Reducing nitrogen losses from dairy farms through nutrition

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Increasingly farmers across the United States are feeling pressure to minimize the impact of their farm management practices on the environment. Human health problems, algae blooms, fish kills, and now the reputed link between nutrient enrichment of streams and *Pfiesteria* outbreaks have increased the pressure to reduce nitrogen and phosphorus losses from farms. The challenge facing the industry is to identify techniques to reduce the environmental impact of farming operations while maintaining their economic viability.

Typically, efforts to reduce nutrient losses from farms have focused on manure management: handling nutrients once they accumulated on the farm. Little attention has been paid to the “front end” of the system, management of the herd and feeding program to minimize nutrient excretion. Recent work suggests real opportunities to reduce nutrient losses through improved nutrition and herd management. This article is the second in a series covering the relationship between dairy farms and the environment, and focuses on the opportunity farmers and their advisors have to reduce nitrogen losses from dairy farms through nutrition.

Recent work suggests real potential to reduce nitrogen losses from dairy farms (nitrogen runoff, leaching, volatilization) through nutrition. Improved efficiency of protein utilization would allow the same or increased productivity with a lower dietary protein (nitrogen) concentration, and reduce nitrogen excretion.

One technique to increase efficiency of protein utilization is to balance rations for ruminally degraded and undegraded protein rather than total crude protein. Feed protein may be degraded in the rumen, or may escape rumen fermentation and flow to the small intestine. The ammonia and amino acids from protein digested in the rumen will be used to synthesize microbial protein if sufficient energy is available, but otherwise will be absorbed. Some absorbed ammonia recycles to the rumen through saliva, but most is excreted in urine. Florida research indicates that balancing rations for ruminally degraded and undegraded protein reduces nitrogen excretion by about 15% compared to balancing rations for crude protein content only.

Forage type and quality also affect nitrogen excretion through their effects on rumen fermentation. The very rapidly degraded protein in immature pasture, for instance, increases nitrogen excretion unless the pasture is properly supplemented. Research at Virginia Tech and at other universities is focusing on proper supplementation of pasture for lactating cows.

Amino acid supplementation is often cited as a technology with real potential to reduce nitrogen excretion. Theoretically, amino acids fed to balance the amino acid flow to the small intestine allow the animal to absorb a “perfect” profile of amino acids, precisely matched to its requirements for maintenance, growth, pregnancy, and milk yield. The benefit of this technology in monogastrics (pigs, poultry) is unquestioned, as supplemental methionine and lysine allow the amino acid requirements of the animals to be met with a reduced crude protein diet. The only difficulty lies in precisely defining the amino acid requirements of the animal.

In ruminants, however, the use of amino acid supplements is complicated by the complexity of rumen fermentation. Predicting flow of amino acid to the duodenum of ruminants is a monumental task, given the variation in feed intake, rumen fermentation, and liquid and solid passage rates. This variation makes it very difficult to predict the response to amino acid supplementation, and limits the use of this technology in ruminants.

One technology with real potential to reduce nitrogen excretion by dairy cows is the use of milk urea nitrogen (MUN) analysis to monitor protein utilization and nitrogen excretion. MUN content is a quick, accurate reflection of how much nitrogen was absorbed by the cow but not used for growth or milk protein synthesis. When cows are overfed protein relative to their needs, the nitrogen from the unused protein is excreted in urine as urea.

Urea is a small metabolic byproduct of protein utilization, and diffuses into milk from the cow's bloodstream. With overfeeding of protein, the concentration of urea in milk increases, and Maryland scientists have recently discovered that urinary nitrogen excretion increases as well. Thus the MUN assay is a powerful tool to tell us when the cow is wasting protein and excreting excessive nitrogen. Elevated MUN indicates an opportunity to reduce protein content of diets, maintain or improve milk yield, reduce nitrogen excretion, and likely reduce feed costs.

How high is too high when it comes to MUN concentrations? A general rule of thumb is that average group or herd MUN should fall between 8 and 16 mg/dl. This range is appropriate for most levels of production, but target MUN varies with milk yield. Herds with high milk production tend to be near the high end of the range, while a herd with lower production would be closer to the low end of the target MUN range.

An important point is that individual milk samples may vary enormously in MUN, and a single sample from an individual cow tells you very little. Factors unrelated to herd protein status (i.e., recent water consumption) may have a strong impact on an individual cow's MUN concentration. Analysis of milk samples from at least 10 cows in a feeding group are necessary to yield an accurate picture of the protein status of the group.

Farmers should be cautious about making feed changes from information from just one test. Instead, watch for a trend in MUN results. If your MUN levels are consistently high (or consistently low) for several months, or if there is an abrupt change between tests, then changes in the ration may be appropriate. Be aware, though, that many herds perform quite well when MUN is below target.

What does it mean when a group of cows has an average MUN concentration higher than this normal range, and how do you determine what changes might be needed? High MUN levels indicate an excess of nitrogen in the cow relative to the animal's level of production. More specifically, elevated MUN concentrations may be caused by a number of nutritional factors, including, but not limited to, too much degradable intake protein (DIP), too little energy, an imbalance of carbohydrate and protein, or not enough undegradable intake protein (UIP). None of these factors alone tells the complete story; high levels of MUN depend on a combination of factors.

MUN is a powerful tool to reduce feed costs, and reduce potential nitrogen losses from your farm. From June of 1997 to June of 1998, 650 herds had their milk periodically analyzed for MUN by Lancaster DHIA, and received feeding advice with their analyses. During that year, the average MUN concentration decreased substantially. Farmers decreased the amount of protein fed to their cows by about 7% and milk yield increased by about 3%. Higher milk production per cow, combined with more precise feeding of protein resulted in increased milk income and decreased feed costs per hundredweight. At the same time, reduced MUN indicates reduced nitrogen excretion. High protein diets increase manure nitrogen, increasing potential nitrogen losses from the farm.

In summary, there is real potential to reduce nitrogen losses on dairy farms through improved herd nutritional management. More precise definition of protein requirements and less overfeeding of protein are practical techniques that significantly reduce nitrogen excretion by the dairy herd. Milk urea nitrogen content is a useful tool to help you identify when protein is being overfed, and to identify opportunities to reduce feed costs, reduce manure nitrogen, and reduce nitrogen lost to the environment. This is the sort of powerful, cost-effective approach we need to protect water quality while maintaining the economic viability of dairy farms.