

This document was initially developed to describe desired updates to the Nutrient Requirements for Swine report. Working with the IFEEDER NASEM advisory group, items highlighted in blue are additional items of interest provided to the NASEM expert panel for consideration.

**Justification for generating the 12th Edition of *Nutrient Requirements of Swine*
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Background

Since 1944, the National Research Council (National Academy of Sciences) has published 11 editions of the Nutrient Requirements of Swine. This reference has guided nutritionists and other professionals in academia and the swine and feed industries in developing and implementing nutritional and feeding programs for swine. The latest update to the report was in 2012 and since then, there have been changes both in the swine industry and in feed ingredients. Some of the requirements and recommendations set forth at that time are no longer relevant or appropriate. A revised edition of the Nutrient Requirements of Swine is needed to build on the previous editions and to synthesize new research published over the last 10 years. In addition to a thorough and current evaluation of the literature on the energy and nutrient requirements of swine in all stages of life, this edition will address the composition and nutrient bioavailability of a wide range of ingredients and their utilization by swine. The report will include a further examination of the requirements for digestible phosphorus and concentrations of it in feed ingredients, a review of the effects of feed additives and feed processing on energy and nutrient availability of all commonly used ingredients, and strategies to increase nutrient retention by the animals to reduce environmental pollution through excretion. The 12th edition of the Nutrient Requirements of Swine will represent a comprehensive review of the most recent information available. It will be used nationally and internationally as an essential reference that supports efficient, profitable, and environmentally conscious swine production.

**Justification for an update of Nutrient Requirements of Swine
*New feed ingredients***

1. Ingredients from the biofuels industry

The continued evolution of the biofuels industry has resulted in a number of new feed ingredients being produced from this industry. The traditional co-product from the dry-grind ethanol industry, distillers dried grains with solubles, is still the major co-product from corn, but due to installation of oil removing equipment at the majority of the dry-grind ethanol plants, the products that are now produced are considerably lower in fat than they were previously. This has resulted in much lower energy concentrations in distillers dried grains with solubles being marketed today. As a consequence of fractionation technologies being used at many ethanol plants, high protein distillers grains with close to 50% crude protein is now widely available in the industry. Technologies to separate the solubles from the wet distillers grains are also available, which results in generation of products that are high in protein, high in soluble phosphorus, and lower in fiber than traditional products. Traditional products from the corn wet milling industry such as corn gluten feed, corn gluten meal, and corn germ meal are also available, and hominy feed is being produced from the dry milling industry. As a consequence, there are a large number of new and traditional co-products produced from the corn industry and establishment of the nutritional value of these products is needed.

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ADDITIONAL INDUSTRY ITEMS OF INTEREST

- Impact of phytate levels in high DDGS because distilling process reduces those levels naturally. So, if you are using phytase in a high DDGS diet, errors can occur in assuming how much phosphorus release you are getting vs. in a more corn and soybean meal diet.

2. *Ingredients from the soybean industry*

Soybean meal, which is the co-product from production of soybeans, is the most important source of amino acids in diets to pigs. However, due to increased yields and use of different genetic materials, the amino acid concentration of soybean meal is different today than it was when the 11th edition of *Nutrient Requirements of Swine* was developed. Likewise, recent research has demonstrated that the net energy of soybean meal is greater than what was previously believed, which is also not taken into account in current feed tables. Due to the continued evolution in production of value added soybean products such as soy protein concentrates, enzyme treated soybean meal, and fermented soybean meal, soybean products have replaced animal by products in many starter diets for pigs, but the nutritional information about these value added soybean products is lacking. There is also an increased usage of soybean hulls in diets for sows and much information about the nutritional quality of soybean hulls has been generated over the last 10 years. As a consequence, updates of the nutritional value of the soybean products used in swine nutrition is required.

ADDITIONAL INDUSTRY ITEMS OF INTEREST

- Concern that protein levels in soybean meal are not as high as they been in the past.
- Concern about trypsin inhibitor levels in soybean and lack of data in trypsin inhibitor in pigs.
- Role of soybean meal level in animal health. Within the NRC, we need to address components relative to what we are feeding for. Are we feeding for health, efficiency, sustainability or performance? What is our target and how does that influence what we formulate? In other words, when we discuss nutrient requirements for swine, what is being defined as the requirement?
- The old NRC had oil values that don't represent the oil that is present today as crush facilities improved their production processes. For both corn and soy, we need to ensure that the values are considered and updated and not just a copy and paste from the old book.

3. *New protein sources for pigs*

Due to the rapidly increasing need for amino acids in the global feed industry, several new feed ingredients that were not available when the current *Nutrient Requirements of Swine* was developed, are now being marketed. Among these ingredients are single cell proteins, insect meal, and co-products from the fermentation industry. Some of these protein sources are already or will soon be used by the swine industry and information about the nutritional value of these proteins is, therefore, needed.

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ADDITIONAL INDUSTRY ITEMS OF INTEREST

- Relative to insects, the industry is seeing the ingredient being marketed as whole insect, insect protein and insect oil. Consideration should be given to more than insect meal in this discussion.
- Because the NRC is used globally, is the table of ingredients comprehensive enough to cover a wider geography of ingredients. A lot of places don't have reliable ingredient specs.
- Keeping the ingredient tables is extremely important for nutrition practitioners including in some cases legal protections. It's a key point of reference that is needed as a standard, and key for research trials.
- New fractionated and fermented products from increasing crush and ethanol facilities.

4. *Use of crystalline amino acids*

The fermentation industry has evolved dramatically over the last ten years and feed grade versions of at least 6 crystalline amino acids are now available. It is therefore possible to produce diets for pigs based on lower levels of crude proteins and with more crystalline amino acids. Theoretically, this approach will reduce nitrogen excretion from animals without impacting growth performance, but there are many contrasting data in the literature on this issue, and there is no consensus on exactly how to formulate diets using large quantities of crystalline amino acids. There is, therefore, a need for a thorough literature review on data generated with low-protein and amino acid fortified diets to be able to draw conclusions about the effects of using this technology.

ADDITIONAL INDUSTRY ITEMS OF INTEREST

- Addressing the different sources of synthetic amino acids is needed. Nothing in the current NRC describes the different sources of amino acids. Propose creation of a table that identifies and describes the various amino acids and sources. Currently there are at least three methionine sources and two lysine sources.
- Potential for planned inclusion of higher limiting amino acids and the continued evolution of the optimal amino acid profiles; we can go deeper into the ratios of amino acid use but we don't understand them yet. A first step could be to ensure the current use ratios are up to date with current research.

Carbon footprint of diets and feed ingredients

The growing need to reduce carbon footprint and climate changing impacts of agricultural production necessitates that feed formulators can calculate the carbon footprint of each diet they formulate. The current *Nutrient Requirements of Swine* has no information about this because such information was not available 10 years ago. However, information about the climate impact of different feed ingredients have been generated in recent years and it is, therefore, now possible to incorporate this information into feed formulation software and modeling of the climate impact of swine production. There is therefore an urgent need to get this information made available to the industry.

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- Discussion should include barriers and cautions as work advances around ration foot printing, and documentation should provide guidance on resources available for NRC users to consider. It should at a minimum be addressed in a forward-looking manner.
- Reference for consideration BASF (Opteinx) or DSM (Sustell)

Digestibility of calcium and phosphorus and use of microbial phytase

One of the changes that was introduced when the current version of *Nutrient Requirements of Swine* was generated was a system to calculate phosphorus digestibility based on the standardized total tract digestibility of phosphorus, which is now recognized as the most accurate system to estimate phosphorus digestibility by pigs. However, one of the main gaps in the literature that was identified during the work to prepare the 11th edition of *Nutrient Requirements of Swine* was that values for the digestibility of calcium were not available and it was, therefore, necessary to base all calcium requirements on total calcium in diets rather than digestible calcium. During the last ten years, digestibility values for calcium have been generated for all calcium containing feed ingredients and much research to determine the requirement for digestible calcium has been published. The information to introduce a system for requirements for both calcium and phosphorus based on the standardized total tract digestibility of calcium and phosphorus is therefore now available. Recent research has clearly demonstrated that implementation of such a system will reduce the excretion of phosphorus in the manure of pigs. The impact on the digestibility of both calcium and phosphorus of using microbial phytase has also been demonstrated and development of new and more efficient sources of microbial phytase has resulted in the calcium and phosphorus release values of modern phytases being much greater than that of previous phytases. Implementation of this information in diet formulation will further reduce the excretion of phosphorus from pigs and thus reduce the environmental impact of swine production.

ADDITIONAL INDUSTRY ITEMS OF INTEREST

- Support this effort, a significant amount of literature has been added and our knowledge is significantly expanded.
- Would benefit from having digestible calcium numbers on ingredients, where possible.

Other feed additives

Due to the limitations in use of antibiotic feed additives and the use of more fibrous feed ingredients in diets for pigs during the last decade, a number of feed additives are now being used. These feed additives include acidifiers, direct fed microbials (“probiotics”), plant extracts, prebiotics, various yeast products, carbohydrate degrading enzymes, and others. Constant development of new and more efficient sources of feed additives necessitates a thorough review of the literature in this area and updated recommendations on the use of these feed additives. This work is urgent because some of these feed additives have been demonstrated to improve intestinal health and therefore partly or fully being able to replace the health benefits of antibiotic growth promoters.

ADDITIONAL INDUSTRY ITEMS OF INTEREST

- The list is missing postbiotics.

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- Suggest being specific on plant extracts, and not just lump them. The industry has gone beyond and a lot of segmentation exists.
- It will be good to have a list of these additives at a high level with an indication of their desired impacts linked to climate/sustainability/growth/production efficiency/digestibility/etc. Anything the panel could do to connect to functional benefits and measurable economically outcomes beyond digestibility because that is what the industry needs. We recognize there the available information may limit what they can include, but even just mentioning it will help us make progress in the future.
- Many of the feed additives are not nutritional in nature, but they are important to growth, feed conversion and survival – all things we are trying to accomplish with rations.
- Consideration could be given for a chapter that brings feeding for performance into the NRC. The Dairy NRC integrated performance into the recent update and we would encourage the expert panel to give it consideration. (Side Note: the launch for the dairy NRC was really well done with multiple webinars and authors walking folks through the book – would encourage then to do that again).

Use of net energy in diet formulation

Our understanding of net energy has changed the way swine nutritionists think about the energetic needs of various classifications of pigs. Because net energy is more directly related to pigs energy needs it can be used in replacement of the metabolizable energy model to more precisely meet the energy needs of the animal. There is, however, a need for updating information about net energy and to increase the awareness of the environmental and economic benefits of formulating diets based on values for net energy.

ADDITIONAL INDUSTRY ITEMS OF INTEREST

- Yes, net energy needs to be reviewed. The question the industry is getting into regards net energy formulation vs. metabolizable energy formulation when health challenge. So where is energy system important in considering how you are going to feed a pig and formulate the diet.
- Would encourage addressing both metabolizable energy and net energy, you can't ignore one and focus on the other.
- Review what models are used to characterize and model net energy (Feedstuffs Aaron Gaines and Dean Boyd); consider presented principles as a thought process; consider trial design for determining net energy values.

Modeling capability

Mathematical modeling has dramatically improved over the past 10 years. This now allows a shift from deterministic modeling to stochastic modeling and gives producers freedom to test the effect of simultaneously changing multiple inputs. The great power in this is to be able to determine outcomes of various scenarios so that the best decision can be made. This new information needs to be incorporated into a new edition of *Nutrient Requirements of Swine*.

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- Encourage the expert panel to discuss with the industry nutritionists what the actual industry needs are, especially to ensure they are developing an application that could be used in current industry use.

Impact of feed technology on nutritional value of diets

In addition to grinding of most feed ingredients new technologies in pelleting, extrusion, and expansion is available to the feed industry. Much new information has been generated in this area since the last edition of *Nutrient Requirements of Swine* was published. Due to the potential for increased efficiency in swine production by using these technologies and due to the potential for reducing nutrient excretion by correct use of feed technology, there is a need for updated information in this area.

ADDITIONAL INDUSTRY ITEMS OF INTEREST

- Encourage engaging industry and other sources to ensure they are up to speed on the newest technologies in the feed mill. The chapter is currently 1.5 pages and does not do justice to what is needed. Charles Stark at KSU could be a good place to engage as someone who is well versed in that literature.
- Questions that need to be addressed include:
 - Impact of feed manufacturing on nutrient utilization
 - Impact of the ingredient on feed manufacturing
 - Impact of feed manufacturing on animal performance.

Interactions between nutrition, immunity, and health

One of the growing areas of importance in swine nutrition is to understand the impact of nutrition on animal immunity and health – and equally important is it to understand the impact of chronic diseases on nutrient requirements. This issue was discussed during preparation of the 11th edition of *Nutrient Requirements of Swine*, but at that time there was insufficient information about these issues to make meaningful conclusions. However, much research has been conducted during recent years in this area and it is, therefore, important to summarize this information and make conclusions on the interactions between nutrition and health and, if possible, to quantify the impact on nutrient requirements of acute and chronic diseases. Likewise, if there is sufficient documentation in the literature to conclude that certain nutritional strategies may infer health benefits on animals, such strategies need to be described.

ADDITIONAL INDUSTRY ITEMS OF INTEREST

- Industry has more data than a decade ago that would allow them to greatly expand the section on interactions between nutrition, immunity and health.
- Would encourage connection with the swine veterinary expertise in the industry.

ADDITIONAL INDUSTRY ITEMS OF INTEREST BEYOND ABOVE TOPICS

- Review acid binding capacity of ingredients in rations

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- For pharmacological Zn and Cu these need to be addressed as to whether we continue to use "pharmacological" to reduce the stigma. At pharmacological Zn there is still a lot of available Zn being supplied and similar for Cu. Zn and Cu need to be re-evaluated whether the performance benefit is an indication of a requirement and thus we change the requirements from the relatively low levels today to what is know to optimize performance and stop using pharmacological
- All of the chapters are about nutrition components, but the title of the book is nutrient requirements of swine. There are no chapters that discuss the nutrient requirements of developing guilts, gestating guilts, lactating sows, weaned piglets. The only thing that is nutrient requirements are the tables. Encourage the committee to consider adding discussion and literature as to why the nutritional requirements for each development stage matters. Also, consider impact of genetics and crossbreeding.
- Based on comments made by authors of the Dairy NASEM launch, it would be good to plan now to include a chapter on existing research gaps with a eye towards directing future research work. Could there be a digital copy through a login to access the NRC?
- Keeping the ingredient tables is extremely important for nutrition practitioners including in some cases legal protections. It's a key point of reference that is needed as a standard, and key for research trials.
- Guidelines on ingredient sourcing and what to consider, questions to ask, etc. There is an existing section on ingredient contaminants (biosecurity), but nothing to address ingredient quality or hygiene of the feed (for example how it is impacted by transport time). KSU has good documentation that could be used.