Manure Management Impacts on Surface-Water Runoff at One Discovery Farm

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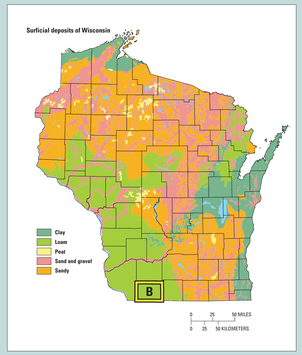
INTRODUCTION

The Discovery Farms program was created to determine the environmental impacts of the diverse farming systems that exist in Wisconsin. If negative impacts are identified, program staff work with the producer to see if the farming system can be modified to mitigate environmental impacts, while ensuring that the farming operation remains economically viable. Research information is also used to educate and to improve communications among the agricultural community, consumers, researchers, and policy-makers to better identify and implement effective environmental management practices that are based on real science and are compatible with profitable agriculture.



The U.S. Geological Survey (USGS), in cooperation with Discovery Farms, has installed 21 water-quality monitoring stations on 7 farms in various physiographic and hydrologic settings in Wisconsin. The study design allows for water-quality comparisons to be made both within-farm and between farms to help understand how each farming system affects water quality. Depending upon the hydrologic setting of the farm, monitoring stations can be located in grassed waterways, within streams, or in subsurface tiles. Sites will be monitored for five to seven years to allow two to three years of background data, and three to four years of data collection after management strategies are implemented.

Farm B

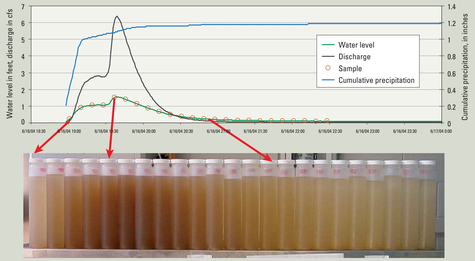
This poster will focus on the data from Farm B in LaFayette County (outlined in yellow above). Farm B is located in southwest Wisconsin and has been an established no-till/direct plant system in a corn/soybean rotation for over 15 years. This farm also finishes beef steers and was a participant in a state-funded watershed project that helped pay for the implementation of barnyard runoff-control devices and field terraces. The soils are classified as deep, well-drained silt loams, which are considered to be some of the most productive in the area. The manure management application is a combination of surface-applied bedding pack beef manure and liquid dairy manure from a nearby farm. There are 3 surface-water-monitoring sites located between three separate grassed waterways, and the contributing basins range in size between 17 and 39.5 acres.

HOW ARE WATER-QUALITY DATA COLLECTED?

This is a typical equipment installation for the surface-water monitoring stations.

All data are retrieved at least twice per day via communications devices, and all data are stored in the USGS National Water Information System (NWIS) database.

Constituent List	
Suspended sediment	Nitrate plus nitrite nitrogen
Total dissolved solids	Ammonium nitrogen
Total phosphorus	Total Kjeldahl nitrogen
Dissolved reactive phosphorus	Chloride

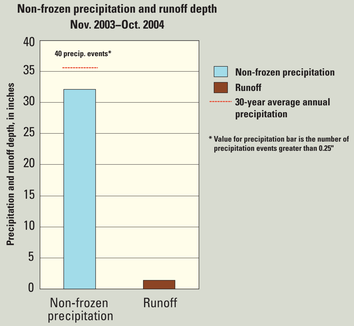


This is a hydrograph for a typical runoff event. The bottles in the photo are the actual samples collected during this runoff event.

An event loss or yield (in pounds/acre) is calculated by multiplying the constituent concentration by the event volume and dividing by the basin area.

AGRICULTURAL RUNOFF DATA

How much surface-water runoff was produced by these farm fields?

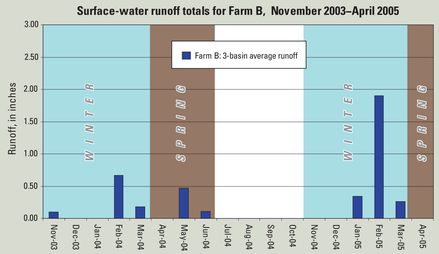


Precipitation highlights:

Below 30-year average annual precip: above average precip. in spring, below average precip. in summer/fall.

- Approximately 4 percent of the measured precipitation contributed to surface-water runoff

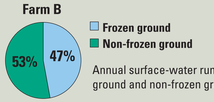
When did the surface-water runoff occur?



- All of the surface-water runoff occurred either when the ground was frozen, or when soils were wet and vegetative cover was minimal.

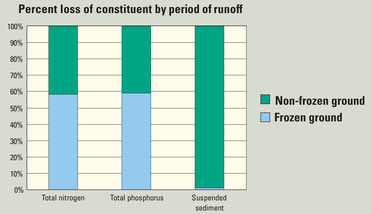
A majority of the annual nutrient losses occurred when the ground was frozen.

What does the frozen ground period contribute to the annual surface-water runoff?



Annual surface-water runoff, broken down into frozen ground and non-frozen ground periods.

- Approximately 50 percent of the first year of surface-water runoff occurred when the ground was frozen.



- Over half of the nutrients (total nitrogen and total phosphorus) were lost to surface-water runoff when the ground was frozen.
- A small percentage of the annual suspended sediment runoff occurred when the ground was frozen.

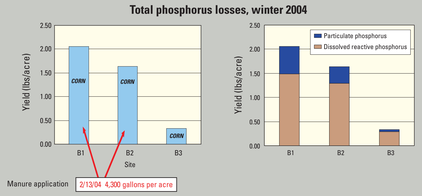
These two observations indicate that a majority of the nutrient losses during the first year were not associated with sediment loss. Why?

Manure management was an important factor.

MANURE MANAGEMENT IMPACTS

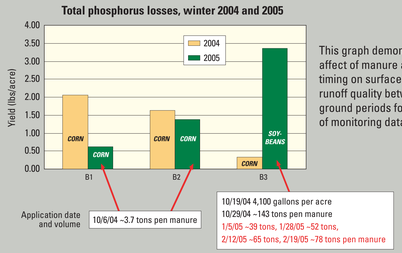
In Wisconsin, manure is applied in many different ways and at different times of the year depending on the management style of the producer. Manure is applied by surface spreading as well as by injection and incorporation into the soil. Some producers apply manure every day. Others, who have storage, wait until the crops are gone and the ground is firm enough to operate equipment on. In Wisconsin, these conditions typically occur in early spring or late in the fall and into the winter. Unfortunately, the periods during which producers in Wisconsin typically apply manure often coincide with some of the periods in which the potential for surface-water runoff is high. This creates a potential risk to water resources.

What is the affect of manure application timing to phosphorus losses?



- Liquid dairy manure was surface applied on February 13, 2004 in basins B1 and B2 at the rate of 4,300 gallons per acre.
- Management (other than manure application) in the basins was similar, highlighted by the same crop type in all three basins.
- The magnitude of total phosphorus losses in surface-water runoff during periods of frozen ground was greater at B1 and B2 than at B3—this is likely due to the manure application on February 13, 2004
- The ground on February 13, 2004 was frozen and snow covered—runoff began on February 18, 2004.
- Most of the total phosphorus lost during periods of frozen ground was in the dissolved form.

Basin B1 at the start of snowmelt, showing liquid manure on top of snow.



This graph demonstrates the affect of manure application timing on surface-water runoff quality between frozen ground periods for both years of monitoring data.

- Sites B1 and B2 showed a decrease in total phosphorus losses between frozen-ground periods for 2004 and 2005, while B3 showed an increase.
  - The decrease at B1 is likely due to *not* applying manure in February, 2005.
  - The increase at B3 is likely due to the January and February manure applications in 2005—most of the runoff occurred 2/3–2/14.
- Site B2 showed little change—this is likely due to a relative increase in the volume of runoff at B2 from 2004 to 2005 compared to B1.
- The manure applied in basin B3 in 2005 was beef pack manure, indicating that both liquid and solid manure applications can impact agricultural surface-water runoff quality.

Beef pack manure being applied.

SUMMARY OF FINDINGS

- **Approximately 50 percent of the first year of surface-water runoff occurred when the ground was frozen.**
- **Surface-water runoff occurred primarily in the late winter (February and March) and spring, when vegetative cover was minimal and soils were wet (April–June).**
- **The periods in which producers typically apply manure to fields in Wisconsin often coincide with the periods in which surface-water runoff is most likely, creating a potential risk to water resources.**
- **A small percentage of the annual suspended sediment losses occurred when the ground was frozen.**
- **Over half of the annual nutrient losses occurred when the ground was frozen.**
- **Nutrients lost to surface-water runoff in the frozen ground period were mostly in the dissolved form.**
- **Nutrient losses were not necessarily associated with sediment losses.**
- **Most of these nutrient losses were likely due to manure application on frozen, snow-covered ground, shortly preceding snowmelt.**
- **Both liquid (dairy) and solid (beef) manure applications resulted in nutrient losses to surface-water runoff.**

Liquid manure on snow.

- **Understanding the relationships between water quality and the timing, rates, and methods of manure application—particularly in the winter—is a big step toward understanding the impact of Wisconsin agriculture on the environment.**

Other contributors to the Discovery Farms program include:

Natural Resources Conservation Service
Wisconsin Department of Natural Resources
Wisconsin Milk Marketing Board
Professional Dairy Producers of Wisconsin
Wisconsin Dairy Business Association
Wisconsin Pork Producers Association
Wisconsin Farm Bureau

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