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Science and Industry Work to Improve Nitrogen Management on New York Dairy Farms

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Nitrogen (N) is a key nutrient for dairy cattle and is the building block of amino acids and proteins in animals and plants. Nitrogen in feed is either used to support milk and milk protein production or it is excreted via urine and feces. Crude protein (CP) is the term commonly used to describe the N content of feeds and rations and is calculated as N content * 6.25 (e.g., a forage with 2.88% N contains 18% CP). Nitrogen is also important for soil nutrient cycling, crop growth, and the environment. Excess N excreted by the cow is a concern for both air (ammonia) and water quality. In addition, excreted manure N contributes to greenhouse gas emissions by contributing to the production of nitrous oxide, a potent greenhouse gas. The goal of feeding dairy cows is to provide adequate N to support maintenance, growth, reproduction, and milk production while minimizing excretion of N to the environment.

How Much CP is Fed to Dairy Cows?

A 1998 survey of the 6 highest producing Wisconsin Holstein herds reported an average ration CP of 19.4% and the average milk production was 31,179 pounds of milk per cow. Surveys in other states in the early 2000's reported similar ration CP levels of 18.2 to 19.1% CP. A decade later, a 2010 survey of the top 5 Holstein herds in Wisconsin reported an average ration CP of 16.8% with a higher average annual milk production of 34,246 pounds per cow. A 2019 report of 79 high producing herds in multiple states found an average ration CP of 16.7%. Similarly, Cumberland Valley Analytical Services reported and average ration CP of 16.6% from 479 samples of total mixed rations formulated for groups of high-production cows in 2018 and 2019. The average ration CP for total mixed ration samples from all cow groups was 15.6%. Other recent surveys have reported ration CP levels ranging from 15.8 to 16.8 %. Thus, the evidence points to a decrease in ration CP levels in the last 20 years in commercial dairy herds.

The 2001 Nutrient Requirements of Dairy Cattle published by the National Research Council (NRC) recommended using metabolizable protein (MP) to formulate and evaluate rations rather than CP. The NRC committee reported that CP only accounted for 29% of the variation in milk production in published research trials. Metabolizable protein is the protein available to the animal and includes microbial protein synthesized in the rumen and rumen undegradable feed protein. The Cornell Net Carbohydrate and Protein System (CNCPS) has used the MP concept for ration formulation and evaluation since it was developed starting in the early 1980's. The

CNCPS model is now used in several commercial ration formulation programs in both the U.S. and many foreign countries. To increase milk production and feed efficiency, the Northeast feed industry has adopted the MP concept for formulating dairy rations which led to use of diets with lower CP content.

What are the Impacts of Feeding Less CP?

To evaluate this, we compared changes in the New York dairy industry between 1999 and 2019. We used ration CP levels of 18.5% for 1999 and 16.5% for 2019 and key outcomes are illustrated in Figure 1.

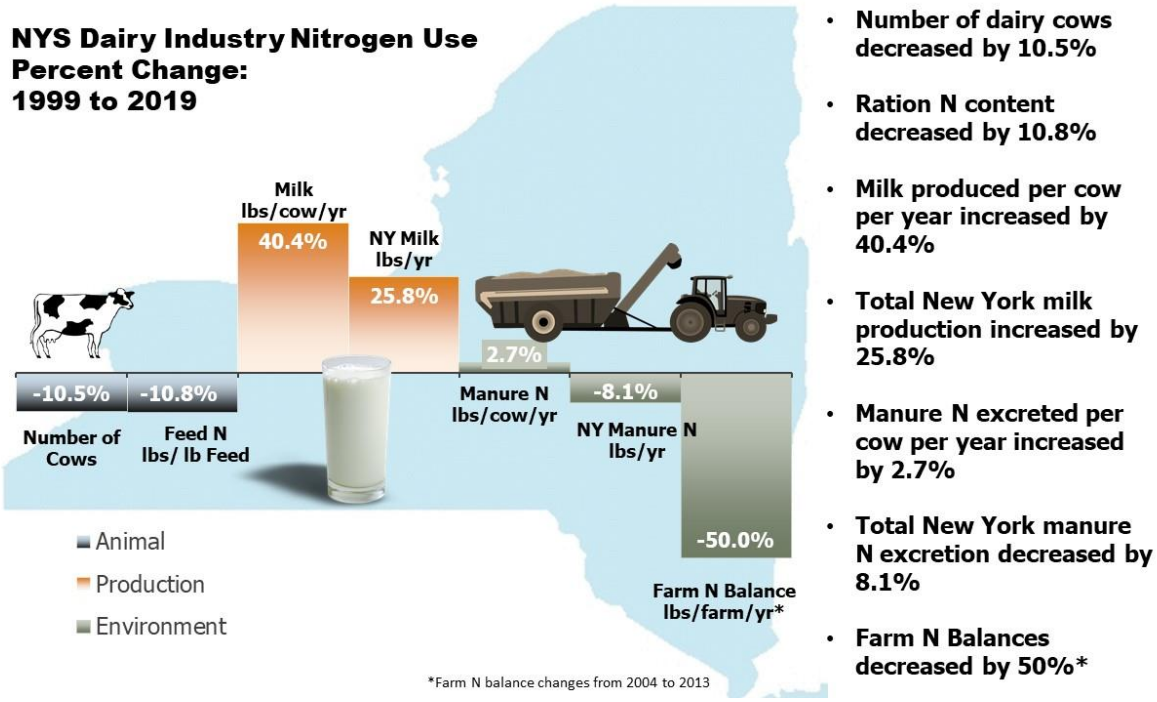

Figure 1. Key changes in the New York dairy industry Nitrogen Use from 1999 to 2019.

The whole farm nutrient balance is the difference between the amount of a nutrient imported onto the farm minus the amount of the nutrient exported from the farm. Dr. Quirine Ketterings and her group at Cornell have been doing whole farm mass balance studies on New York farms for many years. A study of 27 dairy farms from 2003 to 2013 reported a decrease in N mass balance on 70% of the farms. The decrease in N from purchased feeds was a key reason for this change. A second study used 91 dairy farms in the Upper Susquehanna watershed between 2004 to 2013. These farms lowered N mass balance by 50% per hectare not accounting for nitrogen fixation. Imported N decreased by 30% and reduction of feed N imports accounted for 70% of the total reduction in N mass balance.

Can We Decrease Ration Protein Further to Increase Environmental Benefits?

The simple answer is yes. In the survey of the 79 high producing herds, there were 28 herds with a ration CP content of <16.7%. The average for these herds was 16% CP with the lowest observed CP around 14%. Based on current estimates of MP requirements, many of these herds were feeding 105% or more of the estimated requirement to reduce the risk of not meeting the protein needs. This points to the potential for further reductions. The keys to reducing the amount of protein and nitrogen in dairy cattle diets are to improve consistency in daily feed management, reduce variability in forage and feed nutrient composition, and increase knowledge and application of methods to balance protein requirements based on amino acids rather than total MP. Achieving these three objectives will reduce the risk of under feeding protein and improve the ability of dairy ration formulation to meet but not exceed dairy cow protein requirements.

Summary

1. The dairy and feed industry have reduced the crude protein (CP) content of dairy rations which benefits dairy producers by lowering purchased feed N costs and the environment by decreasing N excretion in manure.
2. New York dairy farms have decreased ration CP levels by 10.8% and total manure N excretion by 8.1%.
3. The resulting decrease in total manure N excretion to the environment is 18.6 million pounds per year.
4. The feed industry was the primary driver of decreased ration CP levels through adoption and implementation new methods to balance dairy rations for metabolizable protein (MP).
5. Ration formulation programs are evolving from use of total MP to amino acids as the base for formulating rations. This will provide an opportunity to further lower ration CP, improve the efficiency of N use and decrease N excretion to the environment.

Conclusion

These results are an excellent example of how the dairy industry have adjusted feeding management practices to increase productivity and decrease excretion of N into the environment. The dairy and feed industries will continue to explore opportunities to adjust rations and feeding management practices to lower environmental impact while improving efficiency of nutrient use, productivity, and profitability.

For More Information

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