Fact sheet
U.S. Dairy Forage Research Center
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In addition to measuring nitrogen use efficiency ,

MUN can track ammonia emissions on dairy farms

MUN (milk urea nitrogen) is used as a measure of feed protein efficiency on dairy farms. New research shows that it can also be used to measure the extent of ammonia emissions that escape into the environment from dairy production facilities. Reductions in MUN show a proportional reduction in ammonia emissions. This is one more illustration of how management geared to improve dairy farm profitability can also lessen a farm's environmental impact.

The MUN test was developed as a tool to help fine-tune rations and monitor feed nitrogen use efficiency (the proportion of feed nitrogen that is secreted as milk nitrogen). Whether dairy cows consume protein from home-grown feeds or purchased protein supplements, there's a financial cost. So dairy producers strive to balance cost-effective rations that maximize the amount of protein that the cow uses to make milk, not manure. As dietary crude protein increases and nitrogen intake exceeds the cow's requirement, feed nitrogen use efficiency declines and the excretion of urinary nitrogen increases without gains in milk production or milk protein secretion.

The environment . . .

Feed nitrogen use efficiency is also important from an environmental standpoint. Since protein contains about 16 percent nitrogen, and only 20 to 35 percent of the total feed nitrogen consumed by lactating cows on commercial dairy farms is secreted as milk protein, that means plenty of nitrogen is being excreted in feces and urine. Manure nitrogen, especially that contained in urine, has the potential to enter the environment via ammonia volatilization or nitrate leaching.

As shown in Figure 1, feed 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're 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). High BUN concentrations have long been known as an indicator of inefficient utilization of dietary crude protein by dairy cows. Urea equilibrates rapidly throughout body fluids, including milk and urine, so concentrations of MUN and urinary urea nitrogen (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 nitrogen use efficiency.

Past research has shown that MUN levels between 10 and 14 (mg urea nitrogen per 100 ml milk) indicate optimum feed nitrogen use efficiency. Numbers higher than 14 indicate that the cow is likely to be wasting protein nitrogen by excreting it in urine. Numbers below 10 indicate that the cow may not be getting enough protein to meet her dietary needs for optimal milk production.

Converts to ammonia . . .

So how does ammonia fit into this picture? Dairy cows excrete urea nitrogen in the urine, and this is easily converted to ammonia gas and lost – in the barns, from manure storage areas, and in the fields when manure is land applied. Over the

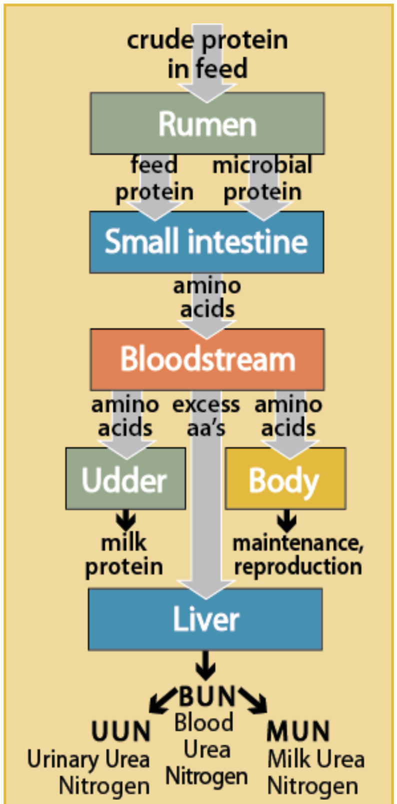

Figure 1: Fate of feed protein. Protein, which contains 16% nitrogen, is broken down into amino acids. Excess protein nitrogen is converted to blood urea nitrogen (BUN) in the liver; this equilibrates rapidly throughout body fluids, including milk (MUN) and urine (UUN).

past decade, in response to concerns related to the impact of ammonia emissions on human health and the environment, much information has been published on the positive relationships between dietary crude protein concentration, MUN, urinary nitrogen, and UUN.

However, very few data were available on the direct relationships between MUN and ammonia emission. So researchers designed a study to determine that relationship with the goal of using MUN in policy development and as a tool to create awareness and incentives that will lead to beneficial feeding practices and the reduction of ammonia emissions. The study was conducted in part to assist the Wisconsin Department of Natural Resources to develop "beneficial management practices for mitigating undesirable air emissions from animal waste in Wisconsin."

In the study, the researchers analyzed the results of five previous feeding trials that took place in three climatically different locations (Wisconsin, California and The Netherlands) and that represented different feed management and housing practices. The total amount of ammonia emitted in the various trials differed greatly (Figure 2). But the percentage drop in ammonia emissions when MUN went from 14 to 12 to 10 (mg urea nitrogen per 100 ml milk) was nearly identical (Figure 2, Table 1).

This is important for two reasons. First, it shows that reductions in MUN can also be used as an indicator of reductions in ammonia emissions. Second, it shows that, regardless of the actual amount of ammonia emitted and/or the method used to measure this (which is hotly debated among scientists and likely the major resason for great differences in ammonia emissions in Figure 2), the relative reduction in ammonia emissions is very similar in each dairy system.

Table 1: Percent reduction in ammonia from baseline MUN of 14.

Study	MUN	% reduction in ammonia
Freestall study #1	14	0
	12	10.5
	10	21.1
Stanchion study #1	14	0
	12	10.3
	10	20.9
Freestall study #2	14	0
	12	16.6
	10	33.7
Stanchion study #2	14	0
	12	14.4
	10	28.2
Stanchion study #3	14	0
	12	12.8
	10	25.6

In summary . . .

The positive relationships between dietary crude protein, MUN, UUN and ammonia emissions are scientifically sound. The relative ammonia emission reductions associated with declines in MUN may offer practical, straightforward approaches for creating new awareness that would motivate change (improved feeding practices) toward desired outcomes (increased profitability and reduced ammonia emissions). Eventually, the dairy industry may be willing to adopt an incentive structure whereby premiums are offered to dairy producers for milk shipped within the desired range of MUN values. This would be a relatively simple way to move the industry in a positive cost-effective direction toward abatement of ammonia emissions and environmental enhancement. ❑

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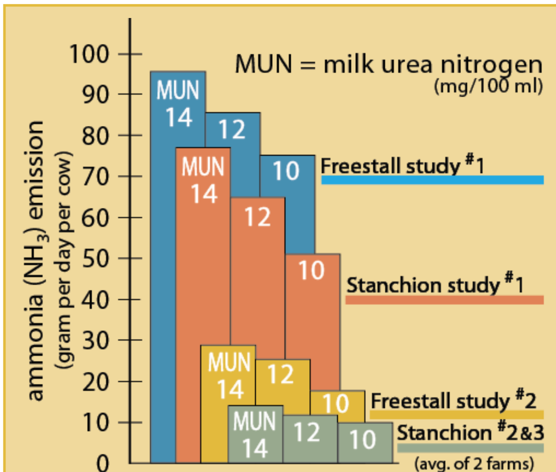

Figure 2: Relationship between MUN, ammonia emissions, and the relative reduction in ammonia emissions from dairy barns as MUN drops from 14 to 10. The same ammonia measuring technique was not used at all locations which is one reason the totals vary greatly; but the percentage reductions are very similar.

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