



NITROGEN BUDGETS FOR YOUR DAIRY

Allen Young
Dairy Extension Specialist
Utah State University, Logan, Utah

September 2002

AG/Dairy-02

A major issue in animal agriculture is waste management. Legislation now requires a Comprehensive Nutrient Management Plan (CNMP) for many producers. For most people that translates into a bigger, better manure storage system. However, it is important to stop and consider the goal of this legislation. USDA and EPA have stated that the goal of the Unified National Strategy for Animal Feeding Operations is, "to take actions to minimize water pollution from confinement facilities and land application of manure." Pollution comes from an excess of nutrients, in this case nitrogen, that leaves your farm. This could be either through contamination of water or air (odor). Therefore, it is important to know the nitrogen balance on your farm and to use this information to identify areas that could lower excess nitrogen loss that might cause pollution. Each farm is unique, but it is helpful to look at whole-farm nitrogen balances from other farms in order to have a reference from which to compare your farm.

WHOLE-FARM NITROGEN BALANCES IN UTAH AND IDAHO

We recently collected information and developed whole-farm nitrogen balances for 41 dairy farms in Utah and Idaho. The average number of cows per farm was 466 and ranged from 57 to 1960. Average milk production was 22,805 pounds. About half of the farms grew some amount of crops on-farm that were fed to their cows, while the other half grew nothing. This difference changed some of the analyses so these two groups of farms were evaluated separately. The effects of feed efficiency, manure storage management, and crop utilization of nitrogen were also evaluated. It should be noted that the values given represent an average for a herd that has 466 cows. The magnitude of the values for each of these areas is very much farm dependent; especially herd size dependent. For example, a 1000 cow dairy will import more feed than a 100 cow dairy assuming neither grows their own crops for feed. We also recommend that balances be adjusted to a per cow basis before comparison with other herds.

In developing a whole-farm budget you need to know all sources of nitrogen that come onto the farm and those where nitrogen leaves. For those farms that grew some feed crops, the two primary forms in which nitrogen entered the farm were feed (overall average was 57.5% of total inputs; $CP \% \text{ of feed} / 6.25 = \text{nitrogen } \%$) and nitrogen fertilizer (overall average = 11.5%). Nitrogen also came onto the farm in the form of bedding and animals, although these are minor, comparatively speaking. Another source that is often overlooked is nitrogen fixation by crops. Almost 30% of the nitrogen inputs for these farms was from nitrogen fixation by alfalfa. On the output side, the primary way nitrogen left the farm was through milk and meat (combined = 80% of output). The latter is through cull animals, including calves. Crops that were sold and exported manure are minor sources in this study.

Farms that did not grow any crops had simpler nitrogen balances. About 98% of all nitrogen came onto the farm in the form of feed. Nitrogen left the farm in animal products (milk and meat; 57%) and manure or compost (43%). Crops grown on a dairy are not figured in a whole-farm balance and therefore, the feed input will be lower for those farms that grew crops. Farms that do not grow crops export their manure either directly or as compost. This makes their whole farm balance look more efficient; however, that may be misleading because the manure has not disappeared and should show up as an input on someone else's farm.

WHAT DO I NEED TO FIGURE MY OWN WHOLE-FARM BALANCE?

The most important information needed to figure your own whole-farm balance is RECORDS. I cannot over-emphasize how important this is. This was a major stumbling block for many of the farmers in this study. To develop an annual balance, you will need the following records:

- a. Amounts and analysis of all purchased **and** sold feeds and bedding. Most farmers have some type of record of how much feed was purchased, but many do not know the crude protein percent ($CP\% / 6.25 = N\%$). Most concentrates have some type of analysis, but forages may not. If you don't have this information, have the feed analyzed by a laboratory of your choosing.
- b. The number and size of purchased and sold animals. This includes cull cows, calves, heifers, and bulls.
- c. Quantities and analysis of all purchased fertilizers.
- d. Total milk pounds sold and the milk protein %.
- e. Quantities and analysis of any manure or compost that left the farm.

Even though the farm balance can be calculated by hand, I would suggest finding a computer program that will do the calculations for you. This will save you a great deal of time, plus allow for "what-if" scenarios to evaluate ways to improve nitrogen balance. Accurate records are crucial if one wants to determine ways of improving nitrogen balance and comply with up-coming laws.

IMPROVING WHOLE-FARM NITROGEN BALANCE AND FEED NITROGEN UTILIZATION EFFICIENCY

Once you have developed a whole-farm nitrogen balance, you can start to consider methods that could be used to improve the balance (i.e., increase efficiencies so that less nitrogen is wasted). Based on the analysis of the data in this study, the MAJOR way to reduce nitrogen waste in manure is to increase the efficiency of conversion of feed nitrogen to milk and meat nitrogen. This will decrease the potential for nitrogen loss into the environment. Regardless of whether a farm does or does not grow crops, this was the major way to improve farm balance of nitrogen. Other research has shown similar results. Restated, farms that trapped more feed nitrogen in milk and meat resulted in less nitrogen loss in manure. This lowered the chance for polluting the environment with waste nitrogen.

Improving feed nitrogen utilization efficiency was related to several aspects of the dairy operation that give suggestions for how a producer could improve whole-farm nitrogen balance:

a) Feeding according to production. Herd nitrogen efficiency of feed conversion into product appeared to be less variable between herds and was about 4% higher for dairies with over 500 milk cows. This may be because larger dairies are better able to group animals based on production and therefore decrease over-feeding of protein. Several researchers have shown that grouping animals according to stage of lactation, and feeding a balanced ration based on production will help improve the overall feed nitrogen utilization efficiency for the herd.

Nutrients such as nitrogen are delivered to cows in quantities closer to their requirements and not nitrogen is not wasted by feeding in amounts that grossly exceed the cow's requirement. Smaller dairies may not have the grouping capabilities because of space considerations and low numbers of cows per group. It is easier to overfeed protein in this situation.

b) Accurate and complete records. It appeared that larger herds keep more complete records than smaller herds. Accurate records are essential for correctly monitoring and increasing the efficiency of your farm. Without accurate and complete records, the required CNMP will also be limited and less accurate.

c) Higher per cow production. Higher feed nitrogen efficiencies were related positively with milk production (i.e., increased feed efficiency was related with increased milk per cow). As more dairies have milk production per cow approaching 30,000 pounds, continued improvement may depend on improvement of nitrogen utilization efficiency.

d) Properly balanced ration. Because the cow is a biological system, 100% utilization efficiency is probably impossible. Some protein nitrogen will always go to things other than milk and meat production and may be wasted. The goal is to maximize protein utilization by making sure that total protein is not overfed, too much non-protein nitrogen is not used, and rumen degradable and undegradable protein (by-pass) is balanced. Ration carbohydrate to protein ratios and degradable and undegradable carbohydrates should also be balanced. Improved herd nitrogen utilization efficiency can help economically and environmentally. Feeding excess protein that is not used by the cow costs money in a higher costing ration. Excess protein increased the amount of nitrogen excreted by the cow and thereby increases the amount of protein available to cause an environmental problem. A regular milk urea nitrogen (MUN) test can be helpful in monitoring these ration problems.

OTHER WAYS TO IMPROVE NITROGEN BALANCE

For farms that grew feed crops, whole-farm nitrogen balance and efficiency can be categorized into three subsystems: the cows (as measured by herd nitrogen utilization efficiency), manure storage efficiency and crop management. The data from this study was modeled to determine the relative influence of the three subsystems on whole-farm nitrogen balance. Of the three subsystems, herd nitrogen utilization efficiency accounted for 50% of the variation in whole-farm nitrogen balance. The next most important component was crop management, which involves things such as crop selection and nitrogen application methods that are most appropriate to the type of production. Other studies have found that most producers do not give credit for any manure nitrogen that is applied to crops and of those who do, only 3% are within 10% of actual nitrogen values of the manure. Management practices that maximize the crop utilization of manure nitrogen can decrease the cost of purchased fertilizer plus decrease the environmental risk on your farm.

The least effective subsystem was manure storage management. It is interesting to note that we were unable to show an advantage of any type of manure storage system in improving whole-farm nitrogen balance. Other researchers have found similar results, which if true, suggests that in order to reduce the potential environmental effects of nitrogen we should be focusing on improving feed nitrogen efficiency rather than manure storage efficiency.

SUMMARY

What are the "take-home" messages from this study?

1. Records, records, records. Without accurate records for your farm, you will be forced to apply assumptions from all farms to your farm when you create a CNMP or comply with any regulations. Accurate records are the first step in making any improvement to your operation and will become necessary if you should ever have compliance problems.
2. Improve your herd nitrogen utilization efficiency. Sit down with your nutritionist and

develop a feeding strategy that will allow your cows to produce the most amount of milk with the least amount of protein or best balance of protein that will optimize your herd's nitrogen utilization efficiency. If nitrogen leaving the cow is reduced, all nitrogen components further "down stream" will also be reduced.

When trying to comply with environmental legislation it is important to remember that the goal is to lower the risk of water and air pollution from animal agriculture. Improved feed efficiency will also decrease volatilized nitrogen, a major source of odor problems, and an area where regulations are currently being enacted in parts of the county. Knowing your whole-farm nitrogen balance can help you decrease the amount of excess nitrogen on your farm, a management practice that will benefit not only the environment, but also your pocket book.

Utah State University is committed to providing an environment free from harassment and other forms of illegal discrimination based on race, color, religion, sex, national origin, age (40 and older), disability, and veteran's status. USU's policy also prohibits discrimination on the basis of sexual orientation in employment and academic related practices and decisions.

Utah State University employees and students cannot, because of race, color, religion, sex, national origin, age, disability, or veteran's status, refuse to hire; discharge; promote; demote; terminate; discriminate in compensation; or discriminate regarding terms, privileges, or conditions of employment, against any person otherwise qualified. Employees and students also cannot discriminate in the classroom, residence halls, or in on/off campus, USU-sponsored events and activities.

This publication is issued in furtherance of Cooperative Extension work. Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Jack M. Payne, Vice President and Director, Cooperative Extension Service, Utah State University. (EP/09-02/DF)