HOARD'S DAIRYMAN


**PROTEIN CONTENT OF THE DIET** can play a significant role in nitrogen lost through manure.

# Harbor nitrogen losses

Managing protein intake, especially rumen degradable protein, helps mitigate nitrogen loss out the other end.

*by Fernando Diaz-Royon, D.V.M.*

RUMINANTS play a key role in society by converting fiber-rich plant resources into high-quality food that humans can eat. However, this conversion causes unavoidable losses of nitrogen in feces and urine that have the potential to become an environmental burden.

Three strategies have been suggested to reduce nitrogen emissions: 1) improving the efficiency of animal use of feed protein, 2) reducing losses during manure storage and handling, and 3) using crop rotations that better utilize manure nitrogen. Of these three options, improvement in animal feed use offers the quickest and easiest implementation.

## Protein in, nitrogen out

There is no question that the most important factor determining total nitrogen excretion as manure (feces plus urine) in lactating dairy cows is total dietary nitrogen intake. Nitrogen intake is the principle driver of nitrogen excretion. Studies have shown that, by lowering dietary protein content, the excretion of this mineral can be significantly mitigated.

Diet also influences the relative proportion of nitrogen in urine compared to feces. In low protein diets, fecal nitrogen represents a larger proportion of total nitrogen intake, up to 50 percent, while urine nitrogen makes up as low as 25 percent. Upon the addition of extra dietary protein, the contribution of fecal nitrogen declines and urinary nitrogen loss rises to 60 percent of dietary intake.

Nitrogen in feces is preferable as it is more stable and less likely to volatilize. Meanwhile, most urinary nitrogen is in the form of urea, which can be quickly hydrolyzed by fecal microbes to ammonia when urine and feces mix following excretion. Ammonia is very vulnerable to volatilization and loss to the atmosphere. Therefore, focus strategies for feeding dairy cows on minimizing urinary nitrogen losses.

## Focusing on urinary nitrogen

Researchers at the Centre of Dairy Research at the University of Reading, UK, compiled five nitrogen balancing experiments to develop a mathematical model that predicts the amount and form of nitrogen excreted in different production systems. These authors found a positive linear relationship between nitrogen intake and fecal and milk nitrogen excretion.

Urinary nitrogen, on the other hand, had a strong exponential relationship with nitrogen intake. The rate of nitrogen excretion per nitrogen intake elevated drastically around 400 grams of nitrogen intake per day. The model predicted about 80 percent loss of nitrogen in urine for levels of nitrogen consumption above 500 grams of nitrogen per day. At the same time, losses of nitrogen in feces and milk climbed by less than 20 percent per unit uptick in nitrogen intake.

In scientific agreement with this model, a study carried out at the U.S. Dairy Forage Center Research Farm in Prairie du Sac, Wis., reported that, as the protein content of the diet expanded, the proportion of nitrogen intake excreted in the urine also went up, going from 23.8 percent of nitrogen intake (at 13.5 percent protein) to 36.2 percent (at 19.4 percent protein).

Moreover, a greater proportion of the urinary nitrogen was excreted as urea. Urea nitrogen rose from 55.4 percent of total urinary nitrogen (at 13.5 percent CP) to 81.8 percent (at 19.4 percent protein). The authors concluded that any additional nitrogen intake in diets above 16.5 percent protein is lost mainly as urinary urea.

## It's also about degradability

Protein degradability also affects the route of nitrogen excretion. Urinary nitrogen excretion goes up as degradability improves. When rumen degradable protein (RDP) exceeds microbial needs, large amounts of ammonium are produced in the rumen, absorbed into the blood, converted to urea in the liver, and excreted in the urine.

Researchers from the University of Reading examined the effects of protein supplementation on lactating cows by providing various levels of protein concentrations and degradability. They found more dietary RDP boosted urinary nitrogen excretion by 21.4 percent. Moreover, in this study, there was not only a significant expansion of urinary nitrogen when feeding more RDP, but the rates at which urinary nitrogen went up as protein degradability improved were much greater on high-protein diets than the low-protein diets.

Several experiments have shown limiting the supply of RDP reduced ammonia losses in the manure of dairy cattle. A University of Idaho study evaluated the effects of three levels of RDP on ammonia emissions from manure in dairy cows. The scientists fed three diets that met the requirements of the cows for metabolizable protein, but one of them exceeded RDP requirements by about 7 percent. The other two diets were 14 and 27 percent deficient in RDP for the level of production of the cows.

Urinary nitrogen excretion, expressed as percentage of nitrogen intake, was greater in the diet with excessive RDP (29.3 percent), and lowest in the diet with the 27 percent deficiency (23.8 percent). However, the proportion of nitrogen intake excreted in feces, milk yield, and milk composition was similar among all three diets.

Additionally, the authors measured the ammonia-emitting potential of manure resulting from the experimental diets during 15 days. The cumulative ammonia nitrogen loss from manure during this period was 37.7 percent lower for the lower RDP diet compared with the higher one.

Overall, this study demonstrated that dairy diets with reduced RDP concentrations produced manure with less ammonia-emitting potential without affecting cow performance, as long as metabolizable protein requirements were met. In agreement with this study, Dutch scientists reduced emission of ammonia from dairy cows housed in a naturally ventilated barn approximately 50 percent by reducing the RDP balance of the ration from 1,000 to 0 grams per cow per day.

Nitrogen consumed in excess of cow requirements and excreted in feces and urine contributes to environmental pollution. Harboring this loss by reducing nitrogen intake, especially in the form of degradable protein, is possible without affecting milk production and milk protein yield. This may mark the future of mitigation of ruminant nitrogen excretion.

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