2002

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Utah State University Extension electronic publishing

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September 2002 AG/Dairy-03

Excess phosphorus from agricultural sources has become a major environmental concern because of its effects on surface waters. Phosphorus is different from nitrogen because it does not volatilize (change into a gas and become airborne). Phosphorus becomes a problem when it ends up in water supplies either through runoff from the dairy or from land application of manure. If phosphorus gets into surface water, it will cause algae to grow. This causes a "bloom" which leads to oxygen depletion in the water and can destroy whole ecosystems. Due to this problem, EPA has enacted legislation to control phosphorus leaving farms. Because it does not change from a solid to a gas, it would appear that phosphorus should be easier to control than nitrogen, but animal agriculture will be faced with challenges in trying to implement these environmental policies. Therefore, it is important to know the phosphorus balance on your farm and use it to identify areas that could lower excess phosphorus that might cause pollution. Each farm is unique, but is helpful to look at whole-farm phosphorus balances from other farms in order to have a reference from which to compare your farm.

WHOLE-FARM PHOSPHORUS BALANCES IN UTAH AND IDAHO

We recently collected information and developed whole-farm phosphorus balances for 41 dairies 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 while the other half grew nothing. This changes some of the analyses and these two groups of farms were evaluated separately. The effects of feed efficiency, manure storage management, and crop utilization of phosphorus 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. 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 phosphorus that come onto the farm and those where phosphorus leaves. For those herds that grew any crops, the two primary forms in which phosphorus entered the farm were feed (overall average was 66%) and fertilizer (overall average = 32%). Phosphorus also came onto the farm in the form of bedding and animals, although these were extremely minor. On the output side, the primary way phosphorus left the farm was through milk (primarily) and meat (combined = 77.6 % of output). The later is through cull animals, including calves. Crops that were sold (5.2%) and exported

manure (17.2%) made up the other sources.

For farms that did not grow any crops, 97% of all phosphorus came onto the farm in the form of feed. Phosphorus left the farm in animal products (milk and meat; 45.5%) or manure and compost (54.5%). 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.. However, information on feed grown on-farm is needed in order to determine how much phosphorus is needed by the crop and is related, indirectly, to the fertilizer usage. Farms that do not grow crops export their manure either directly or by 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 phosphorus level (P %). 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, bulls.
c. Quantities and analysis of all bought fertilizers.
d. Total milk pounds sold.
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. Accurate records are crucial if one wants to determine ways of improving nitrogen balance.

IMPROVING WHOLE-FARM PHOSPHORUS BALANCE AND FEED PHOSPHORUS UTILIZATION EFFICIENCY

Once you have developed a whole-farm phosphorus balance, you can start to look at things such as how to improve the balance (i.e., increase efficiencies so that less phosphorus is wasted). Based on the analysis of the data in this study, the MAJOR way to reduce phosphorus waste in manure, and hence decrease the potential for phosphorus loss into the environment, is to reduce dietary phosphorus.

Regardless of whether a farm does or does not grow crops, this is the major way to improve farm balance of phosphorus. Other research has shown similar results. Another way of saying it is that those farms that did the best job of decreasing feed phosphorus (including supplements), had the best balance.

Improving feed phosphorus utilization efficiency by decreasing phosphorus intake was related to several other aspects of the dairy that give suggestions for how a producer could improve whole-farm phosphorus balance.

a) Feeding according to production. Several researchers have shown that feeding a

balanced ration and grouping animals according to production will help decrease the need to over feed phosphorus. It has been shown in other studies that for every unit of phosphorus an animal is fed above what is required, a unit of phosphorus is excreted This says that all extra phosphorus fed to a cow is simply wasted. New standards suggest only 0.32 - 0.38 % phosphorus is needed in the diet of high producing cows. This is not a case where 'if some is good, more it better'; in fact, more is worse. It is worse because it then becomes an environmental liability and an added expense.

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

c) Higher feed phosphorus utilization efficiencies were related positively with milk production (i.e., increased feed efficiency was related with increased milk per cow). Another study has shown that the most economically efficient way to decrease excess phosphorus is to increase milk production per cow rather than increase production by increasing cow numbers. As more dairies have production per cow approaching 30,000 pounds, continued improvement may depend on improvement of phosphorus utilization efficiency.

d) Another factor related to whole-farm phosphorus balance was phosphorus available to the crops. Many producers apply manure to crops, but do not give credit for the amount of phosphorus in the manure. They buy fertilizer as if no other phosphorus were being applied. By simply acknowledging the amount of phosphorus in manure, the fertilizer bill and excess amount of phosphorus could both be lowered.

Because the cow is a biological system, 100% utilization efficiency is probably impossible. Some phosphorus will always go to things other than milk and meat production and may be wasted. The goal is to maximize phosphorus utilization without overfeeding phosphorus. Improved herd phosphorus utilization efficiency can help economically and environmentally. Feeding excess phosphorus that is not used by the cow costs money in a higher costing ration. Excess phosphorus increases the amount of phosphorus excreted by the cow and thereby increases the amount of phosphorus available for environmental problems.

MANURE PHOSPHORUS STORAGE EFFICIENCY

On farms where no crops were grown, manure phosphorus storage efficiency (how much phosphorus left the storage system as compared to how much went in) was of major importance in explaining the difference in whole-farm phosphorus balance. This is not surprising because most of the manure on these farms was exported off the farm, greatly lowering the whole-farm phosphorus balance. This should not be seen as a 'quick-fix' because the phosphorus is going to another farm and has not disappeared. Here again the best solution would be to decrease the amount of feed phosphorus so that the amount of phosphorus going into the manure storage system would be reduced. It also suggests that care must be taken not to let little streams of liquid leave the manure storage system. These run-offs are the major route that phosphorus could leave the farm.

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 phosphorus utilization efficiency by decreasing the amount of phosphorus in the feed or supplement. 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 phosphorus. If phosphorus leaving the cow is reduced, all phosphorus components "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 pollution from animal agriculture. Decreased feed phosphorus has the potential to decrease the amount of phosphorus available to contaminate surface and ground water. Knowing your whole-farm phosphorus balance can help you decrease the amount of excess phosphorus on your farm with the benefit of improving the environment and also your pocket book.

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)