Whole-farm modeled phosphorus loss low on grazing dairy farms

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Surface water pollution from plant nutrients such as phosphorus can degrade water quality for drinking, recreation and industry. When excess nutrients accumulate in lakes and reservoirs, water quality issues such as algal blooms often result. Because agriculture is a major nonpoint phosphorus pollution source, there is strong interest in identifying and managing farm sources of phosphorus runoff. On dairy farms, possible sources of this runoff include cropland, grazed pastures, and outside cattle holding areas such as barnyards and overwintering lots. In the United States, research on phosphorus loss due to runoff from grazed pastures has been limited. A new study based on modeled data for four dairy farms that use managed grazing found that these farms have very low phosphorus losses on a whole farm basis.

Background

Physically monitoring phosphorus loss from farms is an expensive, lengthy process. Simulation models are potentially a more rapid, cost-effective way to estimate phosphorus loss from farms. Agriculture Research Service soil scientist Peter Vadas, who works at the U.S. Dairy Forage Research Center in Madison, worked with a team of USDA scientists to develop the Annual Phosphorus Loss Estimator (APLE) spreadsheet, which predicts the phosphorus lost through runoff for diverse types of farms and field conditions. APLE is free to download at ars.usda.gov/Services/docs.htm?docid=21763.

Building on this work, Vadas, along with Mark Powell and Geoff Brink from the Dairy Forage Research Center and Dennis Busch from UW-Platteville, used APLE to predict phosphorus runoff from grazing farms. This research took place from 2010-2012 at the UW-Platteville Pioneer Farm and four Wisconsin grazing farms; it was funded by the USDA-NRCS Grazing Lands Conservation Initiative (GLCI). The researchers monitored phosphorus loss due to runoff from beef and dairy grazed pastures at the Pioneer Farm. They used this data to validate that APLE can reliably predict phosphorus loss from grazed pastures. They then used APLE to simulate phosphorus loss from the four farms for the purpose of testing the model on a whole-farm basis. The focus of this brief is on the modeling results from these farms.

The researchers visited each farm three times in January, June and November 2011 to gather seasonal information about farm management. Questionnaires completed by each farm provided snapshot assessments of cattle, feed, fertilizer, manure and cropping management. Using this information, the researchers modeled year-round, whole-farm phosphorus losses under typical management for each farm.

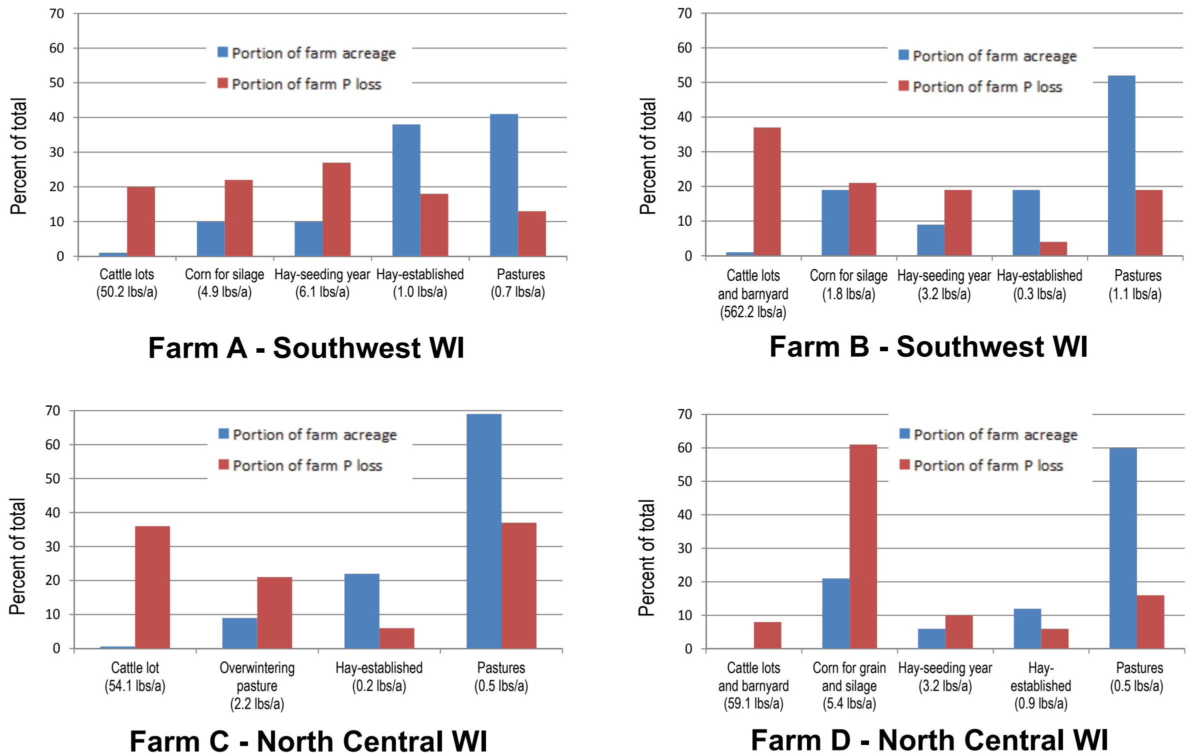
The four study farms

Farm A, located in southwestern Wisconsin, has an annual average of 40 milking cows, 20 heifers and one or two dry cows. This farm has about 100 acres of cropland in a six-year rotation, with one year of corn silage (20 acres), and one year of an oats/grass/alfalfa seeding mix followed by four years of an alfalfa/grass hay mix (80 acres). The farm has 44 acres of pastures rotated for milking cows and 28 acres of non-rotated pastures for dry cows and heifers; the hay ground is also grazed. There are two outdoor lots totaling 1.5 acres used for overwintering cows. Soils are mostly silt loams, with some fairly steep slopes. There is no manure storage on this farm.

Farm B, also in southwestern Wisconsin, has an annual average of 118 milking cows, 92 heifers, 23 dry cows and 20 beef steers. The farm rents 200 acres of cropland under no-till management with a five-year rotation: two years of corn silage (80 acres), and one year of an oats/grass/alfalfa seeding mix, followed by two years of an alfalfa/grass hay mix (120 acres). The home farm has about 120 acres of rotated pasture for lactating cows, and 100 acres of non-rotated pasture are rented locally for dry cows, heifers and steers. There is one quarter-acre barnyard, and 2.5 acres of lots on the home farm are used for overwintering and housing young stock year-round. Soils are mostly silt loams, often on steeper slopes. There is a small pit on the home farm that stores manure from the parlor, barn and half of the barnyard.

Farm C in north central Wisconsin has an annual average of 164 lactating cows, 130 heifers and 17 dry cows. There are 226 acres of pasture at the home farm, and the farm locally rents 70 acres of grass hay ground. A two-acre dry lot next to the barn is used for freshening cows and, infrequently, for milking cows in the winter. Milking cows are in the barn, barnyard and dry lot from December 1 to February 1. As they dry off, they are moved to overwintering areas until April 1. These overwintering areas are several-acre portions of pasture, with a different area used each winter. From April 1 to December 1, milk cows graze pastures with some time spent in the barn on hot days. Soils are silt loams with mild slopes. There is a pit on the home farm that stores manure from the parlor, barn and barnyard.

Percent of acreage and APLE-simulated phosphorus loss by farm use area on four Wisconsin grazing farms (P loss per acre in parentheses)



The bars representing pastures in each graph include both rotated and non-rotated pastures.

Farm D, also in north central Wisconsin, annually averages 60 milking cows, 46 heifers, 21 calves and nine dry cows. It has 110 acres of cropland in a six-year rotation, with three years of corn (30 acres in corn silage and 30 acres in grain), and one year of an alfalfa/grass seeding mix followed by two years of an alfalfa/grass hay mix (50 acres). The farm has 70 acres of rotated pasture for lactating cows and 30 acres of non-rotated pasture for dry cows, heifers and calves. The heifers also graze about 70 acres of woods near the crop ground. There is one 0.2-acre barnyard and one half-acre dry lot for cows and heifers. Soils are silt loams with mild slopes. Manure from the parlor and barn is stored in a pit.

Findings from the simulations

Whole-farm phosphorus loss per unit of land on the grazing farms was low, ranging from 1.2 to 2.4 lbs./acre. This compares favorably to the WI 590 Nutrient Management Standard where the risk of runoff phosphorus as determined by the Phosphorus Index must be at or below 6 lbs./acre in order to apply manure to a field. Phosphorus loss from grazed pastures was consistently very low. However, some land uses on these grazing farms have the potential for significant phosphorus loss. The graphs above show that cattle lots and barnyards, and overwintering pastures are a small portion of farm area (blue bars), but they contribute a significant portion of the total phosphorus loss (red bars). This is expected, since these areas can have high manure and animal densities. These areas represented seven to 37 percent of total farm phosphorus loss, depending on lot management and phosphorus loss from other farmland uses. Potential mitigation strategies for these areas include cleaning barnyards frequently and containing runoff in a storage area.

Corn fields and hay fields in a seeding year also have the potential for high phosphorus loss due to the increased risk of soil erosion and sediment loss. In general, the simulation results showed that the greatest variability in phosphorus loss was due to erosion. When erosion was low, total phosphorus loss was also low. No-till practices are a management option to reduce phosphorus loss due to erosion in cropland.

Vadas notes that, "Overall, the project demonstrates how simulation models can be reliably used to identify areas on dairy farms with the high potential for phosphorus loss, which in turn helps to target cost and environmentally effective management alternatives."

For more information or for the full study, contact:

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