TECHNICAL NOTES

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NUTRIENT MANAGEMENT – NO. 3

FEED AND ANIMAL MANAGEMENT FOR SWINE (GROWING AND FINISHING PIGS)

DESCRIPTION

The attached material was prepared by Dr. Alan Sutton, Professor of Animal Science at Purdue University and Charles H. Lander, NRCS, National Agronomist.

This technical note provides a general discussion on how the feed and animal management for swine operations can be used to alter the nutrient content in the excreted manure.

USDA United States Department of Agriculture

NRCS Natural Resources Conservation Service

Ecological Sciences Divison

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(Growing and Finishing Pigs)

Introduction

Swine operations may include a complete farrow to finishing unit, or various combinations of separate units for feeder pig production, including nursery units, grower-finishing pigs, or the breeding herd. Each stage of the life cycle requires distinctly different diets, resulting in great differences in the volume and nutrient composition of the manure produced.

This technical note briefly highlights some factors affecting nutrient excretion. These factors include potential dietary adjustments that can be used to minimize excess nutrient excretion from growing-finishing pigs.

Selected nutrient requirements for pigs of different sizes, as listed in the National Research Council's (NRC) publication *Nutrient Requirements of Swine* (10th revised edition, 1998), are given in table 1. Reference to these guidelines is important for a thorough evaluation of all swine diets, including the breeding herd, on a commercial operation.

Table 1 Selected nutrient requirements for grower-finisher pigs [1]

Nutrient (% or unit/kg of diet, 90% dry matter)	Pig wt. 7–11 lb	Pig wt. 11–22 lb	Pig wt. 22–44 lb	Pig wt. 44–110 lb	Pig wt. 110–175 lb	Pig wt. 176–265 lb
Crude Protein, %	26.00	23.70	20.90	18.00	15.50	13.20
Lysine, %	1.50	1.35	1.15	0.95	0.75	0.60
Lysine, % true ileal dig.	1.34	1.19	1.01	0.83	0.66	0.52
Calcium, %	0.90	0.80	0.70	0.60	0.50	0.45
Phosphorus, % total	0.70	0.65	0.60	0.50	0.45	0.40
Phosphorus, % available	0.55	0.40	0.32	0.23	0.19	0.15
Potassium, %	0.30	0.28	0.26	0.23	0.19	0.17
Sodium, %	0.25	0.20	0.15	0.10	0.10	0.10
Copper, mg/kg	6.00	6.00	6.00	4.00	3.50	3.00
Zinc, mg/kg	100.00	100.00	80.00	60.00	50.00	50.00

1 Adapted from tables 10–1 and 10–5 in *Nutrient Requirements of Swine*, revised edition, 1998, National Research Council (NRC), National Academy of Sciences, National Academy Press, 2101 Constitution Avenue, Washington, DC 20148 (G.L. Cromwell, chair, Subcommittee on Swine Nutrition).

This is the third in a series of nutrient management technical notes on feeding management.

Series was prepared by **Dr. Alan Sutton,** professor of Animal Science at Purdue University, West Lafayette, Indiana, and **Charles H. Lander,** national agronomist, NRCS, Washington, DC. This series was developed from material published by the Federation of Animal Science Societies (FASS), Savoy, Illinois.

Diet formulation

Feeding diets that are higher in crude protein or phosphorus (P) than required by swine result in manure with more concentrated N and P. Producers should feed diets that meet the requirements of their animals without having excess overages.

Phase feeding. Dividing the growth period of the pigs into several periods with a small spread in body weight allows producers to provide diets that more closely meet the pig's nutrient requirements. Feeding three or four diets during the grow-finish (G-F) period, compared with feeding only two diets during this period, would reduce N and P excretion by at least 5 to 10 percent.

Split-sex feeding. Gilts require more protein and amino acids than barrows. Penning barrows separate from gilts allows the feeding of lower protein and amino acid levels to barrows without compromising the growth and performance efficiency of gilts. It also reduces nutrient waste, and can reduce N excretion by at least 5 to 10 percent.

Formulate diets on an available nutrient basis. A high proportion (55-80%) of the P in cereal grains and oilseed meals occurs as phytate. Phosphorus in this form is not well utilized by pigs because they lack sufficient intestinal phytase, the enzyme needed to remove the phosphate from the phytate molecule. Therefore, supplemental P is added to the diet to meet the pig's phosphorus requirements for growth and bone formation. The indigestible phytate P and any excess P in the diet are excreted in the feces.

Supplementing the diet with the enzyme phytase is one of the most effective means of increasing the breakdown of phytate P in the digestive tract and reducing P excreted in the feces. Using phytase allows a lower level of supplemental inorganic P in the diet because a portion (35%) of the unavailable phytate P in the grains is released and made available by the phytase enzyme to help meet the pig's P needs. Inclusion of phytase increases the availability of P in a corn-soy diet by threefold, from approximately 15 percent up to 45 percent, and results in reduced P excretion of 20 to 30 percent.

Because some feedstuffs are high in phytate and because there is some endogenous phytase in certain small grains (wheat, rye, triticale, barley), the bioavailability of P in feed ingredients varies widely. For example, the P in corn is only 12 to 15 percent available, while the P in wheat is 50 percent available. The P in dehulled soybean meal is more available than the P in cottonseed meal (23% vs. 1%), but neither source of P is as highly available as the P in meat and bonemeal (90%), fishmeal (93%), or dicalcium phosphate (95%). To reduce excretion levels, diets should be formulated on an available P basis according to NRC (1998) recommendations, making any adjustments needed for farm-specific pig performance.

Some feed manufacturers formulate swine feeds on an **ideal protein** basis. An ideal protein is one in which the amino acids closely match the animal's requirements for lean tissue protein synthesis and maintenance. One way of doing this is to reduce the crude protein level in the diet and supplement with synthetic amino acids. Although nutritionists cannot prepare perfect amino acid balances from natural feed ingredients, using computers and an array of many different ingredients and synthetic amino acids allows them to produce feeds that have reduced amino acid excesses. Reducing the crude protein in the diet by 3 to 4 percent and supplementing with synthetic amino acids (generally, lysine, methionine, threonine, and tryptophan) have shown a 20 to 40 percent reduction in N excretion.

Feed management

Controlling feed wastage improves herd feed conversion and reduces nutrient losses. Feed wasted in the manure pit can add considerably to the nutrients that need to be applied to the land. Check and adjust feeders often to reduce wastage.

Wet-dry feeding systems can significantly reduce feed and water wastage. Some research has shown that manure volume per pig was reduced by 30 to 50 percent by using wet-dry feeding systems. However, the nutrient concentrations in the manure from a wet-dry feeding system generally are significantly higher. Therefore, routine manure analyses are needed to adjust application rates of such manure to cropland.

The mineral content of the water supply should be considered with regard to the total intake of dietary minerals. Depending on the quality of the water supply available, water intake may make a substantial contribution to daily mineral intake, particularly with regard to sulfur and, in some areas of the country, salt. Routine water sampling can help the nutritionist formulate properly for the amount of minerals that need to be added to the diet to meet the animal's actual requirements.

Maintaining pigs under comfortable environmental temperature and humidity conditions improves feed utilization and can reduce nutrient excretion. Cold temperatures increase caloric requirements for body maintenance, and, therefore, increase feed intake and nutrient excretion. Likewise, extremely hot temperatures reduce feed intake, decrease growth rate, and increase time to market, thereby ultimately increasing nutrient excretion.

Raising genetically lean pigs (rather than fat ones), controlling diseases and parasites, and using good management practices are further examples of how one can improve feed conversion efficiency and reduce nutrient excretion.

Fine grinding (600 to 700 microns is most desirable) and pelleting feed are also effective ways in improving feed utilization and decreasing dry matter manure volume. Dry matter manure volume may be reduced by 15 percent, and nutrient excretion, especially N, by about 5 percent. By reducing the particle size, the surface area of the grain particles is increased, allowing greater interaction with digestive enzymes. Addition of enzymes, such as phytase, amylase, protease, and glucanase, may release nutrients that will enhance nutrient retention and reduce excretion. This is especially true in corn-soybean meal diets.

Summary

The National Research Council's *Nutrient Requirements for Swine*, 1998 edition, is a key reference to evaluate all swine diets, including the breeding herd, on a commercial operation.

Also, consult qualified nutritionists to accurately evaluate current or planned diet compositions during the development of conservation plans, particularly Comprehensive Nutrient Management Plans (CNMPs).

Using multiple strategies in the formulation of swine diets and techniques to improve feed use efficiency can significantly reduce the nutrient content of excreted manure. The potential for these strategies to impact manure nutrient content is shown in table 2.

The actual impact of a feed management strategy or strategies on a swine operation can only be determined by analysis of the manure after the strategy has been implemented. During the development of CNMPs, the potential impact of a strategy or strategies can be estimated using the values in table 2. In using data from this table, planners are encouraged to be conservative in their selection of factors. Also, it is important to remember that the impact of using multiple strategies in a single diet is not likely to be additive for each single strategy being used. Rather, it is more likely to be something greater that the value for the strategy with the smallest impact, but less than the sum of values for all the individual strategies being used.

During the development of CNMPs, it is better to underestimate the potential impact of feed management than to overestimate it. Later, the plan can be modified based upon data accumulated from the actual production operation.

Table 2 Potential for feed management to impact the nutrient content of swine manure [1]

Strategy	Nitrogen reduction %	Phosphorus reduction %
Formulate diet closer to requirement	10–15	10–15
Reduced protein/AA supplementation	20–40	n/a [2]
Use highly digestible feeds	5	5
Phytase/low phosphorus diet	2–5	20–30
Selected emzymes	2–5	5
Growth promotants	5	5
Phase feeding	5–10	5–10
Split-sex feeding	5–8	n/a [2]

[1] Adapted from the Federation of Animal Science Societies (FASS) publication, *Dietary Adjustments to Minimize Nutrient Excretion from Livestock and Poultry*, January 2001.

[2] Not applicable.

Glossary

Available nutrient basis. Formulating a diet based on the bioavailability of the nutrients from the feed ingredients in the diet for the intended production purposes.

Bioavailability of nutrients. The amount of nutrient in the diet that is released in the digestion process and that can be absorbed in a form that can be used in the body for normal metabolic functions of the nutrient.

Crude protein, A measure of dietary protein that is based on the assumption that the average amino acid in a protein contains 16 percent nitrogen. Thus, total chemically determined nitrogen × 6.25 (100 ÷ 16) = crude protein.

Diet formulation. The process of combining an assortment of feed ingredients into a diet that will meet the nutrient and energy requirements of the animal for the intended purpose for which the animal is produced.

Digestibility. The relative amount of nutrients released from the digestion process.

Endogenous. Nutrients within the animal that may be produced or synthesized. Excretion of endogenous nutrients may occur from the recycling of nutrients and normal cellular metabolic processes.

Endogenous phytase. The enzyme naturally derived within the animal or from microbial sources within the animal that degrades phytate and releases phosphorus.

Ideal protein basis. Formulation of a diet based on the concept that the protein content of the diet has a balance of amino acids that exactly meet an animal's amino acid requirements.

Phase feeding. Changing the nutrient concentrations in a series of diets formulated to meet an animal's nutrient requirements more precisely at a particular stage of growth or production.

Phytase. An enzyme that degrades phytate, making phosphorus available to nonruminants.

Phytate phosphorus. A complex, organic form of phosphorus that is bound to the phytate molecule and is not readily digested by nonruminant animals.

Split sex feeding. A feeding and housing program that divides animals by gender and formulates diets to meet the specific nutrient requirements of each sex more precisely.

Wet-dry feeding systems. Feeding systems designed to introduce water with dry feeds either at prescribed periods or on demand by the animal. Introducing water at the time of feeding also reduces the potential for water spillage and dust from feed sources.

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