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Strategies to Reduce Amounts of Nitrogen and Phosphorus in Dairy Rations

Charles C. Stallings, Extension Dairy Scientist and Professor, Virginia Tech
Katharine F. Knowlton, Associate Professor, Dairy Nutrition, Virginia Tech

Nitrogen (N) and phosphorus (P) are the two nutrients that cause the most concern with respect to environmental pollution from animal manure. Generally, higher concentrations of N and P in the ration result in their greater excretion in urine (N) and feces (N and P). Overfeeding these nutrients can be a significant problem, particularly if nutrient levels accumulate in the soil and contaminate water sources through leaching or surface runoff. Nitrogen can also volatilize as ammonia and pose a potential environmental problem with air emission standards, which are currently under review. Phosphorus does not volatilize and typically will stay attached to soil particles and saturation can occur. Most dairy farms import excess N and P when they purchase feeds from off the farm. N and P excretion can be better managed by getting the proper nutrient amounts into cows at the proper stages of their production cycle. Some strategies for reducing overfeeding are:

- Group and feed animals according to their nutrient needs.
- Balance rations according to the 2001 NRC guidelines for protein and P.
- Re-evaluate the use of high-P by-product feeds and maximize the use of forages in rations.
- Use tools such as milk urea nitrogen and nutrient monitoring software to track status.

Group and Feed Animals by Nutrient Needs

The trend in Virginia has been to manage and feed milking cows as one group. This trend has been driven by herd size and the lack of time and labor available for mixing rations and feeding more than one group. In order to feed the top-producing cows in a one-group herd, overfeeding lower producers is unavoidable. Feeding and managing cows this way can be a problem, especially with respect to N and P excretion. When your herd size increases, you should consider multiple feeding groups. Feeding cows in groups based on similar nutrient requirements lets you formulate the rations closer to the average cow's requirements for each group and minimize overfeeding. Basically, cows should be grouped and fed according to milk production and reproductive status. Further grouping might be for early-lactation cows (less than a month in milk) and first-lactation animals. Cows take a few weeks after calving to increase their dry matter intakes so higher nutrient concentrations are often warranted. First lactation animals are typically smaller and may need higher nutrient concentrations due to their limited intake capacity and the fact that they are still growing; however, high concentrations of ration protein should be avoided.

Growing dairy heifers should be managed and fed in several groups. A simple grouping strategy would be 1) baby calves on liquid feed, 2) weaned to six months of age, 3) six months to breeding age (13-15 months), and 4) bred heifers to calving. Generally, more animals would dictate more groups. Dry cows should have their own separate group and, in most cases, two groups (drying off until three weeks before calving and within three weeks of calving).

Balance Ration Protein (N) and P to 2001 NRC Guidelines

The most recent Nutrient Requirements for Dairy Cattle published in 2001 did a thorough job of describing the dynamics of digestion as it relates to protein and energy.

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Theoretically, it is often possible to reduce the ration's crude-protein concentration if the proper amounts of rumen degradable and undegradable protein are fed. The NRC model also considers the amount of ruminal energy that is available when calculating the microbial protein produced by a given diet. All of this is considered when the flow of amino acids for absorption from the intestine is calculated. The bottom line is degradable and undegradable protein should be balanced with adequate rumen-available energy in order to maximize the amount of microbial protein produced. This allows the cow's requirements to be met with a reduced dietary N content, reducing N excretion.

Phosphorus requirements have been revised with the 2001 NRC and typically are 0.38 percent to 0.42 percent of the ration dry matter for lactating cows. In the past, rations were often much higher in P than this. These revised requirements are based on more recent published research in high-producing cows. In this revision, the NRC determined that availability of P is 64 percent for forages and 70 percent for grains, protein supplements, and by-product feeds. Availability of P in mineral supplements varies by product with monosodium phosphate being 90 percent and dicalcium phosphate 75 percent. These improved estimates of availability of feed P in the new NRC, are the reason that the total amount of P needed in the ration can be reduced. With more information available about P availability from feeds, increased awareness about the lack of benefit of overfeeding, and increasing environmental concerns, it seems reasonable to reduce supplemental P if applicable. In a typical Virginia dairy herd, excess supplementation of P from an inorganic mineral source can add hundreds, if not thousands, of dollars to the yearly feed bill.

Evaluate Use of High PBy-product Feeds and Maximize Use of Forages

Maximizing the amount of forage in the ration not only improves cow health but also reduces the need for supplemental feeds that are typically high in P. For instance, soybean meal contains 0.7 percent P (dry basis) compared to 0.3 percent for alfalfa. Simply supplying more protein with alfalfa in the ration will reduce the need for purchased soybean meal and result in lower ration P. Many by-product feeds contain high concentrations of P. Feeds such as whole cottonseeds (0.6%), brewers' grains (0.67%), and distillers' grains (0.83%) are good examples. These feeds are often useful in dairy rations, but their overuse can inadvertently cause increased manure P content. Using more forage in the ration can reduce the need for these by-product feeds and reduce the overfeeding of P. Corn silage is relatively low in P (0.26%), for instance, and the fact that most forage is grown on the farm using recycled nutrients in manure makes it a desirable practice. The increased use of homegrown forages allows for a net reduction of nutrients onto the farm and subsequently, into the soil where accumulation can occur with the possibility of water contamination.

To maximize forage in the ration, a complete forage analysis should be conducted every month to monitor quality and make ration adjustments as needed. A complete analysis would include dry matter, crude protein, fiber (acid detergent fiber [ADF] and neutral detergent fiber [NDF]), estimated energy, plus minerals on a less regular basis (refer to *Tests Available for Measuring Forage Quality*, Virginia Cooperative Extension Publication 404-124, for more information). The test for mineral content of all forages should be conducted by wet chemistry (not NIR), when major changes are expected (at harvest or when beginning use of a new silo). Many forage reports will give protein solubility and in some cases estimated protein degradability. A fermentation profile can also be obtained with pH and acids reported for fermented feeds to tell how complete the fermentation was and how stable it might be over time. Another measurement that is being used increasingly is NDF digestibility. This measurement can be used to more correctly estimate the energy content of the forage because fiber is an important indicator of the energy supplied by forages such as corn silages. In order to use the maximum forage, attention is needed pre- and post harvest. Forage quality needs to be measured periodically with the latest techniques available to improve the estimates of energy content and evaluate the need for supplementation. With high-quality forage, supplementation can sometimes be reduced with no loss of milk production.

Use Tools to Track Nutrition Status

Milk urea N (MUN) is an indicator of an animal's protein status and most Dairy Herd Improvement (DHI) labs will offer this analysis. Urea is a small molecule that travels dissolved in water. Urea will be in the blood, urine, and milk at approximately the same concentrations. Urea is a product of protein degradation and does reflect the protein status of the animal. Over- or underfeeding can result in high or low levels of MUN, respectively. High levels of rumen degradable protein

can result in elevated MUN. Energy intake can have an impact on MUN levels as well. If there is not enough energy present in the rumen to utilize all the nitrogen that is available, some will pass into the blood and be transformed into urea in the liver.

Typically expect herd average MUNs to range between 11 and 15 mg/dl. Pennsylvania DHI reports are available on a website maintained by the University of Pennsylvania's Center for Animal Health and Productivity. Summaries of all cows that have been tested since September 1995 are included with these reports. They find that first-lactation cows averaged 12.9 mg/dl MUN plus or minus a standard deviation of 3.8. The standard deviation gives the range for two-thirds of the cows tested. In other words, one-third fall outside this range (9.1 to 16.7 for first-lactation cows). Second-lactation cows averaged 13.2 ± 4.0 (9.2 to 17.2) and third- and later-lactation cows averaged 13.1 ± 4.1 (9.0 to 17.2). Jersey cows generally have between 1 to 2 mg/dl more MUN than Holsteins.

High MUN concentrations do give an indication of how efficiently protein or N is utilized and can be an indicator of overfeeding. Individual cows may be outside the normal range and factors such as feed and water intake, time of eating relative to sampling, and level of production will all have an influence on MUN levels. If herd average MUNs are elevated or depressed, check total protein intake, rumen degradable protein intake, and rumen available energy.

There are software programs that can assist in whole-farm tracking of N and P. In these programs, calculations are based on the input of nutrients in the feed and into the manure (urine and feces). Cropping strategies are evaluated and nutrient recycling is tracked. Net accumulation or depletion is calculated and adjustments made to reduce over fertilization if needed. These computer programs can be valuable tools in estimating the impact of your production practices on net N and P accumulation on the farm. Feed, manure, and soil testing can also be tools to evaluate farm impact.

Summary

Both N and P are expensive to overfeed. This is especially true if the excess is coming from purchased ingredients. With new environmental regulations they may also become more costly to depose of. The 2001 NRC allows calculation of rumen degradable and undegradable protein, rumen available energy, and P absorbed. These are important when formulating rations that are environmentally friendly. Increasing the use of forage in the diet by improved forage quality and testing reduces the need for supplementation. Tools such as MUN testing can give an indication of unbalanced rations. Nutrient tracking software programs can assist in monitoring the nutrient status of individual fields as well as the whole farm. The result can be reduced nutrients in waterways and improved water quality.

References

National Research Council. 2001. *Nutrient Requirements for Dairy Cattle*. National Academy Press, Washington D.C.

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University of Pennsylvania's Center for Animal Health and Productivity website, *http://130.91.88.59/mun/mun.html*.