MONITORING AND PREDICTING PHOSPHORUS LOSS FROM WISCONSIN DAIRY GRAZING FARMS

Peter Vadas and Mark Powell [1/]

Non-point source pollution of surface water by 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 has been identified as a source of non-point phosphorous pollution, there has been a strong push to identify and manage farm sources of phosphorus runoff. On dairy farms, possible sources of this runoff include cropland, grazed pastures and outside cattle holding areas such as feedlots, barnyards and overwintering lots. In the United States, research on phosphorous loss due to runoff from grazed pastures has been limited.

Physically monitoring phosphorous loss from farms is an expensive, lengthy process. Simulation models are potentially a more rapid, cost-effective way to estimate phosphorous 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 Phosphorous Loss Estimator (APLE) spreadsheet, which predicts the phosphorous lost through runoff for diverse types of farms and field conditions. APLE is free to download at http://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, monitored phosphorus loss in runoff from grazed pastures and 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, and was funded by the WI DATCP Grazing Lands Conservation Initiative (GLCI). The researchers monitored phosphorous 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 phosphorous loss from the four farms, all of which use managed grazing. 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.

[1/] USDA-ARS Dairy Forage Research Center, Madison, Wisconsin.

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.

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.

Details of APLE-simulated total P lost from four Wisconsin grazing dairy farms

Land use	Acres	Total P loss (lbs/acre)	% of farm area	% of Total Farm P Loss
		Farm A		
Corn silage	16.7	4.9	9.6	22.0
Hay, all*	83.5	2.0	48.1	44.8
Pastures	72	0.7	41.4	13.1
Cattle lots	1.5	50.2	0.9	20.1
Whole farm		2.4		
		Farm B		
Corn silage	80	1.8	18.8	21.2
Hay, all	120	1.3	28.2	23.4
Pasture, all	221.5	0.6	52.1	18.6
Cattle lots and barnyard	3.5	79.2	0.9	36.7
Whole farm		1.6		
		Farm C		
Hay, all	70	0.2	21.5	5.6
Pasture	226	0.5	69.3	37.3
Overwintering pasture	28	2.2	8.6	20.7
Cattle lot	2.0	54.1	0.6	36.4
Whole farm		1.2		
		Farm D		
Corn, all	60	5.4	21.4	60.9
Hay, all	50	1.7	17.9	15.7
Pastures	169	0.5	60.4	15.6
Cattle lots and barnyard	0.7	59.1	0.3	7.7
Whole farm		1.9		

*Runoff, erosion, and total P loss was always higher in the seed year of hay than in established hay fields

Findings from the Simulations

Whole-farm phosphorus loss per unit of land on the grazing farms was relatively low, ranging from 1.2 to 2.4 lbs./acre. This compares well to the WI 590 Nutrient Management Standard 590 where the risk of runoff phosphorus as determined by the Phosphorus Index must be at or below 6 lb/acre in order to apply manure to a field. Phosphorus loss from pastures was consistently very low. This demonstrates that these types of grazing farms as a whole may not represent significant sources of phosphorus loss to the environment.

However, some land uses on these grazing farms have the potential for significant phosphorous loss. While barnyards, dry lots and overwintering areas tend to be a small portion of each farm, phosphorus loss per unit of land area can be high. This is expected, since these areas can have high manure and animal densities. These areas represented seven to 57 percent of total farm phosphorus loss, depending on lot management and phosphorus loss from other farmland uses. Farm management options to decrease phosphorus loss in these areas include frequent cleaning of barnyards and containing runoff in a storage area. Corn fields and 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 phosphorous loss was due to erosion. When erosion was low, total phosphorous loss was also low. No till practices are a management option to reduce phosphorus loss due to erosion in cropland.

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.