/health	5.5	6.1	5.4	5.5	4.8	5.6	3.9	5.4	5.8
Environment	5.5	5.4	5.9	5.3	5.0	4.6	5.6	6.0	5.4
Feed additives (other than antibiotics)	6.9	7.1	6.9	7.0	6.3	6.3	5.1	7.0	7.3
Feed processing	4.3	4.0	4.1	5.2	4.5	4.0	4.4	4.8	4.2
Genetics	3.7	2.8	4.0	4.2	3.7	5.1	3.8	3.0	3.7
Health	2.2	2.3	2.2	2.1	2.2	2.8	2.6	2.7	1.9

[1] Important = 1; not important = 10.

Table 17. Priority rankings by demographic segments for discovery question 2[1]

Topic	Total responses	Industry segment				Years of experience			
		Producers	Consultants	Academia	Other	0 to 5	5 to 10	10 to 20	20+
Alternative feed ingredients	4.1	4.3	4.4	4.0	3.2	3.9	4.1	4.3	4.1
Amino acids	4.1	4.3	4.4	3.7	3.3	3.3	3.6	4.2	4.2
Antibiotics	5.9	6.0	5.9	6.3	5.2	5.5	5.6	6.1	5.9
Dietary energy	3.7	3.7	3.8	4.1	2.8	2.9	3.2	3.8	3.8
Digestive tract microbiology/health	3.9	4.2	3.9	4.6	2.2	3.8	2.7	3.9	4.1
Environment	4.4	4.5	4.7	5.0	3.0	3.8	4.0	4.8	4.4
Feed additives (other than antibiotics)	4.2	4.2	4.6	4.4	3.1	2.9	3.2	4.8	4.4
Feed processing (expanding/extrusion)	4.7	5.1	5.0	5.0	3.2	4.3	3.6	5.1	4.9
Feed processing (particle size)	4.2	4.4	4.2	4.7	3.6	4.0	3.3	4.9	4.2
Feed processing (pelleting)	4.3	5.1	4.2	4.6	3.1	2.8	3.7	4.9	4.4
Genetics	3.6	2.9	4.1	4.7	2.2	3.5	2.5	4.1	3.7
Health	3.2	3.0	3.5	4.1	1.8	3.4	2.5	4.0	3.0

[1] Important = 1; not important = 10.

Table 18. Priority rankings by demographic segments for discovery question 3[1]

Topic	Total responses	Industry segment				Years of experience			
		Producers	Consultants	Academia	Other	0 to 5	5 to 10	10 to 20	20+
Alternative feed ingredients	5.1	5.4	4.7	5.4	5.4	5.5	4.4	5.3	5.1
Amino acids	4.8	5.8	4.4	4.9	4.5	6.5	3.9	4.8	4.9
Antibiotics	5.0	5.6	4.7	5.3	4.3	7.4	5.4	5.2	4.6
Dietary energy	5.1	5.3	5.0	5.3	4.9	6.5	4.6	5.3	5.0
Digestive tract microbiology/health	6.0	6.2	5.7	6.5	5.7	7.0	6.0	5.8	6.0
Environment	5.1	5.0	5.1	5.2	5.2	6.0	5.0	5.3	5.0
Feed additives (other than antibiotics)	5.7	6.4	5.2	6.3	5.4	5.5	4.9	5.8	5.9
Feed processing (expanding/extrusion)	6.6	7.0	6.6	6.7	6.1	7.3	6.8	7.1	6.4
Feed processing (particle size)	4.7	4.9	4.3	4.8	5.2	5.8	4.4	5.7	4.2
Feed processing (pelleting)	5.1	6.1	4.5	5.0	5.2	5.8	5.7	5.7	4.7
Genetics	5.2	4.9	5.3	5.0	5.8	7.1	5.3	5.9	4.8
Health	5.3	4.8	5.4	5.8	5.0	5.6	5.1	5.8	5.1

[1] Knowledgeable = 1; need more information = 10.