The Catalyst

CANWEST DHI

Nitrogen efficiency: where do we start?

By Michelle Aguilar and Mark Hanigan, Depart. of Dairy Science, Virginia Tech, Blacksburg, VA. Reprinted with permission from Hoard's Dairyman.

A heightened demand for affordably priced animal products has resulted in highly specialized operations that generally produce and release excess nitrogen (N) into the environment. This can be harmful, contributing to water and air quality issues. As a result, agricultural research has focused on strategies to maximize animal N efficiency without compromising production.

Excess N fed to animals results in N losses in feces and urine. Depending on management of manure application to land, this excreted N can contribute to high levels of nitrates in groundwater and, when combined with excess phosphorus, eutrophication of surface water. Eutrophication results in low dissolved oxygen levels, which causes fish kills, reduced water quality and growth of organisms. It can also lead to shellfish poisoning in humans.

Nitrate in groundwater can migrate into aquifers that are used for drinking water. Consumption of water with high nitrate levels causes blood oxygen exchange problems in infants. Excreted N can also be released into the atmosphere as ammonia, which can react with oxides of N and sulfur forming particles less than 2.5 microns in size.

These particles cause haze and contribute to lung problems and asthma. Thus, improving the efficiency of N use by animals can reduce N release to the environment and human health risks.

We Lag Behind

Lactating dairy cows fed diets with 17 percent or more crude protein typically only transfer 25 percent of consumed N to milk or tissue N (in the form of protein). The remainder is excreted in urine and feces. Industry standard feeding programs for production species, other than beef animals, result in greater N efficiencies. When fed industry standard diets, growing beef cattle, growing pigs, growing broiler chickens and egg layers have N conversion efficiencies of 26, 33, 45 and 34 percent, respectively (Figure 1).

Efficiencies pushing 85 percent have been observed in swine fed low protein rations supplemented with the most limiting amino acids. This is more than triple the efficiencies observed for dairy cows managed under current conditions. The question that arises is whether we could get lactating cows to operate at a similar high efficiency if we had better knowledge of their total N and amino acid requirements.

Recognizing that there are some inevitable losses associated with ruminal N metabolism, 85 percent efficiency is likely not attainable, but 50 to 60 percent may be possible. Obviously, this would be a huge gain, which would dramatically reduce the environmental footprint of the industry and feed costs.

However, to get there, we have to gain a better understanding of N and amino acid metabolism in the cow. Our knowledge base is not nearly as advanced as it is in swine and poultry.

Efficiency's Economic Impact

In the past, U.S. dairy producers often fed protein above National Resource Council (NRC) requirements to ensure that cows received enough N. This practice has waned in the past few years due to skyrocketing dietary protein costs.

Using Eastern U.S. ingredients at prevailing prices in early 2013, we found that lactating cow diets could be formulated to meet requirements down to 15.25 percent crude protein (CP). The lowest cost ration was at 15.5 percent CP (Figure 2).

When formulated at 15.5 percent CP, N efficiency will be almost 30 percent. Thus, improving the N efficiency of dairy cows should reduce the negative impacts on the environment and improve profit margins.

Although 30 percent N efficiency would certainly be an improvement over the prevailing 25 percent, it is nowhere near the efficiency that should be achievable. To make additional progress, we need to improve our knowledge of ruminal microbe N needs and animal requirements for specific amino acids.

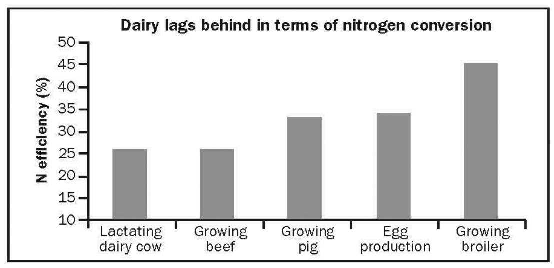

FIGURE 1

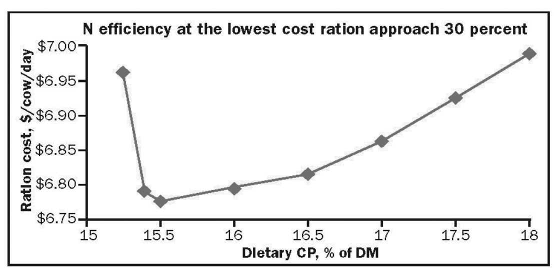

FIGURE 2

Dietary protein fed in excess of requirements results in ammonia generation in the rumen and excess amino acids in blood. The N contained in these compounds is converted into urea within the liver and released into blood, which then equilibrates with bodily fluids, including milk.

As a result, blood urea N (BUN) and milk urea N (MUN) are highly correlated with dietary N intake. In a well-managed feeding program, bulk tank MUN should be at 12 mg/dl or below. Several factors can cause deviations in expected MUN values. Those factors include time of sampling, season of the year, body weight, breed, nutritional factors or sire selection.

We observed highly significant cow effects and a strong trend for a herd effect on MUN concentrations when analyzing data from six herds in Virginia. Despite the variation, a consistent observation is that a gain of 1 percentage unit in dietary CP results in a MUN evaluation between 1.04 and 1.24 mg/dl for milk yields of 90 and 65 pounds per day, respectively.

Thus, a good average to use is 1.15 mg/dl for each 1 percentage unit change in dietary CP. Accordingly, if you see that your cows have a MUN of 13 mg/dl, you likely would have to remove slightly less than 1 percentage unit of CP from the diet to get them down to 12 mg/dl.

Due to genetic and herd specific conditions, the MUN value you observe may vary. Thus, you should establish a MUN target specific to your herd. Twelve mg/dl is a good general target, but many producers can likely operate below 12 mg/dl without experiencing a protein deficiency.

Monitor Your MUNs

Given the high cost of dietary protein, it is worthwhile to determine whether your herd can tolerate a lower protein diet. Once a herd MUN target is set, you can estimate how much protein must be missing from the diet if MUN values fall below target and how much extra is in the diet if MUN values rise above it.

Staying at the target MUN value for your herd is important economically. For example, a cow producing 90 pounds of milk per day could easily drop 18 pounds per day in production if fed a 15 percent CP diet that contains 0.8 pound per day less metabolizable protein than she needs. At $20 per hundredweight, that loss in production will cost the producer $3.52 per cow per day.

MUN: a great tool to monitor nitrogen efficiency

Milk Urea Nitrogen (MUN) analysis is a great way to monitor both the efficiency of the feeding program but also ensuring that excess nitrogen is not released in the environment. In areas of concentrated animal production, as is the case in many regions of British Columbia, optimum nutrient management is critical for farm profitability but also for soil and water quality. MUN analysis is an inexpensive, effective and convenient way to monitor nitrogen utilisation and efficiency.
For more information on MUN testing, talk to your feed advisor or your DHI representative.

Alternatively, the same cow fed an 18 percent CP diet that exceeds her need for metabolizable protein by 0.7 pound per day could cost the producer 28 cents per cow per day given a value of 43 cents per pound of metabolizable protein. So, clearly the risk of underfeeding protein is much greater than the slightly elevated cost of overfeeding protein.

Improve your N use

Even in the absence of a perfect N requirement system, one can take steps today to improve N efficiency and reduce feeding program costs. One of the challenges with reducing dietary protein below 16 percent is that any safety margin in the system is reduced or removed. Thus, a monitoring system to ensure the feeding program stays on target is needed to avoid deficiencies. Such a system includes:

1. Monitor feedstuffs for nutrient content. Nutrient contents can vary, so ration adjustments help ensure that cows are not fed too much or too little protein.

2. Balance rations to meet current protein requirements. Although the 2001 NRC requirements are not perfect, they are safe guidelines. If you design rations to meet NRC and monitor nutrient contents, it is highly unlikely your cows, heifers or calves will experience a protein deficiency.

3. Monitor your feeding programs for accuracy. The ration won't work as intended if the wrong amounts of each ingredient are added or too little feed is delivered.

4. Use MUN concentration to help monitor your feeding program in real time. It is important to verify what equipment your milk company is using to determine MUN. All of the analyzers manufactured in the last 20 years are capable of generating reliable numbers provided they are maintained and calibrated correctly.

Implement a feed management monitoring system to ensure the feeding program stays on target and you achieve N efficiency gains. This system should include frequent assessment of bulk tank MUN content. Using these tools should allow you to achieve 30 percent N efficiency for the lactating herd. Any gains in N efficiency not only reduce environmental impact but also improve economic performance.