Using MUN to Reduce Nitrogen Emissions from Dairy Farms

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The old adage 'you can't manage what you can't measure' is especially true when it comes to managing nutrients on a dairy farm. Recent research has shown milk urea nitrogen (MUN), a common measurement used to monitor feed efficiency, can be used to enhance profits and help reduce nitrogen (N) emissions from dairy farms.

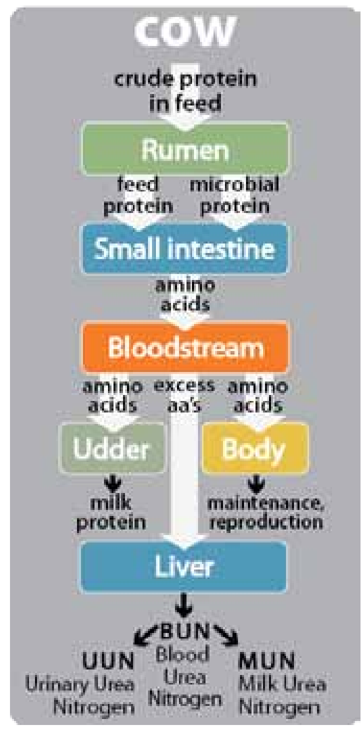
Dairy producers need to manage N for two main reasons: profitability and pollution abatement. As N use efficiency improves (cows using more of their feed protein to make milk, not manure), profitability improves. At the same time, there is a reduction in the amount of nitrogen being excreted and lost to the environment. These are desirable outcomes.

But cows utilize only 25-35% of the protein N that they consume; the unused N is excreted in urine and feces, mostly as urine urea nitrogen (UUN). Once it leaves the cow, UUN is transformed into different compounds, including ammonia (NH_3) and nitrous oxide (N_2O), the most potent greenhouse gas from agriculture. These N emissions are not desirable outcomes.

Researchers at the U.S. Dairy Forage Research Center have studied the fate of N on dairy farms from many angles – the protein in the forage plant itself, the protein nutritional requirement of dairy cows, how rumen microorganisms digest feed, changes in manure chemistry with varying diets, manure management in the barn and field, and measurements of N in the environment.

A specific interest has been the relationship between protein N in the diet, N excretion by dairy cows, and the fate of that N on the farm and in the environment. Research has found very predictable relationships between N inputs and outputs – such that MUN can be used to measure not only feed transformation into milk but also a farm's success at reducing N lost to the environment.

Figure 1. Protein, which contains 16% N, is broken down into amino acids. Excess protein N is converted to blood urea nitrogen (BUN) in the liver; this equilibrates rapidly throughout the body fluids, including milk (MUN) and urine (UUN). This equilibrium is why MUN can be used to accurately predict UUN (and subsequent N emissions).



As shown in Figure 1, crude protein meets three different fates when it enters the rumen. Some is digested by rumen microbes which produce more microbes; when these microbes pass out of the rumen they are digested and absorbed as an excellent source of protein which the cow uses to make milk, maintain her body, and produce a calf. Some of the crude protein 'escapes' the rumen and is used directly by the cow for the same purposes.

Excess protein (not used by the microbes or directly by the cow), after being digested and absorbed from the small intestine, travels to the liver where it is converted to blood urea nitrogen (BUN). Urea equilibrates rapidly throughout body fluids, including milk and urine, so concentrations of MUN and UUN reflect those of BUN. Since milk samples are much easier to obtain than blood or urine samples, MUN became the industry standard for measuring feed N use efficiency. MUN levels of ≤12 mg/dL (where 100mg/dL equals 0.10% weight/volume) reflect adequate dietary N for high-yielding cows.

A recent study had three objectives: 1) study the relationship between dietary crude protein, the secretion of urea in milk (MUN) and urine (UUN), and N emissions from dairy production systems; 2) evaluate how changes in dietary crude protein, MUN, and UUN affect atmospheric nitrogen emissions from dairy farms; and 3) discuss challenges and opportunities of using MUN to increase feed efficiency and decrease N emissions. MUN data from Wisconsin dairy herds were gathered by randomly extracting 37,889 test-day records from a 2-year period and 197 herds. Data from five nutrition trials with lactating cows in Wisconsin were also gathered which consisted of 18 dietary treatments comprised mostly of alfalfa silage, corn silage, corn grain, protein supplements, and other minor ingredients fed as total mixed rations to 203 mid-lactation cows. The data were entered into the Integrated Farm System Model and then analyzed for results.

1) Approximately half of Wisconsin's lactating dairy cows are likely fed dietary crude protein in excess of requirements (Table 1). This is more apt to happen on farms feeding the same ration to all cows and/or farms with more variability in feed quality and management.

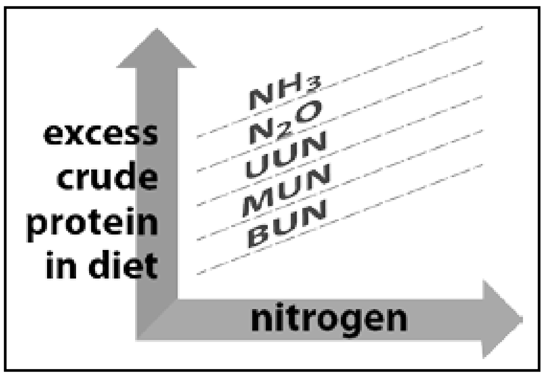
2) Highly significant positive relationships were determined between dietary N, MUN, UNN excretion, and state-wide N emissions. This implies an expanded use of MUN as a N management tool may not only enhance dietary N use efficiency and reduce milk production costs, but also reduce the negative impacts of N emissions.

3) Within the range of 16-10 mg/dL, each MUN reduction of 1 mg/dL leads to a UUN excretion decrease of 16.6 g/cow/day which, in turn, results in ammonia and nitrous oxide reductions of ~7-12%.

Table 1. Percent of cows at different levels of MUN; MUN levels of ≤12 reflect adequate dietary N for high-yielding cows.

MUN	% Cows	Implications
> 16	14	Excessive Dietary N
15-16	16	
13-14	23	
11-12	24	Adequate Dietary N
≤ 10	23	

Figure 2. As the amount of excess crude protein in the diet increases, the amount of N in the cow's body fluids (BUN, MUN, UUN) increases proportionately. And when UUN is excreted in urine, it is proportionately transformed to ammonia and nitrous oxide. Therefore, using one measure of N on the inside (MUN) correlates to what is happening on the outside (gas emissions).



If the dairy industry developed MUN as a multi-purpose N management tool, it could offer a relatively straightforward and practical way to move the industry in a positive, cost-effective direction toward abatement of ammonia and nitrous oxide emissions.