NITROGEN CYCING ON WISCONSIN DAIRY FARMS

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Improving nitrogen (N) use on dairy farms provides both economic and environmental benefits. The goal is to have more N recycled on the farm (from crops to cows to manure used as fertilizer), which results in fewer N inputs purchased and brought onto the farm and less N lost to the environment. But because N cycles through the whole farm system, positive changes in one part of the N cycle might create negative tradeoffs in another part of the N cycle. Two emerging dairy industry trends are used to elaborate the complexity of N use and N loss from dairy production systems (1) feeding less protein to reduce both feed costs and emissions of ammonia and nitrous oxide (the most potent agricultural greenhouse gas) from the farm, and (2) feeding more corns silage and less alfalfa silage to feed more cows and reduce feed costs.

Nutrition trials coupled with in-barn, laboratory and field experiments revealed that feeding less crude protein (to approximately 16% of dietary dry matter intake) to lactating cows has no effect on milk production or quality but this practice reduces urinary N excretion and ammonia loss from dairy barns and soils. Although this strategy enhances profits through reduced feed costs, it appears to also decrease the crop-available N after manure application to soil, requiring more fertilizer N.

The whole-farm scale Integrated Farm System Model (IFSM) was used to evaluate how feeding more corn silage (CS) and less alfalfa silage (AS) may impact N use and N loss on a typical Wisconsin dairy farm. In the model, crop and animal production, and N use and N loss are simulated daily over 25 years of weather. The quantity and N content of milk, meat and manure are a function of the feeds consumed and herd characteristics. Nitrogen flows are tracked through the farm to predict N losses. IFSM simulations revealed that growing and feeding more CS and less AS to dairy cows reduces the land requirement for feed production by 27% (feeds more cows); maintains milk production per cow; increases herd N use efficiency from 20 to 25%; decreases manure N excretion per unit milk by 22%; increases nitrate and nitrous oxide loss from the farm; and requires additional fertilizer N to offset soil N immobilization after land application of manure from cows fed high levels of CS.

Alfalfa for silage (AS), corn for silage (CS), corn grain (CG), and soybeans (later made into soybean meal SBM) were enriched in the field with the stable isotope ^{15}N to track how much of each component's N is secreted in milk, excreted in manure, and after application to soil, recycled back into the feed supply. Relative more of the N contained in the concentrates CG and SBM was secreted as milk N (about 32%), than the N contained in the forages AS and CS (about 18%). Approximately 32, 24, 22, and 16% of the ^{15}N

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contained in CG, SBM, CS, and AS respectively was retained by the cows. The differences in ^{15}N recoveries and retention seem to warrant new investigations into how the concentrates, especially CG, may be fed differently (rather than their single daily offer in the TMR) to more effectively synchronize dietary N supply with cow N demands. This could maximize N secretions in milk and minimize N excretions in manure. There were distinct differences in how much of each diet component's manure N was recycled back into the feed supply. Approximately 38, 35, 33, and 30% of applied manure ^{15}N derived from SBM, CG, AS and CS was incorporated into corn for silage. Study results seem to bolster other findings that feeding more CS and CG require more fertilizer N and increase N loss per unit land area and milk produced. The long term environmental impacts associated with land use changes to grow different diet components will likely be more important than short-term impacts of dietary components on cow N use and manure N recycling through crops. A balance between corn, alfalfa and soybeans in dairy cropping system would be needed to not only enhance overall N use efficiency and reduce N loss, but also to capture many of the benefits of corn-legume rotations.

Further Reading

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