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Using Non-Protein Nitrogen to Control Feed Costs

by E. Kim Cassel, Extension dairy specialist

What is non-protein nitrogen?

All proteins contain nitrogen, but not all nitrogen is contained in proteins. For example, urea and anhydrous ammonia are two compounds which contain significant amounts of nitrogen, but neither is a protein. Instead, they are called nonprotein nitrogen (NPN) compounds.

How do ruminants use NPN?

Ruminants have the unique ability to metabolize dietary nitrogen for synthesis of protein within the rumen. The central component for protein synthesis in the rumen is ammonia. The ammonia can be derived from metabolism of naturally occurring feed proteins by rumen bacteria or directly from NPN compounds.

Rumen-made protein or microbial crude protein passes into the abomasum and into the small intestine. There it is broken down into amino acids that are absorbed and used to meet the daily protein requirements of the animal.

Why is NPN used in ruminant rations?

Since feed costs are often the greatest costs associated with production of milk, meat, and fiber, minimizing these costs can make the difference between profit and loss. NPN compounds are used in ruminant rations as a less expensive alternative to purchased, preformed proteins of plant origin (such as soybean meal or cottonseed meal) or of animal origin (such as fishmeal or bloodmeal).

Table 1. Savings in daily feed costs per cow from substituting 7 pounds shell corn and 1 pound urea for 8 pounds soybean meal.^a

Price of shell corn (\$/bu)	Price of soybean meal (\$/ton)			
	250	300	350	400
2.00	.60	.80	1.00	1.20
3.00	.47	.67	.87	1.07
4.00	.35	.55	.75	.95
5.00	.23	.43	.63	.83

^a Urea values at \$0.15 per pound

The profitability of substituting NPN for preformed protein supplements depends on a number of factors:

- Cost of NPN.
- Relative price of energy and the protein being replaced.
- Animal response to the substitution of feeds.

It generally is assumed that 8 pounds of soybean meal is equal in value to 7 pounds of shell corn and 1 pound of urea. You may substitute corn silage plus NPN for alfalfa hay.

Table 2. NPN application guide for treating corn silage.

Corn silage % dry matter	Final crude protein level of silage			
	11 percent		13 percent	
	Urea ^a	Anhydrous ^b ammonia	Urea	Anhydrous ammonia
	lb/ton			
28	6.0	4.4	10.0	7.3
29	6.2	4.6	10.4	7.6
30	6.4	4.7	10.7	7.8
31	6.6	4.8	11.0	8.0
32	6.8	5.0	11.4	8.3
33	7.1	5.2	11.8	8.6
34	7.3	5.3	12.1	8.9
35	7.5	5.5	12.4	9.2
36	7.7	5.6	12.8	9.4

^a Based on 281% crude protein (45% N); filling loss = 0%

^b Based on 512% crude protein (82% N); filling loss = 25%

The data in Table 1 indicate that as the price of soybean meal increases so do the potential feed savings. In an economy where the price of corn increases with the price of soybean meal, however, the potential feed savings decreases. Consider the relationship between the cost of the energy and protein feeds, such as corn and soybean meal, when making a decision about using NPN.

How is NPN added to rations?

NPN can either be incorporated into a grain mix or added to forages. The type of livestock fed and feeding system will dictate the mode of incorporation of NPN in ruminant rations. Due to palatability problems, limit the amount of NPN to 0.92 percent of the concentrate mix or the equivalent of 2 percent urea.

NPN raises the protein level of ensiled forages such as corn silage. Urea and anhydrous ammonia are the two most common NPN compounds added to corn silage. Although

a more corrosive material, anhydrous ammonia has two advantages to the addition of urea. First, during the fermentation process, microbial proteins are formed increasing the true protein content of the silage. Second, the ammonia is a preservative and, therefore, tends to enhance the bunk life of the silage particularly during warm weather. NPN treatment in the form of ammonia also improves the nutritive quality of forages such as small grain straw, grass hay, and corn stover or stalkage.

Table 2 is a guide for applying NPN to corn silage to increase the crude protein content from 8 percent to 11 or 13 percent.

In addition to the higher protein levels, treating forage with ammonia can result in higher digestibility, increased dry matter intake, and better preservation of wet forages (70 to 75 percent moisture).

In a year when dry matter and yield may vary greatly field to field, urea would be better incorporated into grain mix or TMR. This will give you more control over intake and accuracy of ration formulation.

Table 3 summarizes the results of several research trials involving ammoniation of forages. Note enhanced protein content of feeds, dry matter digestibilities, and intakes. Ammoniation of these feedstuffs may play a critical role in using low-quality feed supplies for beef cows or non-producing dairy cattle.

What are the feeding guidelines?

To avoid potential problems with feed palatability or toxicity from excessive NPN in the diet¹, follow these guidelines:

Use NPN only when additional protein is necessary in the ration. NPN is not beneficial when a ration contains adequate protein.

Introduce NPN rations slowly. Usually a three-week adaptation period is necessary for the rumen bacteria to achieve maximum utilization from NPN.

Table 3. Results of several forage ammoniation trials.

Number of trials	Forage	Percentage ammonia	Percentage crude protein		Percentage DM digestibility		Increase in intake
			Untreated	Treated	Untreated	Treated	
5	Wheat straw	1.5-3.25	3.7	9.7	38.9	48.0	18%
4	Corn stover	2.5-5.0	6.2	11.0	48.0	56.2	22%
1	Corn cobs	3.0	4.2	9.3	42.7	47.9	70%
1	Sorghum stover	5.0	5.4	16.8	46.2	61.3	—
2	Soybean straw	3.0-5.0	4.9	14.1	41.1	47.1	16%
2	Fescue hay	3.0	6.6	14.8	39.7	57.7	36%
1	Orchardgrass hay	3.0	7.1	14.2	46.1	54.3	22%
1	Clover-grass hay	1.0	12.1	16.4	60.9	61.9	12%

Add NPN with high energy feeds such as corn silage or grains and mix thoroughly.

Balance rations ensuring all mineral requirements of the animal are met.

Add a maximum of 0.92-percent NPN in a concentrate or grain mix. This is equivalent to approximately 2 percent added urea.

Add a maximum of 0.23-percent NPN in corn silage. This is equivalent to approximately 0.5-percent added urea.

Make sure that no more than one-third of the total ration protein equivalent comes from NPN.

Add a maximum of 0.5 percent NPN in ration dry matter (total). This is approximately equal to 1.1 percent additional urea.

Add a maximum of 0.5 pounds urea per day or the equivalent from NPN per 1000 pounds body weight.

¹ These guidelines are for mature ruminants. Therefore, when feeding NPN to other classes of livestock, additional restrictions may be necessary.

What are other considerations?

There are suggestions that feeding NPN adversely affects reproductive performance by lowering conception rate. The majority of data, however, indicates that when fed properly, NPN feeding does not negatively affect reproductive performance. Ensuring proper rate of NPN addition to the diet and a balanced ration is fed can alleviate potential problems.

NPN and nitrate toxicity effects are not additive. Both compounds do contain nitrogen but the chemical reactions necessary to create a problem are vastly different making it a remote possibility that one compound could influence the toxicity of the other.

Conclusion

NPN compounds can be an economical alternative for purchased protein supplements without sacrificing the productivity and profitability of the ruminant animal being fed. You can reduce the risks and potential problems associated with NPN by following the feeding guidelines.



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