

Nutritional and Feeding Strategies to Minimize Nutrient Losses in Livestock Manure

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Introduction

The livestock industry has undergone substantial changes in the past few decades. The poultry, swine, and dairy industries in particular have become increasingly concentrated. This has resulted in fewer, but larger, livestock operations throughout the country. As a result, there has been a growing concern about odor emissions from livestock operations and potential decreased water quality caused by nutrient runoff from livestock manure. One of the key components to lowering air and water pollution from manure is the animal diet.

All animals, whether ruminant (cattle and sheep) or non-ruminant (pigs and chickens), have five basic nutritional needs. Animals need energy which is provided by fats and carbohydrates in the diet, protein, water, vitamins, and minerals. Even in the best management situations, animals are not able to utilize 100% of the nutrients that are consumed. Some nutrients will be excreted in the manure. Nutrients excreted in manure come from four primary sources: (1) feed wastage, (2) excess nutrients provided in the diet, (3) undigested nutrients in the diet, and (4) biological losses from dead cells in the body. From a manure management perspective two nutrients are of particular interest: **nitrogen** from the breakdown of protein, and the mineral **phosphorus**.

Nitrogen and Phosphorus

Nitrogen is essential in livestock diets. Proteins are made up of building blocks called amino acids, which in turn, contain the element nitrogen. Therefore, nitrogen is necessary to build protein. However, nitrogen excretion from animals is an environmental concern because it can volatilize into the air as ammonia causing offensive odors from livestock operations. Ammonia present in lakes and streams can be toxic to aquatic life. Nitrogen can also leach into ground water and cause pollution. Fifty percent of the total U.S. and 95% of rural residents obtain their drinking water from ground water sources.

Phosphorus is also necessary in animal diets. It is a key component of bone and teeth and is part of high energy compounds. Phosphorus is also an important part of cell membranes, RNA and DNA molecules. Phosphorus from animal manure binds to soil particles and can be carried by erosion to surface water such as lakes and rivers. Once in the surface water, phosphorus can cause excessive growth of algae. The algae use oxygen needed by fish, resulting in fish kills.

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Table 1 shows the average concentration of nitrogen and phosphorus in livestock and poultry manure. These are only averages. The actual concentration of nitrogen and phosphorus in the manure of a given livestock operation will vary with management, diet, manure storage facility, and age of animal housed in the facility.

Table 1. Estimated phosphorus and nitrogen content of livestock manure (Midwest Plan Service 18.1)

Type of manure	N Concentration	P Concentration
Solid Beef Manure	11-14 lb/ton	8-12 lb/ton
Solid Poultry Litter	34-46 lb/ton	60 lb/ton
Liquid Swine Manure	27-53 lb/1,000 gal	27-42 lb/1,000 gal
Liquid Dairy Manure	25-32 lb/1,000 gal	14-15 lb/1,000 gal

Strategies to Reduce N and P

Reduce Feed Waste

What can producers do to reduce the nitrogen and phosphorus that is excreted in livestock manure? One method of reducing nutrient losses in the manure is to ***reduce feed wastage***. Feed wastage is any feed that is provided to, but not consumed by the animal. It can be feed that is left over in the trough or bunk or feed that is slopped over the edge of the feeder and ends up on the ground or in the pit. Van Heugten and Van Kempen (1999) found 2-12% feed wastage in the U.S. swine industry. They estimated that if just 5% of feed is wasted, a net income loss of \$1.77/pig depending on the market can result and an additional 327 grams of nitrogen and 82 grams of phosphorus is excreted per pig. Producers can reduce feed wastage in their livestock operation by regularly adjusting feeders, using proper feeder design for age and type of animal, and regular maintenance of the feeders or bunks. The use of total mixed rations (TMR) for cattle and pelleted feed for swine and poultry can also reduce feed wastage.

Increase Accuracy

A second method of reducing nutrient losses in manure is to ***more accurately meet the nutrient requirements of the animal***. Animals are only able to utilize a certain amount of any given nutrient for maintenance and productive purposes. Nutrients supplied above that level are excreted by the animal. Therefore, while it is important that all animals are supplied sufficient amounts of each needed nutrient, it is also critical that producers do not grossly over-supply nitrogen and phosphorus in the diet. Male and female animals do not have the same nutrient requirements. Nutrient requirements also change as the animal progresses from one phase of production to another. For example, the nutrient needs of starter calves are not the same as the nutrient needs of feeder cattle. Therefore, animals should be grouped by gender and phase of production and fed diets specific to their nutrient needs. Feeding animals in groups according to their gender is known as split-sex feeding. Feeding according to phase of production is known as phase-feeding.

In the past, many producers added nutrients at levels above the recommended level necessary for maintenance and production as a “safety margin.” Spears (1996) found that the typical diet for North Carolina finishers contained 0.40 to 0.70% total dietary phosphorus. The recommended phosphorus level for finisher pigs was only 0.40%. On average, producers were supplying their pigs with 1.55 times the phosphorus necessary for growth and maintenance. A similar study conducted with Wisconsin dairy cattle revealed that producers were providing 0.45 to 0.50% total phosphorus in the diet when the recommended level of total phosphorus for a dairy cow was only 0.38%. Excess phosphorus provided to livestock can not be utilized by the animals and is excreted in the manure. Simply lowering the dietary phosphorus level 0.1% will decrease phosphorus excretion about 8.3% in pigs (Kornegay and Verstegen, 2001). Due to research studies such as these, many producers now lower safety margins to reduce nutrient excretion and save money.

Another way to more accurately meet the nutrient requirements of the animal is to use synthetic amino acids in poultry and swine diets. Synthetic amino acids are manufactured sources of highly concentrated specific amino acids. Traditionally, high protein ingredients such as soybean meal or meat and bone meal were used to supply the animal with necessary protein and amino acids. But these feed ingredients provide a wide variety of amino acids, not always in the specific quantities needed by the animal. When synthetic amino acids are supplemented into the diet, less high protein feed ingredients are needed to meet to the amino acid requirement of the animal, and the amino acids are added at levels more closely reflecting the nutrient needs of the animal. This reduces the total protein content of the diet and decreases nitrogen excretion in manure. For every 1% reduction in crude protein achieved by using synthetic amino acids, total nitrogen losses are reduced by 8% (Kerr and Easter, 1995). Reducing nitrogen excretion also decreases ammonia production and may lower odor emissions from the livestock facility.

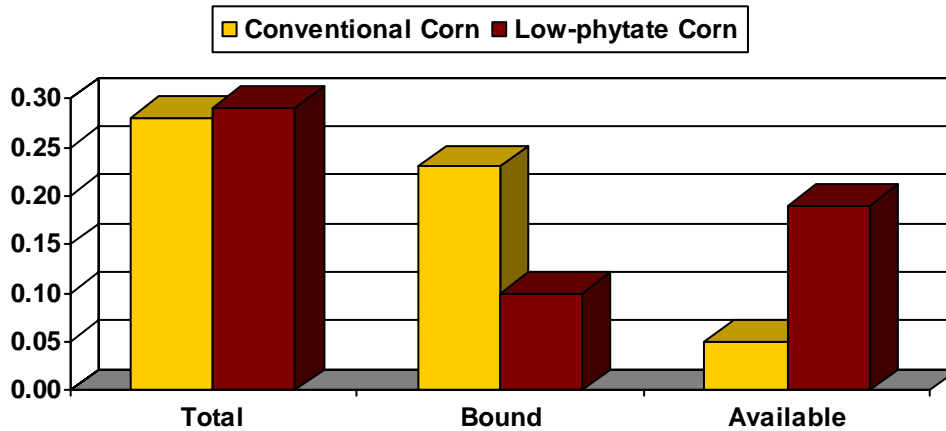
Improve Digestibility

A third method of reducing nutrient losses in manure is to ***improve the digestibility of the diet***. When a highly digestible diet is fed, a higher percentage of the nutrients are used by the animal for maintenance and growth and fewer nutrients are excreted in manure. Some feed ingredients are more digestible than others. For example only 14% of the phosphorus in corn is actually in a form that is available to a pig, while 90% of the phosphorus in corn distiller’s dried grains with solubles is available to a pig. By selecting feed ingredients that are highly digestible, producers can reduce the nutrients excreted in manure. However, producers need to balance digestibility of the diet with economics when deciding which feed ingredients best fit into their operation.

An increasingly common way to improve phosphorus digestibility in swine and poultry diets is to add a commercially available enzyme called phytase to the diet. Most phosphorus in cereal grains fed to livestock is bound to a compound called phytate. As a result, the phosphorus is not available to the animal for growth and maintenance purposes and is excreted in the manure. Phytase is an enzyme that breaks the phytate compound and increases phosphorus availability. As a result, more of the phosphorus from cereal grains is available to the animal and less is excreted in the manure. Phosphorus excretion can be reduced 33% when phytase is added to a low phosphorus diet (Kornegay and Verstegen, 2001). It is not necessary to add phytase to cattle diets because the microbes in their stomach naturally produce phytase.

There is a variety of corn called low-phytate corn that has the same effect as adding phytase to swine and poultry diets (Figure 1). This corn variety has the same total phosphorus as conventional varieties, but low-phytate corn naturally has less total phosphorus bound to the phytate compound. Consequently, more phosphorus is available to the pig or chicken. Currently, it is more economical for producers to feed conventional corn with supplemental commercial phytase than to use low-phytate corn in the diet. This may change with continued improvement in plant genetics.

Figure 1. Increased availability of phosphorus in low-phytate corn compared to conventional corn



Summary

The implementation of nutrition and feed strategies discussed above will significantly reduce nutrient excretion, but they are not the total solution to the amount of manure produced by livestock, since 100% utilization of a diet is not possible. As we look ahead to the future, there may be other dietary strategies that become available to assist with lowering nitrogen and phosphorus excretion in livestock manure. However, economics will always be a driving factor behind producer acceptance of these new technologies since the producer must maintain a profit to stay in business. Therefore, continued research is needed in this area to ensure that producers have economical technologies available to help lower nutrient excretion from their livestock facility.

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