Best Environmental Management Practices

Farm Animal Production

Feeding Strategies to Lower Nitrogen and Phosphorus in Manure

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Introduction

Reducing nitrogen (N) and phosphorous (P) excretion from livestock and poultry currently is receiving attention because of the potential for manure to affect water and air quality. Proper ration management is a valuable tool to reduce nutrient flows and reduce potentially negative impacts on the environment. Excess excretion of N and P can cause build-up in soil, potential losses to water sources through runoff or leaching, and ammonia emissions to the air. This brochure covers the basic principles of nutrition and feeding management, and potential adjustments, to minimize nutrient excretion. The guidelines presented here can reduce nutrient excretion from animals for any nutrient provided in rations.

Nutrient Utilization and Excretion

Rations must contain adequate amounts of nutrients to meet the needs for maintenance, pregnancy, growth, and other productive functions (e.g., meat, milk, and eggs). Stage of growth and the type of production affect these requirements. How well animals utilize nutrients for productive purposes depends upon the availability of the nutrients in the diet, absorption, metabolism, and ultimately, the retention of the nutrients. The amount of nutrients excreted by animals is affected by three main factors: **1)** the amount of nutrients consumed; **2)** the efficiency with which they are utilized by the animal for growth and other functions; and, **3)** the amount of normal endogenous losses (metabolic and obligatory losses). In other words, the amount of excreted nutrient can be expressed as: nutrient excreted = nutrient intake - nutrient utilized + nutrient from endogenous sources.

Reduce N and P

The best ways to reduce the amount of nutrients excreted by animals include matching the amount consumed to that needed to meet the animals' requirements and increasing the efficiency of utilization of the nutrients consumed. Often rations are formulated with a "safety margin" by increasing the concentrations of nutrients beyond that needed to meet requirements, possibly by as much as 30 to 50%. This results in excretion of the excess N and P. The goal of efficient and productive feeding of animals, within economic and environmental constraints, is to provide essential available nutrients for maintenance and production while minimizing excess amounts. Check ration formulations against the N (protein) and P requirements listed in the *Nutrient Requirements of Dairy Cattle* (poultry, beef cattle, and swine, respectively) published by the National Research Council and reduce excesses.

Nutrient concentrations in feeds vary considerably, and not all nutrients in feeds are equally available to the animal. Obtain the most current information on the **availability of nutrients** in the feed ingredients used and formulate diets based on an **available nutrient basis.** Because of variability composition, **routine laboratory feed analyses and a ration formulation program are necessary to adjust diets and maintain minimum nutrient excretions.** Careful selection of feed ingredients also is important. The availability of P in grains varies from 14 to 50% in swine and poultry diets. For example, corn gluten or distillers grains are inexpensive sources of N and energy in cattle rations, but the P content is nearly twice that of more traditional feed grain sources. In the laboratory, wet-chemistry methods (not near-infrared reflectance spectroscopy) must be used to obtain accurate results of P concentrations in animal feeds.

Protein concentrations in beef and dairy cattle rations should be formulated to meet the **metabolizable protein needs [rumen degradable plus undegradable (post-ruminally absorbable) protein]** for certain growth rates or milk production levels. Formulating the protein content of cattle rations to more closely meet the animals' requirements for essential amino acids can reduce N excretion by 15% compared with more traditional feeding. The **concentrations and ratios** of available amino acids in swine and poultry rations for growth performance should be the criteria to reduce N excretion. Reducing the crude protein of the ration by two percentage units (from 14% to 12%) and adding supplemental dietary essential amino acids will reduce N excretion by 20 to 25% in pigs. Although currently not cost-effective, it is possible to reduce N excretion by as much as 40 to 50% by reducing the crude protein of the ration and adding supplemental amino acids. With new amino acid production plants being built and new technologies being developed, however, more amino acid supplementation is likely in the future. Another benefit of reducing N excretion is a significant reduction of ammonia volatilization and odor emissions into the air.

Proteases, xylanases, arabinoxylanases, amylases, and other enzymes have been used in poultry rations to break down proteins and carbohydrates for increased nutrient utilization.

Absorbable P in the ration is the criterion used to meet maintenance and production P requirements of animals. Recent research has shown that the P level needed to meet the requirement for lactating dairy cows ranges from 0.32 to 0.38% of dry matter in the feed, depending upon level of milk production and feed intake. Because a typical ration composed of corn silage, soybean meal, alfalfa and corn grain contains about 0.40 to 0.45% P, no supplemental P is required. A similar scenario is found with beef cattle rations. The P concentration to meet the requirement of growing-finishing beef cattle is less than 0.34%, but corn alone as a major component of the ration will provide 0.32% P. Therefore, the contribution of P from corn grain in the ration alone is adequate for feedlot cattle. In both of these scenarios, **do not add supplemental P in cattle rations**. The potential reduction in P excretion ranges from 25 to 50% depending upon the P supplementation in traditional feeding systems. If P supplementation is reduced, this is also a major cost benefit as P is the second most costly nutrient in rations.

Reducing supplemental P in pig and poultry rations, generally as dicalcium phosphate, and **using phytase** to increase the availability of P (from phytic-P) in corn and soybean meal is cost-effective and can reduce P excretion by 25 to 35 %. In most rations, a 0.1% decrease of P can be replaced with 300 to 600 phytase units. In addition, phytase can increase the availability of other minerals and amino acids. Vitamin D derivatives and citric acid have also been used to improve the utilization of P in poultry rations and may gain commercial acceptance in the future.

Feeding Management

Several management techniques can be used in feed preparation, handling and delivery that can affect animal performance and, consequently, nutrient excretion. For instance, **pelleting** and reducing the particle size (**grinding**) of a ration increases the digestibility of the ration for pigs and poultry, improves N and P utilization and reduces excretion by 5 to 15% each. **Ensiling forages and cracking grains** increases the digestibility of the ration for beef and dairy cattle.

Phase feeding involves formulating and providing more specific rations during growth-specific periods. By dividing the growth interval into several periods with a smaller spread in body weight between changes in the rations, rations more closely meet the animals' nutrient requirements. Similarly, lactating dairy cows can be fed specific rations at separate periods in their milk production cycle. As a consequence, fewer nutrients are wasted and excreted (from 5 to 10% less). This requires grouping or penning animals together of similar ages, weights and (or) production or management groups. Offering three or four feeds in a multi-phase program compared with only offering two feeds with growing-finishing swine can result in 5 to 10% less N and P excretion. Any **approved feed additive** that increases N and P efficiency reduces N and P excretion. Examples are antibiotics and growth enhancement agents.

Adjust rations to meet the specific **genetic potential** of animals, including feed intake and responses to environmental conditions. Some pigs require a higher N and P content in the ration for maximal lean tissue production, especially if feed intake is lower. Also, separating animals by gender (**split-sex feeding**) for feeding specific rations can reduce excretion of N and P. Generally, females require a ration that is higher in protein than castrated males.

Keeping animals **comfortable and healthy** helps optimize N and P utilization. Under extreme climatic conditions, e.g., high or low temperatures, adjust the diet N and P concentrations if intake levels change or more energy is needed to maintain the animal.

Regulate and maintain **feeders, bunks and waterers** to minimize spillage of feed and water into the manure storage. Wasted feed increases the amount of nutrients in the manure and significantly (and economically) reduces feed efficiency. Excess water results in additional liquid manure volume that must be field applied. Nutrients in drinking water add to the mineral intake of animals. Obtain laboratory analysis of the water and check for the potential of drinking water minerals supplying significant amounts and make adjustments in ration formulations.

New Technologies

Several new technologies are being developed and tested to enhance the nutrient content or utilization of feed ingredients, or to alter the availability of nutrients in current commercial feeds. This includes enzymes, genetically modified feed ingredients and feed processing technologies to enhance the availability of nutrients to meet the needs of specific animals and reduce excretion of nutrients. These specialty feeds and new technologies will provide nutrients in a proper balance that will allow "**precision-feeding**" of animals. Examples to reduce P excretion are highly available P in corn and soybeans, phytase, vitamin D derivatives and citric acid. Examples to reduce N excretion are low oligossaccharide soybeans, nutrient-dense corn, organic acids, synthetic amino acids and proteases.

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