University of Wisconsin – Extension

DISCOVERY FARMS

University of Wisconsin – Madison

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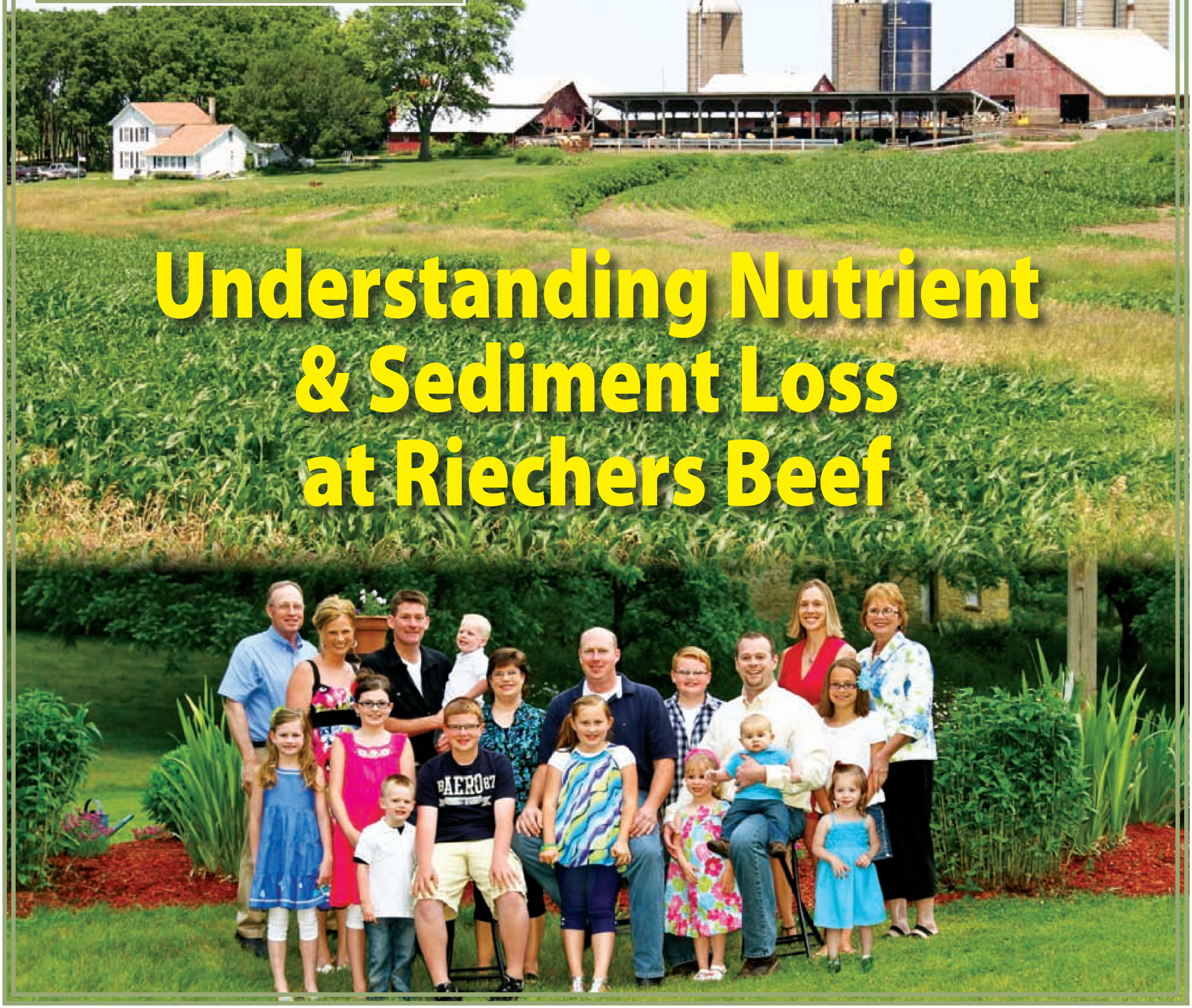
Winter 2013



Understanding Nutrient & Sediment Loss at Riechers Beef

Farm, Site and Study Design

The University of Wisconsin—Discovery Farms Program conducted on-farm research at Riechers Beef, near Darlington, Wisconsin. The project was designed to provide information to better understand how farm management practices could impact the potential for sediment and nutrient loss in surface water runoff. The study design allowed comparisons of three paired surface basins. This project provided information on surface water flow periods and durations in this landscape. Through the work at Riechers Beef, we are now better able to identify some of the strengths and challenges of no-till farming systems with surface applied livestock manure and explore management practices that best fit this farming system and minimize nutrient and sediment loss to surface water. 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.

Overview of farm operation

Riechers Beef is a family farming operation under the care and management of Mark and Jan Riechers, and their sons, Joe and Jeff. The Lafayette County farm has participated in the state sponsored Galena River Watershed Project to install barnyard runoff control measures and in-field terraces. The farm finishes beef steers and produces feed through a direct plant (no-till) corn and soybean cropping system. Corn is harvested as either silage or grain and then stored and fed to the cattle. On fields where corn is harvested for grain, approximately two thirds of the residue is removed for livestock bedding. Most of the soybeans are sold to a local seed company. Depending on soil test levels and the following year's crop, solid beef manure is surface applied to the cropland.

Figure 1. Livestock facilities on home farm

Family

Mark and Jan Riechers' family includes three grown children, Joe, January, and Jeff, and 11 grandchildren. Joe has taken over many of the chores and management decisions from Mark. Jeff currently works as the operations manager for Rural Route 1 Popcorn, but comes home frequently to assist with the cropping and livestock duties. January is married to a local farmer who does some custom harvesting for Riechers Beef. Mark has a degree in agricultural education from the University of Wisconsin - Platteville and spent a few years teaching high school agriculture before returning to the farm. Mark's active engagement in the agricultural industry is a hallmark of his career. He has been an involved member—including leadership roles in—WI Beef Council, WI Veterinary Diagnostic Lab, WI Agribusiness Council, and UW - Discovery Farms' Steering Committee. In 1992, he was honored as the Farm Steward of the Year in Farm Journal's first Farm Stewardship Contest.

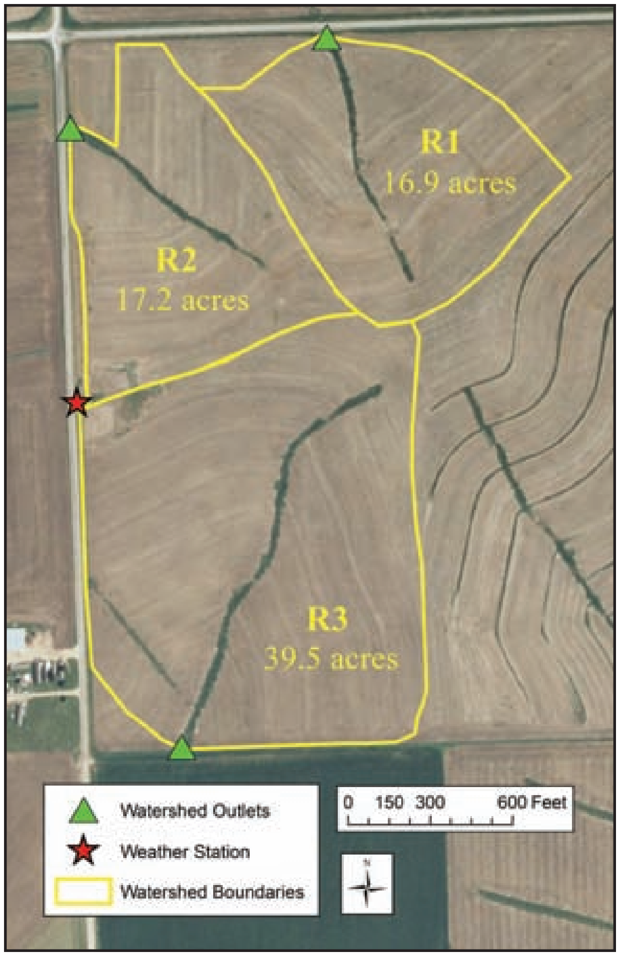


Figure 2. Monitoring locations

Farm operation and landscape

Minimizing soil and nutrient loss has always been a priority. The cropland is located on one of "the most productive soils in the county," Tama silt loam. Crop fields have grassed waterways draining to intermittent and perennial streams. The farm operated about 750 acres of cropland managed in a 3-year rotation of corn—corn—soybeans. Crops are planted in 30 inch (corn) and 15 inch (beans) rows, directly into surface residue from previous crops using a high residue planter. Yields routinely exceed 200 bushels of corn and 50 bushels of soybeans per acre. The farm chops 100 acres of corn silage annually. A crop consultant is hired to scout fields and provide recommendations on crop management.

Riechers Beef purchases feeders at 800 pounds and finishes them to a weight of approximately 1380 pounds over a six month period (2 cycles/year). Feedlots are naturally ventilated and bedded with corn stalks. The farms produce about 7,600 tons of solid beef manure each year. Manure in winter, spring and fall is immediately spread, as weather conditions permit. Summer manure is stacked and spread in the fall. Fields receive manure applications that total 8-13 tons per acre (corn) or 5 tons per acre (beans). The farm utilizes nutrient management and soil conservation practices to reduce soil loss, improve soil quality, and provide for crop nutrition. The farm has a soil and water conservation plan, and also cooperated with the UW - Discovery Farms Program to develop a Comprehensive Nutrient Management Plan (CNMP). The NRCS - RUSLE2 soil loss model estimates the defined cropping system used by Riechers Beef is causing less than one ton per acre of annual soil loss.

Farm and site selection

This farm was chosen to represent medium sized beef feedlot operations that have cropland devoted to row crop production. Surface water quality was monitored from three watersheds, varying in size from 17-40 acres, all under the control of the cooperating farmer (Figure 2). These surface sites provided an edge-of-field evaluation of nutrient and soil loss from agricultural fields under a long-term no-till system, with and without livestock manure. Data collection from the surface water monitoring sites began in December of 2003 and concluded in September of 2010. A weather station was installed in March of 2004.

Research plan

In the fall of 2003, staff from the U.S. Geological Survey and UW - Discovery Farms Program worked cooperatively with the producers to install three flumes in grass waterways. For the first few years the main focus was the collection of baseline information so we could determine how the cropping system was impacting the quality of surface water runoff. During this time frame, the Riechers applied both liquid and solid manure at critical times so that we could determine the effect of manure application on frozen and snow covered ground. Runoff derived from storm events and snowmelt were collected from each flume and analyzed for sediment, nitrogen and phosphorus content.

Additional special projects

Special projects are short, targeted studies designed around specific topics. This farm conducted two special projects:

1. Assessing the effects of hormones in livestock manure: a study with UW–Madison and the State Laboratory of Hygiene to assess the effects of hormones in livestock manure. Conducted from July 1, 2007, through September 30, 2011. The results are summarized in a final report written under the EPA agreement number R833421. A summary is available at our website http://www.uwdiscoveryfarms.org/OurResearch/ManureManagementConsiderations/AssessingHormonesinManure.aspx
2. Soil moisture and rainfall intensity thresholds for runoff generation in southwestern Wisconsin agricultural watersheds: compared farming systems and soil moisture conditions to identify time periods when manure applications are more likely to contribute sediment and nutrients into surface water runoff. The project was conducted from 2004-2007. A journal article written by Timothy Radatz, Anita Thompson and Fredrick Madison was published in Hydrological Processes. Published online in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/hyp.9460.

Equipment and Sampling Procedures

On-farm water quality monitoring used to be conducted only during the growing season, with little or no monitoring occurring during the winter months because the monitoring equipment was not well suited to the freezing and thawing temperatures. Improvements in equipment have made it possible to monitor runoff throughout the year. The three small watershed sites at Riechers Beef were installed and managed by personnel from the U.S. Geological Survey Wisconsin Water Science Center and the staff of Discovery Farms to collect water quality data from November 2003 to October 2010, with monitoring taking place on a year round basis.

Equipment

Aluminum clam-style enclosures were used to house equipment designed to measure flow (discharge), collect water samples, and provide two-way communications that facilitated data collection and real-time programming (Figure 3). All sites had electricity and a camera and were locked to prevent unauthorized access.

Three watersheds were selected to represent "typical" fields in this region,

Figure 3. Monitoring station

Figure 4. Sample collection bottles from runoff event

Figure 5. Rain gauge, camera enclosure, solar panel and telemetry radio antenna

with sizes of 16.9, 17.2, and 39.5 acres. A 2.5-foot H-flume was installed in a plywood wingwall to measure runoff volume. A datalogger was used to read and store sensor data and control station equipment. An automated, refrigerated, 24-bottle ISCO® 3700R sampler was used to collect surface water runoff samples. Samples were pumped from the flumes into 1-liter bottles housed in the refrigerator.

Sampling runoff events

A runoff event is from the start of rainfall or snowmelt surface runoff, to when runoff stops. Sampling frequency was controlled and adjusted by the datalogger. The program was modified to adjust for changing weather and storm characteristics to prevent filling the sample bottles before the end of an event and ensure that samples properly characterized the event. For certain storms it was possible to have more than 24 samples per event when samples were retrieved, new bottles were put in place, and the sampler was reset.

Water samples were generally retrieved within 24 hours. Once collected, sample quantity and appearance was recorded and equipment accuracy was checked. Samples were labeled, placed in coolers with ice, and transported to the UW-Stevens Point Water and Environmental Analysis Lab (WEAL) for analysis. Samples were typically received by the lab within three days of a runoff event. WEAL took pictures of each event for visual analysis (Figure 4). To assure that water quality data accurately represented actual runoff water quality, field blanks were used to determine if contamination was introduced by the entire sampling process. Analysis of these quality control samples indicated that contamination in the sampling process was very small compared to the measured water quality. Water samples were taken with a goal of achieving a good sample distribution. Samples were recombined in the lab so that one representative sample could be analyzed for each event. The lab tested for the following parameters:

- ➢ Suspended sediment and total dissolved solids
- ➢ Nitrogen: nitrate/nitrite, ammonium, and total Kjedahl nitrogen unfiltered
- ➢ Phosphorus: total P unfiltered and dissolved reactive P

Supplemental data collection

Environmental conditions were monitored at the sites and at a central weather station. The information collected at the weather station included soil temperature, precipitation, air temperature, relative humidity, wind speed, and wind direction (Figure 5). One final parameter monitored at each monitoring station was soil moisture. A Sentek EasyAg high-frequency capacitance soil moisture probe was used to take moisture contents at 10, 20, 30 and 50 centimeters (4, 8, 12 and 20 inches). A Campbell Scientific CS616 was also installed which utilized a time domain reflectometry soil moisture measurement that monitored the average soil moisture from 0—30 centimeters (0—12 inches) (Figure 6).

Maintenance

Maintenance is vital to accurately measure runoff water quantity and quality. Spring, summer, and fall, the equipment was checked and mowing was done around the gauge and wing-walls to ensure easy access and inspections. Flumes were cleaned and surveyed with an auto level at least twice per year. Surface flumes require more maintenance in winter as snow and/or ice can fill the flume and downstream channel causing backwater conditions if runoff occurred. Ice in the flume can also freeze the bubble tubing and sample intake line, causing erroneously high water level measurements and prevent samples from being taken. Snow and ice were removed from the flumes prior to any anticipated wintertime runoff (Figure 7). A trench dug in the snow upstream


Figure 6. Campbell Scientific CS616 soil moisture probe

of the flume prevented surface water runoff from flowing on top of the snow and cascading into the flume. The trench downstream of the flume was cleared enough to assure proper downstream conditions and prevent water from backing up into the flume.

Frequent visits were necessary to remove ice prior to a runoff. Ice was removed by carefully breaking it into smaller pieces with a hammer. Portable clothing steamers or jugs of warm water were also used to remove ice from around the sample intake and bubble lines to prevent damage. Numerous attempts were made to reduce maintenance required by the ice formation in the flumes; however, excessive energy requirements or design flaws rendered these attempts unsuccessful.

Year-round monitoring is very maintenance intensive, especially during snowmelt conditions. Snow removal prior to runoff should only be done immediately (1 - 2 days) before snowmelt.

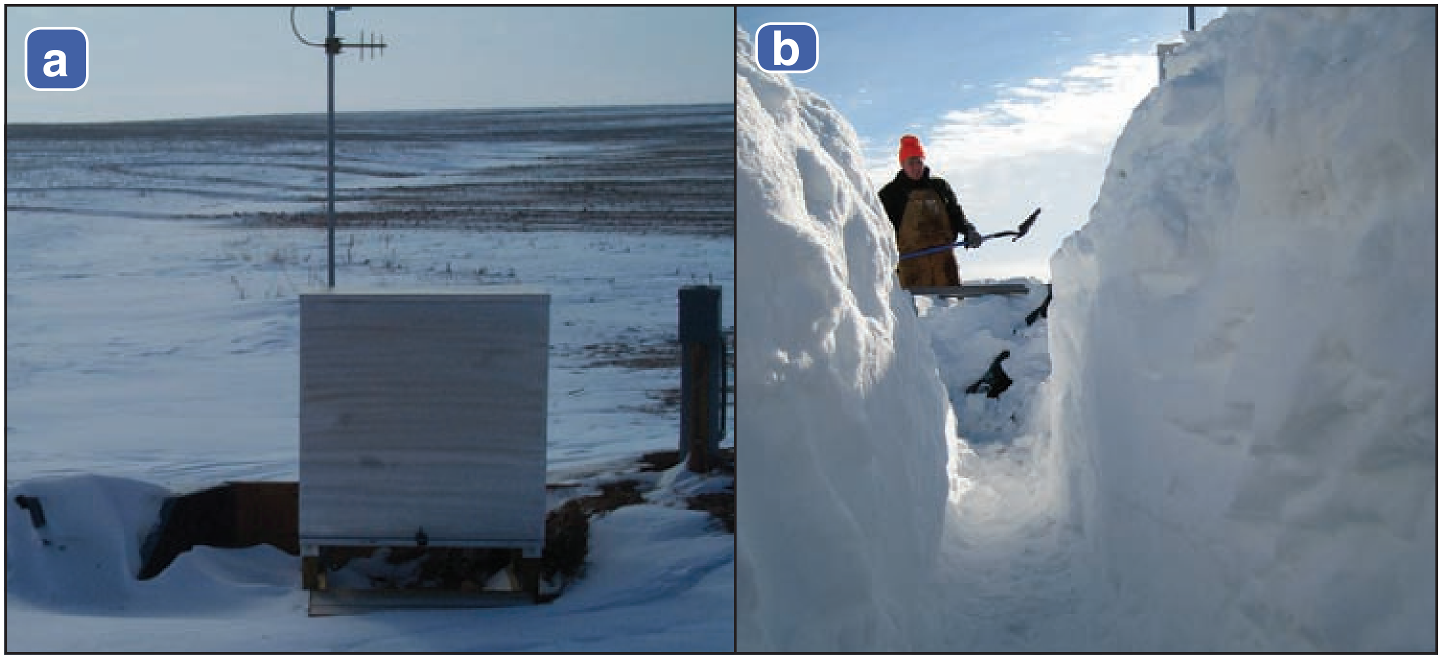


Figure 7. Winter maintenance: (a) snow covered site and (b) snow removal prior to runoff events

Additional Information

Detailed information on sampling materials and methods, can be found in the publication: *Methods of Data Collection, Sample Processing, and Data Analysis for Edge-of-Field, Stream Gauging, Subsurface-Tile, and Meteorological Stations at Discovery Farms and Pioneer Farm in Wisconsin,* 2001-2007. The report is also available for download at http//wi.water.usgs.gov/pubs/index.html.

Understanding Surface Water Runoff

Farming system and water quality monitoring

Crops at Riechers Beef were in a 3 year rotation of two years corn then soybeans, with about 75% of the corn harvested as grain and the remainder harvested as silage. Crops were directly planted into the previous year's residue using a one pass planting system. After corn grain harvest, a portion of the stalks were harvested as bedding. The residue remaining after soybeans/silage was 50-55% and 65% residue remained after corn harvested as grain. Nutrients from manure were applied based on crop phosphorus needs and commercial nitrogen was supplemented to fields planted in corn. Manure was removed from feedlots as necessary, approximately every other week. Winter, spring and fall manure were immediately field spread, as weather conditions permitted. Summer manure was field stacked and spread in the fall. Surface manure applications of 13-15 ton/acre were made to fields that were planned for corn.

Monitoring ran from December 2003 through September 2010 at the outlet of three watersheds (R1, R2, and R3) and weather conditions were monitored at a single onsite weather station (Figure 2). Average slope in all three watersheds was 5% and the dominant soil was Tama silt loam. Conservation practices included the direct plant system, contour planting, grassed waterways and broad-based terraces.

Water budget

Total precipitation was 255 inches, or 4% higher than historical averages. About 90% was rainfall and 10% was snow or sleet. Annual precipitation was near normal in FY04, FY07 and FY09; much below normal in FY05 and FY06, and much above normal in FY08 and FY10 (Figure 8). Runoff was 18.2, 14.0, and 14.0 inches at R1, R2, and R3, respectively (Figure 9). Precipitation did not correspond with runoff, and runoff was rare with only 6% running off.

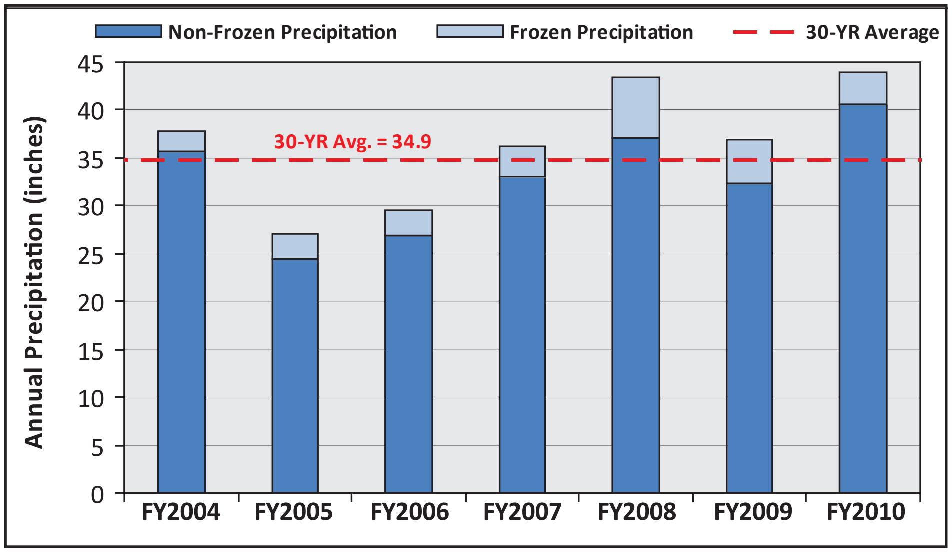


Figure 8. Annual precipitation

Frozen ground/snowmelt was important, 80% of runoff was during this time period (Figures 9 and 10). Runoff occurred every year on frozen ground, but timing and nutrient or sediment content was unpredictable. Non-frozen runoff accounted for 20% of the total. Non-frozen contributions and timing was also unpredictable. Factors affecting non-frozen ground runoff included rainfall characteristics (depth and intensity), landscape characteristics (vegetation, soils, topography, etc.), and soil moisture conditions prior to a rainfall event (antecedent soil moisture).

The direct plant cropping system with high residue levels was a key factor in limiting the amount of non-frozen ground runoff. Long term direct plant farming systems improve soil quality by increasing organic matter content and improving soil structure. Improved soil structure tends to increase infiltration rates by macropore flow and reduces runoff amounts. High residue cover also decreases runoff by intercepting and retaining precipitation and promoting infiltration.

Large storms produce rainfall at a rate higher than the soil profile can infiltrate. There were 17 storms that met or exceeded the one year return period (recurrence interval); including one exceeding the 25 year (8/8/10) and one exceeding the 10 year (7/3/07). These storms produced 11% of the total runoff and 53% of the non-frozen runoff during the study period.

Antecedent soil moisture had a large influence on the rainfall-runoff response in these watersheds. A soil profile that is initially dry will infiltrate water more rapidly than at a higher soil moisture. Storm events with a high antecedent soil moisture (≥35% volumetric soil moisture) produced 16% of the total runoff and 77% of the non-frozen ground runoff during the study period.

Runoff timing

The average annual runoff during the seven year study period was 2.2 inches, with 1.7 inches occurring on frozen ground and 0.5 inches on non-frozen ground. On average, 70% of the annual runoff was observed in the months of February and March and 13% was observed in June and July. Runoff was observed every year during the month of March. Runoff was observed in approximately three out of every four years in June and one out of every two years in January, February, July, and August. Runoff was not common in October, November, December, April, May, and September (Table 1).

Conclusions

- Runoff occurred infrequently, only 6% of precipitation became surface runoff. During the entire 2500 day study period, runoff was observed on only 175 of the days monitored (7%).
- Approximately 80% of the total runoff was observed during frozen ground periods with over 70% of the annual runoff coming during the months of February and March.
- Annual precipitation totals did not correlate with annual runoff totals. Landscape characteristics and local environmental conditions including, snowpack depth, rate of snowpack melt, frost depth, and rainfall on frozen ground during frozen ground periods and precipitation intensity and soil moisture conditions during non-frozen ground periods greatly influenced the runoff response of agricultural watersheds at Riechers Beef.

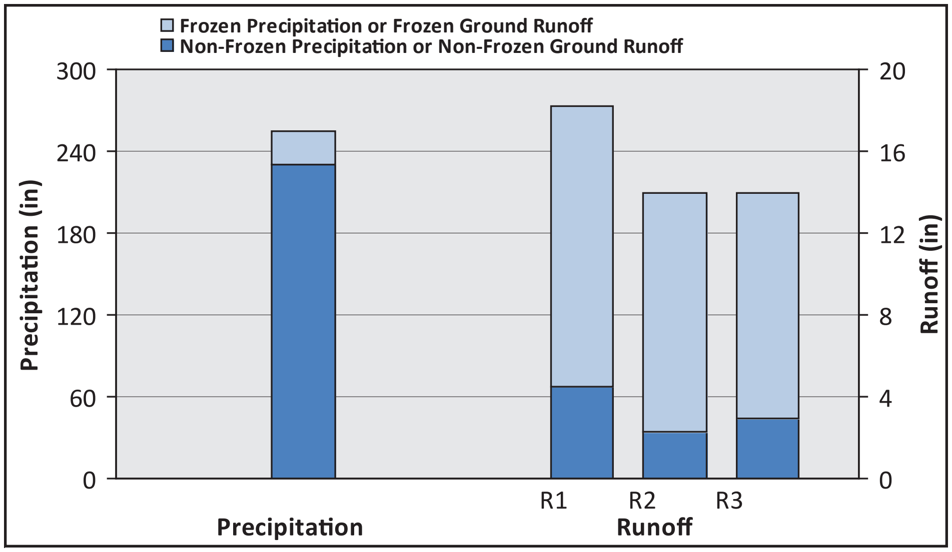


Figure 9. Precipitation and runoff

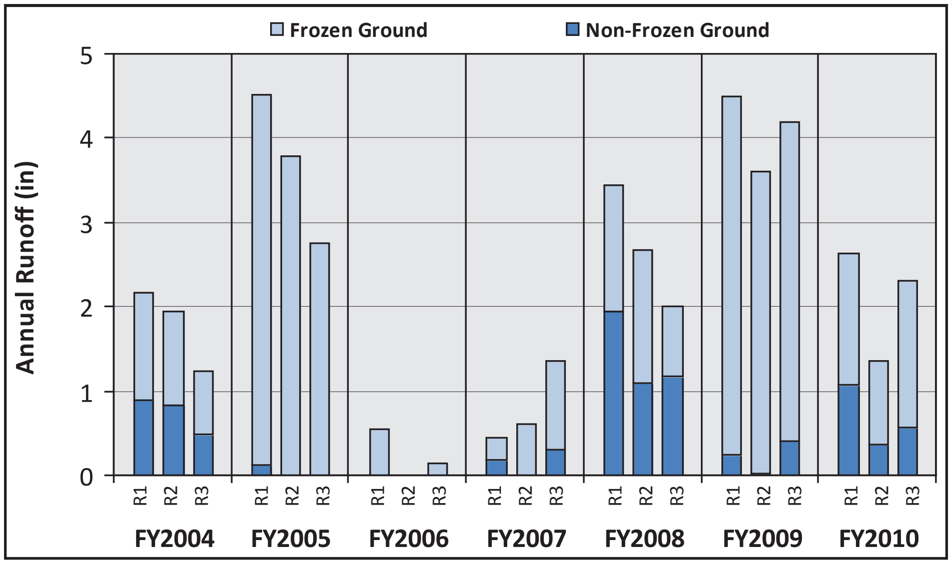


Figure 10. Annual runoff

Year	Total Precip (inches)	Dominant Runoff Period	Runoff Totals (inches) R1	R2	R3	Notes
FY04	37.7	Snowmelt, May/June	2.2	1.9	1.2	Monthly rainfall exceeded average in November and May
FY05	27.1	Rain on snow, snowmelt	4.5	3.8	2.8	Driest year of study period, 14% of precipitation as runoff
FY06	29.5	Snowmelt	0.5	0.0	0.2	Shallow frost and slow snowmelt
FY07	36.3	Frozen ground	0.5	0.6	1.4	Very wet July and August
FY08	43.4	50% frozen, 50% non-frozen	3.4	2.7	2.0	Record snowfall
FY09	36.8	95% snowmelt and rain on frozen ground	4.5	3.6	3.8	
FY10	43.9	70% frozen ground	2.6	1.4	2.3	Terraces removed in R3, no influence on runoff observed

Table 1. Summary of precipitation and runoff totals

Understanding Sediment Loss

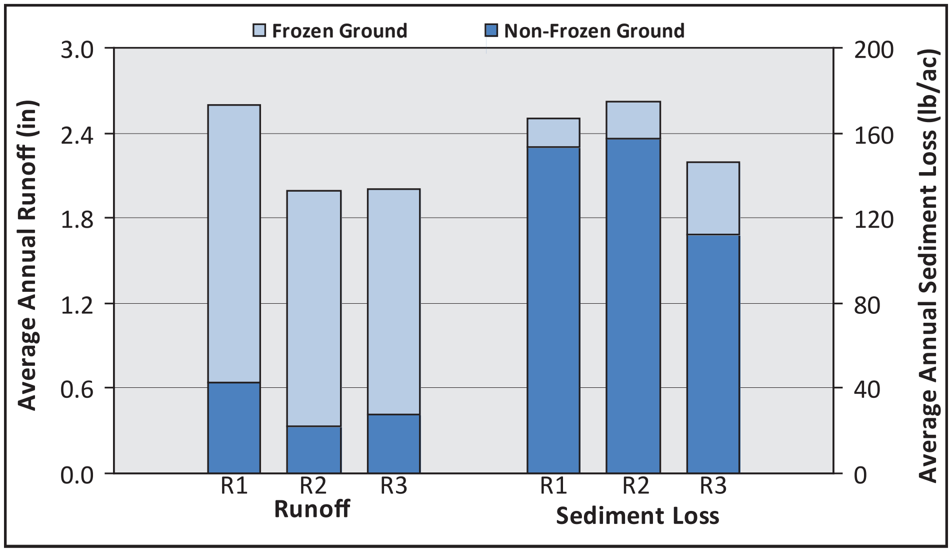


Figure 11. Average annual runoff and sediment loss

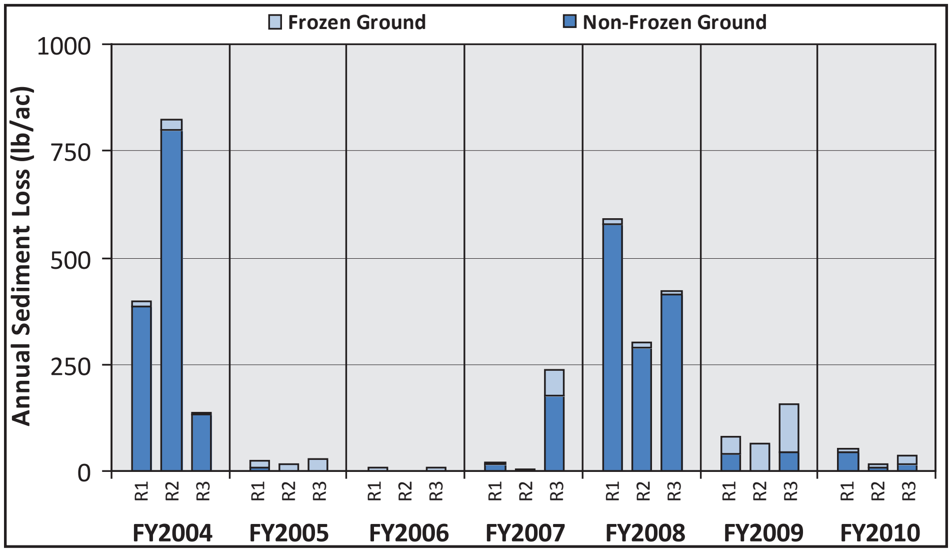


Figure 12. Annual sediment loss

Sediment losses

The average annual sediment loss for the entire study period was 163 lb/ac/yr (Figure 11). Sediment loss was particularly low on this operation as the farming system and good conservation practices (contour planting, well established grass waterways, and broad based terraces) limited sediment movement within the fields. The direct plant management was a key factor in limiting sediment loss by increasing infiltration, reducing runoff and protecting the soil surface from raindrop impact with high residue levels (50-65%).

On this farm, 80% of the surface runoff was observed while the soil was frozen. However, almost all of the sediment loss (87%) was observed during non-frozen ground periods (Figures 11 and 12). The most likely reason for this discrepancy is that soil particles are frozen together during the winter and are therefore less likely to be transported in runoff.

The annual runoff amounts did not correspond well to annual sediment loss. The greatest runoff occurred in FY05 and FY09, while the highest sediment loss was in FY04 and FY08 (two-year average of 445 lb/ac/yr; Figures 12 and 13). Sediment loss in FY04 (particularly R2), was likely influenced by waterway and/or terrace modification that occurred during installation of the monitoring equipment. Removing FY04 and FY08 from the data yields an average sediment loss under 100 lb/ac/yr (Figure 12). Terraces were removed in R3 in the fall of 2009 and did not seem to influence sediment loss in FY10. More data is necessary to accurately assess the impact of terrace removal.

R1 had the highest runoff every year of the study period except for FY07 (Figure 13). However, R1 did not consistently lose more sediment than the other sites. R2 had the lowest sediment loss in all field years except for FY04. R1 and R2 had the same crop rotation, management systems, slopes, and soils, but R1 consistently lost more sediment.

Large storms can generate loss by producing rainfall at higher intensities and volumes than the soil profile can infiltrate. There were 17 storms during the study that met or exceeded the one year return period, including one storm exceeding the 10 year return period (7/3/07) and a storm event exceeding the 25 year return period (8/8/10). These 17 storms produced 46% of the total sediment loss during the study period.

Most of the sediment loss during the study period occurred during the months of May, June, and July (Figure 14). Over 80% of the annual sediment loss, but only 18% of the annual runoff occurred during May, June, and July. In contrast, 70% of the annual runoff and only 13% of the annual sediment loss occurred in February and March.

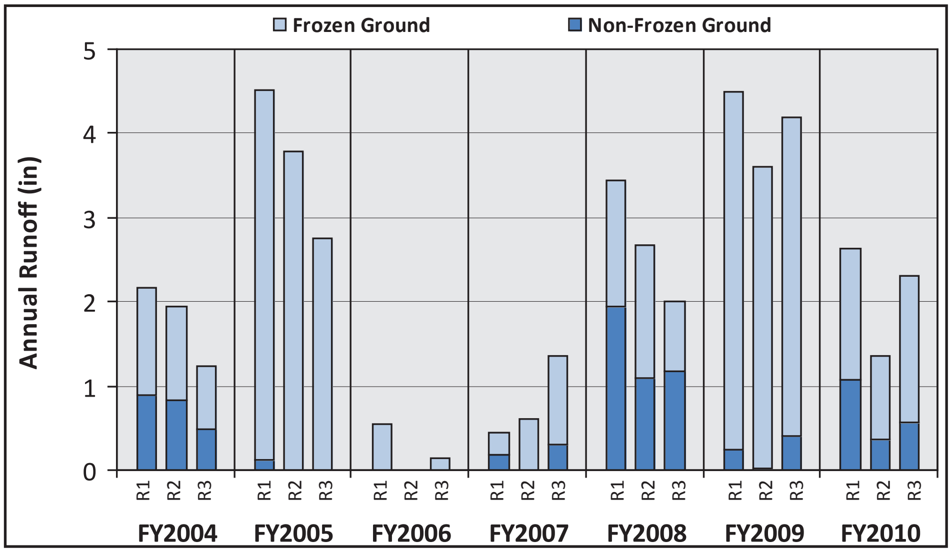


Figure 13. Annual runoff

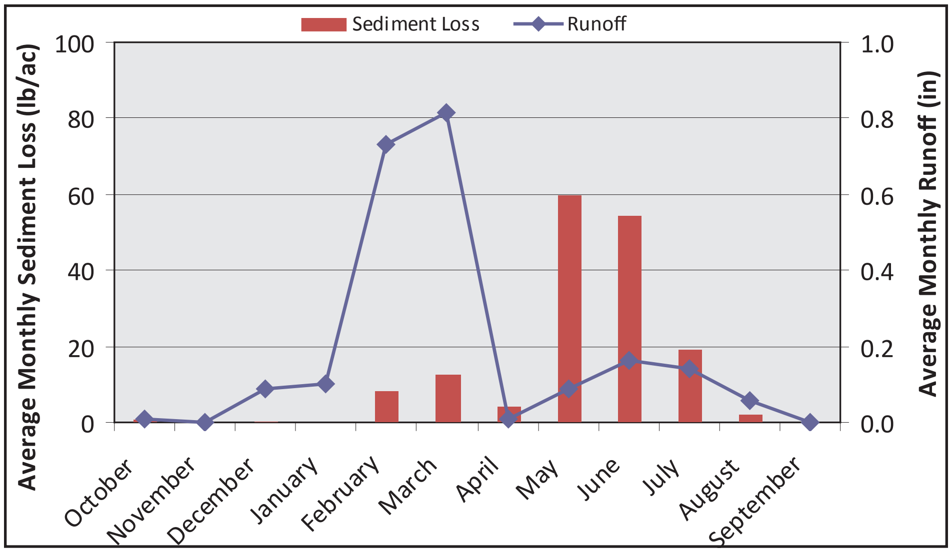


Figure 14. Average monthly sediment loss and runoff

Over 65% of the total sediment loss during the study period occurred during May 2004 and June 2008. During May 2004, there were two storm events (both on 5/23) that contributed 36% of the total sediment. During June 2008, there were four storm events (on 6/5, 6/7, and 6/8) that contributed 30% of the total sediment (Table 2).

Field Year	Storm Times Start	Stop	Precipitation	Sediment Loss (lb/ac) R1	R2	R3
2004	05/23/04 00:16	05/23/04 02:00	1.24	321	668	75
2004	05/23/04 03:42	05/23/04 06:00	0.71	54	57	49
2008	06/05/08 05:00	06/05/08 06:33	1.02	42	12	24
2008	06/07/08 23:09	06/08/08 01:55	1.18	160	63	160
2008	06/08/08 08:48	06/08/08 12:10	0.73	64	45	28
2008	06/08/08 19:36	06/09/08 00:10	0.78	164	122	135

Table 2. Sediment loss for selected storm events

Conclusions

- ➢ Sediment loss at Riechers Beef was minimal during the study period. The average annual sediment loss was 163 lb/ac. The direct plant management system was a key factor in limiting sediment loss by increasing infiltration and reducing runoff and protecting the soil surface from raindrop impact with high residue levels (50-65%).
- ➢ Almost 90% of the total sediment loss occurred during non-frozen ground conditions and over 80% of the sediment loss occurred during May, June, and July. This is typical of data from other Discovery Farms sites around the state as these months typically have little crop canopy and high intensity rain events.
- ➢ Annual runoff amounts did not correlate with annual sediment loss. Sediment loss was more related to ground conditions and the timing of runoff than annual runoff amounts.

Understanding Nutrient Loss

Phosphorus losses

Total phosphorus refers to the combined total of the particulate form (bound to soil) and the dissolved form. Particulate is usually the dominant form transported in agricultural runoff. Dissolved phosphorus can be related to soil-test phosphorus concentrations, fertilizer and manure applications, or be associated with plants and crop residue. The average total phosphorus loss at Riechers Beef was 1.8 lb/ac/yr (Figure 15). Over 80% of total phosphorus was lost during frozen ground conditions and approximately 75% of frozen ground loss was in the dissolved form (Figure 16). Higher dissolved phosphorus levels can be attributed to the timing of runoff events (80% on frozen ground) and the farming system (direct plant). The lack of tillage and incorporation allowed nutrients to concentrate at the soil surface and interact with runoff which can increase dissolved phosphorus loss.

Losses of different phosphorus species were dependent on the ground condition at the time of runoff (Figure 16). Particulate phosphorus comprised the majority (66%) of the total phosphorus loss during non-frozen ground periods. Conversely, dissolved phosphorus was dominant (80%) during frozen ground periods.

On average, 80% of the phosphorus loss during the study period occurred during the months of February and March, which were the same months when runoff was highest (Figure 14). Phosphorus loss was quite strongly correlated with runoff amount on both a monthly and annual time scale; as runoff increased, so did phosphorus loss. Phosphorus losses were almost exclusively in the dissolved form in the months of December, January, February, and March. On the other hand, phosphorus losses were almost exclusively in the particulate form in the months of April, May, June, July, and August.

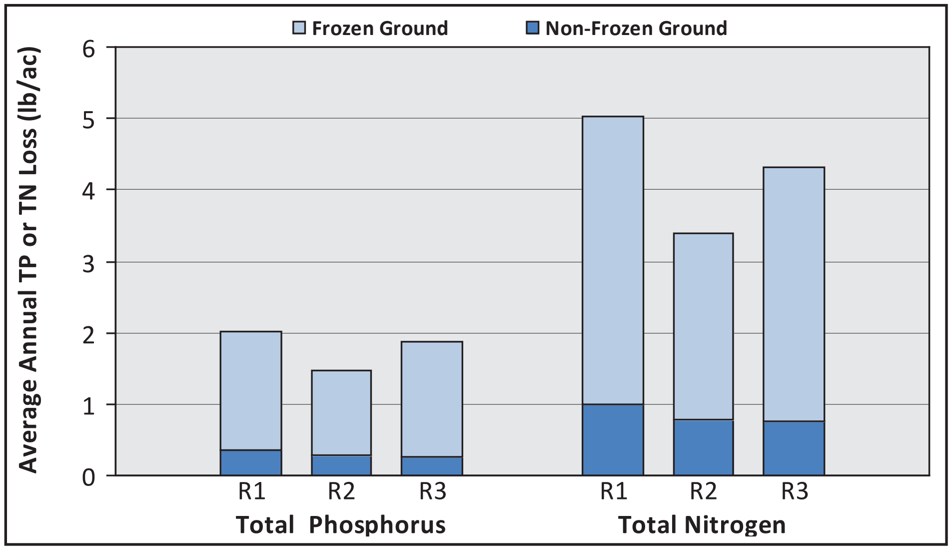


Figure 15. Average annual total phosphorus & nitrogen

Nitrogen losses

Total nitrogen refers to the combined total of nitrate nitrogen, ammonium nitrogen, and organic nitrogen. Organic nitrogen can be attached to soil particles, found in manure, or be associated with plants and crop residue. Nitrate can be associated with manure, fertilizer, the atmosphere, and soil-available nitrogen because it is a stable breakdown product of biological processes. Ammonium nitrogen can be linked to manure, fertilizer, soil, and atmospheric nitrogen.

During the study at Riechers Beef the average annual total nitrogen loss in surface runoff was 4.2 lb/ac/yr (Figure 15). About 80% of the total nitrogen loss was observed during frozen ground conditions. Total nitrogen losses were composed primarily of organic nitrogen (61%), followed by ammonium (24%), and nitrate (15%) (Figure 17). Almost all (98%) of the ammonium loss occurred during frozen ground conditions.

Approximately 80% of the nitrogen loss during the study period occurred during the months of February and March, which were the same months where runoff was highest (Figure 14). In general, nitrogen loss was strongly correlated with runoff amount on both a monthly and annual time scale. In most instances nitrogen loss increased with runoff volume. Ammonium and nitrate losses almost exclusively occurred during the months of February and March.

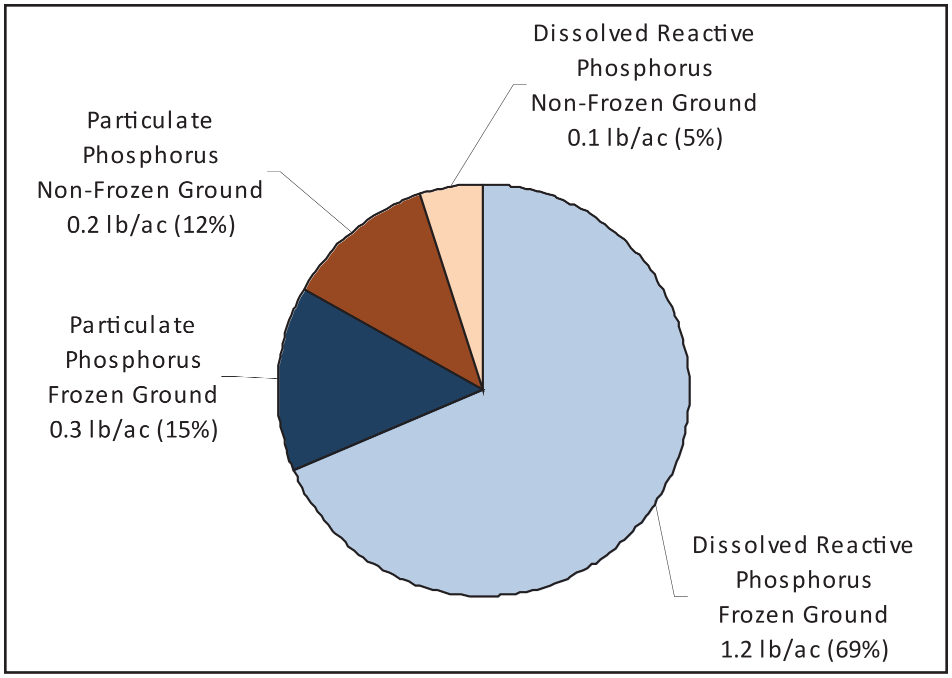


Figure 16. Average annual phosphorus loss and percent of total by ground condition and phosphorus species

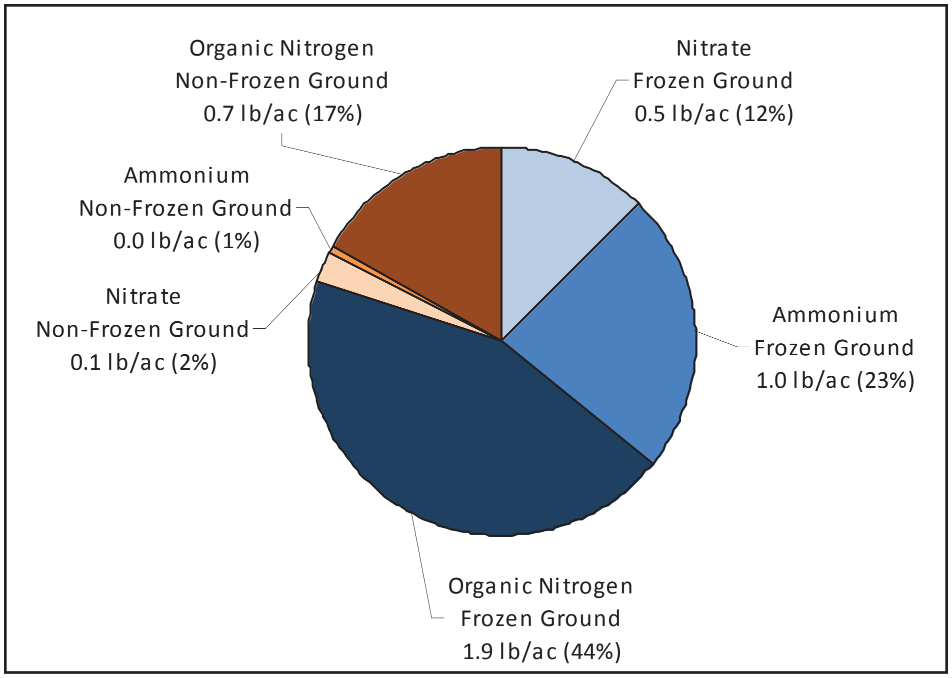


Figure 17. Average annual nitrogen loss and percent of total by ground condition and nitrogen species

Conclusions

- Annual phosphorus loss averaged 1.8 lb/ac for the entire study period at Riechers Beef and ranged from 0.0 to 5.1 lb/ac depending on the year. Over 80% of the total phosphorus loss was observed during frozen ground conditions and approximately 75% of the total phosphorus loss was in the dissolved form.
- Annual nitrogen loss averaged 4.2 lb/ac for the entire study period at Riechers Beef and ranged from 0.0 to 12 lb/ac depending on the year. About 80% of the total nitrogen loss was observed during frozen ground conditions. Total nitrogen losses were composed primarily of organic nitrogen (61%), followed by ammonium (24%), and nitrate (15%).
- Phosphorus and nitrogen losses were both strongly correlated with runoff amount - as runoff increased at Riechers Beef, so did phosphorous and nitrogen losses.
- Nutrient losses at Riechers Beef were impacted by manure application upon frozen, snow-covered ground shortly preceding runoff. Timing was the most important factor, as both liquid dairy and solid beef manure application increased nutrient losses. When winter manure was applied and no runoff occurred until several months after the application, the impact on nutrient losses was reduced.

Additional Information

Detailed information on nutrient losses from fields receiving manure application shortly preceding runoff events can be found in the following article: Komiskey MJ, Stuntebeck TD, Frame DR, and Madison FW. 2011. Nutrients and sediment in frozen-ground runoff from no-till fields receiving liquid-dairy and solid-beef manures. *Journal of Soil and Water Conservation* **66**(5): 303-312. This article can be found at the following website: http://www.jswconline.org/content/66/5/303.full.pdf+html?sid=30120fff-2110-4ede-9e69-a76f024d611b

The Impact of the Farming System at Riechers Beef

Farming system

The farming system at Riechers Beef is a major reason for the low surface water runoff volumes and low levels of nutrient and sediment loss during non-frozen ground periods. Even though this project did not conduct field trials on all cropping systems used in this region of Wisconsin (minimum tillage, strip tillage, etc), a comparison of the data from this farm and the University of Wisconsin—Platteville Pioneer Farm (located six miles away) shows that this farming system greatly enhances infiltration of precipitation. Any time infiltration is increased and surface runoff is decreased, the risk of nutrient and sediment loss decreases.

Crops are "direct planted" on the contour into the previous year's residue using a one pass planting system. Manure is applied to the soil surface and incorporated through the action of rainfall, earthworms and soil disturbance that occurs from field activities. Fields have established waterways and terraces. After corn grain is harvested, stalks are chopped and harvested with the intent of leaving 1/3 of the total for residue. Approximately 65% of the soil surface is covered with residue after corn grain and 50-55% remains after soybeans or corn silage. No tillage implements are used. The only tillage done during the

Figure 18. Planter in action

Figure 19. Rear spike closing wheels

study was during FY04 after re-grading the waterway (R2); and FY09 to spread soil and even the fields after terraces were removed (R3). The most aggressive field operation is done by the planter (Figure 18), which causes minimal soil disturbance. The planter is equipped with a single fluted coulter in front of the disk opener and spike closing wheels to close the slot and insure seed contact with soil after placement (Figure 19). The black gage wheels control planting depth and carry weight away from the seedbed sidewall to avoid compaction.

Impact of the farming system on soil

At planting the majority of residue is undisturbed and the residue remaining within the seedbed is pressed into the soil. The planter is used for corn and soybeans, but with soybeans another set of seed boxes are added so that row spacing is at 15 inches instead of the 30 inch row width for corn. Soil investigations showed that residue remained not only on the soil surface but also within the upper levels of the soil profile. The soil organic matter content on these fields ranged from 2.9 - 4.0%. The soil survey for this area of the state indicates that a Tama silt loam soil will have about 2.5% organic matter. The organic (O) horizon of the soil profile was thick and contained large amounts of previous year(s) residue in a wide range of decomposition stages. This farm has been using a direct plant farming system with surface manure application for over 20 years, greatly influencing soil characteristics. The high residue levels limited the amount of non-frozen ground runoff. The direct plant system has improved soil structure, infiltration capacity and macropore connectivity leading to high infiltration rates and reduced runoff amounts.

Impact of the farming system on sediment and nutrient loss

We can't determine whether nutrient and sediment losses were reduced because of any one practice, as that question is beyond the level of detail that this study was designed to assess. However, this project was able to evaluate whether the system effectively protects water quality, and some of the mechanisms involved. To truly assess the impact of the farming system, it is helpful to compare losses from this system to average losses from a variety of systems around the state. Monitoring on this farm took place over a period of seven years, during which additional UW-Discovery Farms monitoring was taking place around Wisconsin. The data from all of these stations were combined to define state averages that span a variety of landscapes, farming systems, and precipitation conditions.

Surface Losses	State Average	Riechers Beef
Runoff	2.6 inches	2.2 inches
Frozen	54%	80%
Non-Frozen	46%	20%
Sediment Loss	667 lbs/acre	163 lbs/acre
Total Phosphorus	2 lbs/acre	1.8 lbs/acre
Dissolved	51%	74%
Particulate	49%	26%
Total Nitrogen	7.2 lbs/acre	4.2 lbs/acre
Organic	54%	61%
Ammonium	21%	24%
Nitrate	25%	14%

Table 3: Comparison of Riechers Beef and WI statewide surface water losses (yields per acre), 2004-2010.

Table 3 shows a comparison of the losses from this farm to the average of 84 site years of data collected statewide during the same time period. As shown in the table, average runoff (2.2 vs 2.6"), sediment (163 vs 667 lbs/acre), phosphorus (1.8 vs 2 lbs/acre) and nitrogen (4.2 vs 7.2 lbs/acre) losses were all lower on this farm. Soil characteristics and cropping systems play an important role in the amount of runoff that occurs in non-frozen periods. This farming system promoted high infiltration, thus reducing runoff during the non-frozen period (20% of the total vs statewide 46%).

Sediment loss was low compared to statewide average because of the low soil disturbance and high residue levels. Soil loss on this farm was at or above 667 lbs only once in 21 site years, likely due to waterway repairs.

This farming system surface includes manure applied as a fertilizer and protective cover for the soil. The data clearly shows that management decisions (timing and placement) can have dramatic impacts on phosphorus loss. The annual total phosphorus loss was close to the state average. Particulate phosphorus losses were lower than average, and consequently a large proportion of the loss was in the dissolved form. Systems utilizing some tillage in the rotation have less nutrient stratification due to soil mixing. For this farming system, higher dissolved phosphorus loss can be attributed to a higher concentration of phosphorus at the soil surface.

Advantages and disadvantages of this farming system

There are many advantages to this farming system, the most commonly identified include saving time and fuel through fewer field passes, lower equipment cost, and less soil disturbance. This type of farming system does have some disadvantages. The most commonly identified disadvantages include slow warming and drying of the soil, planting through and managing high crop residue rates, pest control, phosphorus stratification and dissolved phosphorus losses. This approach also takes lots of experience and commitment to tweak it to the specifications of each individual farm.

Conclusions

- The direct plant farming system was effective at increasing infiltration rates and reducing runoff.
- Runoff occurred infrequently at Riechers Beef, with only 6% of the precipitation leaving as surface runoff. About 80% of the total runoff was observed during frozen ground periods with over 70% of the annual runoff coming during the months of February and March, when the

infiltration and soil conservation advantages of the farming system were minimal.

➢ Sediment losses at Riechers Beef were minimal during the study period. The average annual sediment loss was 163 lb/ac. The direct plant management system and other conservation practices including high residue levels were key factors in limiting sediment loss by increasing infiltration, reducing runoff and protecting the soil surface from raindrop impact.

➢ Annual phosphorus loss averaged 1.8 lb/ac for the entire study period at Riechers Beef and ranged from 0.0 to 5.1 lb/ac depending on the year. Annual nitrogen loss averaged 4.2 lb/ac for the entire study period at Riechers Beef and ranged from 0.0 to 12 lb/ac depending on the year. Phosphorus and nitrogen losses were both strongly correlated with runoff amount—as runoff increased on this farm, so did phosphorous and nitrogen losses.

➢ Producers are evaluating direct plant/no-till farming systems as a means to achieve the required level of soil conservation (soil loss) at a time when equipment and field sizes are increasing. Direct plant systems need to be evaluated to determine if soil loss rates are acceptable, and work needs to be done with producers to design conservation systems that work on larger fields and with bigger equipment.

Manure Applications on Frozen and/or Snow Covered Ground

Introduction

Managing manure applications during the frozen ground period is essential to reducing nutrient loss in surface water from cropland. As a state annual average, we lose about 8% of precipitation or 2.55 inches of water as surface runoff each year. Water-quality data collected through the UW-Discovery Farms Program show that at least 50% of runoff occurs on frozen ground, even though precipitation is much greater during the non-frozen time period. Monthly runoff was highest during two time periods: February thru March; and May thru June. This paper provides background on the issues, challenges and potential opportunities involved with manure application during frozen or snow covered ground periods.

Riechers and other Discovery Farms sites clearly show that runoff volumes at the end of the winter months contribute an important amount of runoff. At this farm, runoff from frozen ground/snowmelt conditions contributed 80% of the total annual surface runoff (Figure 20), though only 10% of the annual precipitation occurred during this time. Frozen ground runoff was observed every year, yet the contribution and timing was extremely unpredictable, varying from year to year depending on snowpack depth, rate of snowpack melt, frost depth, and rainfall amount on frozen or snow covered ground. On average, there were 11 runoff events/site/year and runoff was recorded on 7% of the days monitored (25.5 days each year).

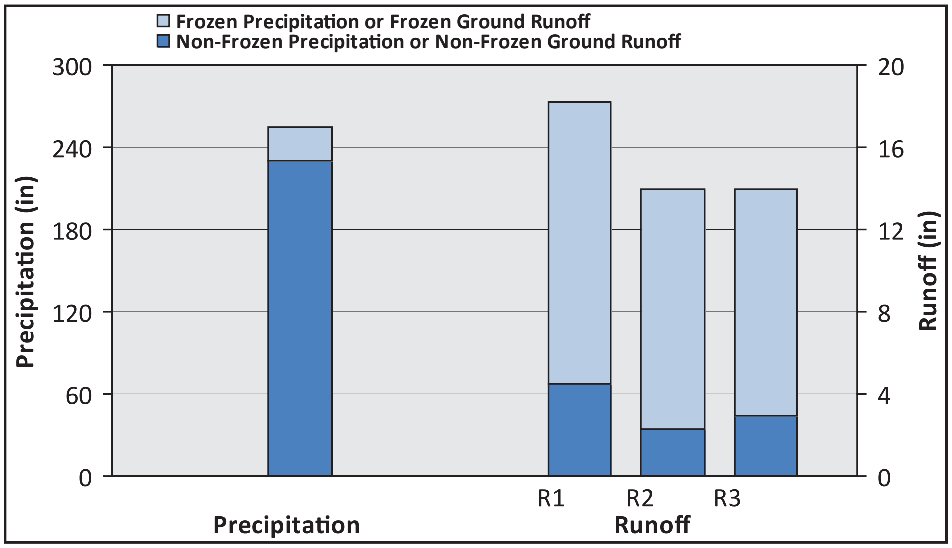


Figure 20. Study period precipitation and runoff

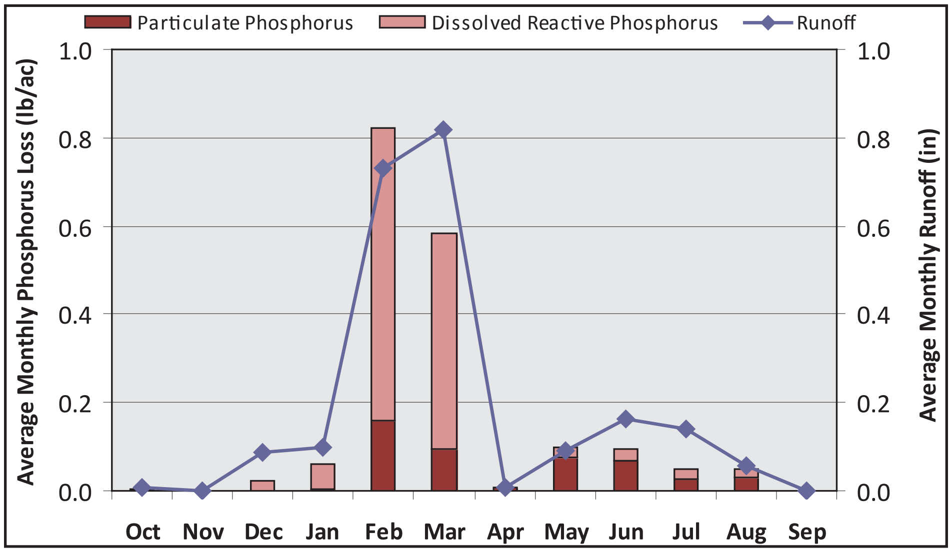


Figure 21. Average monthly phosphorus loss

Manure on frozen ground

Wisconsin livestock operations apply manure in the winter months for a variety of reasons. One of the main reasons is animal health and welfare. Animals can handle most cold weather as long as they are dry and clean. Keeping animals dry, clean and providing them some sort of wind protection is crucial in northern climates. Manure applications also happen when farmers have time. The period after harvest and before spring planting is often when farmers have the most time available to properly apply manure that has been stored through the growing season. Another advantage to applying manure while the ground is frozen is that it reduces the chance of soil compaction. Soil compaction can result from heavy machinery or intense animal hoof traffic compressing wet soil. It can reduce yields and increase runoff.

Manure application and handling has changed and improved over the last several decades. When it was necessary to haul manure every day, inclement weather forced operators to spread most of the winter manure on fields close to the barn, as extremely cold weather was uncomfortable for the operator, hard on equipment, and caused issues like frozen manure in the spreader. It is important to understand critical risk periods and take care to avoid applying manure during high risk periods. Spreading a load of manure every day did not provide options to spreading in high risk conditions, but the areas of daily application were small.

Today, with larger volumes of manure applied at once, it is critical for farmers to avoid and manage for high risk time periods. Factors that increase the risk for frozen ground runoff include the amount of snowpack present, the speed at which it melts, and the amount and type of frost present in the soil. Through the frozen ground time period, managers should use caution and recognize a higher runoff risk during times of rapid and dramatic temperature increase, longer days with clear sunny skies or a layer of ice over the soil, as these conditions can lead to high runoff volumes during the winter months.

Rain events cause snow to rapidly melt, leaving little chance for infiltration into the soil. Establishing a (regulatory) time period that allows or prohibits manure spreading will not eliminate the risk of nutrient loss from runoff because of the variable nature of weather.

Runoff and winter manure applications

Sediment and nutrient losses at Riechers Beef are discussed earlier in this report. A key finding on this farm is that 80% of the phosphorus loss occurred in February and March (Figure 21). There are two reasons for this:

- ➢ The farming system improved soil infiltration so that very little runoff occurred during non-frozen soil months,
- ➢ Losses were influenced by manure applications done either immediately preceding or during the snow melt period.

Winter manure applications occurred each year of the 7 year study period. Annual phosphorus losses ranged from 0.0 to 5.3 lb/ac (Figure 22). Phosphorus losses were higher in FY04, FY05 and FY09 and lower in FY06 and FY07. During the years with higher losses, a manure application was made during or shortly preceding runoff events in the winter.

In FY04, liquid dairy manure was surface applied in November at R3 and in September and February at R1 and R2. The February manure application at R1 and R2 occurred only five days before a significant runoff event. Phosphorus losses were five times greater at R1 and R2 compared to R3 for the entire year. The majority of the FY04 phosphorus loss difference between R1/R2 and R3 can be attributed to the February runoff time period.

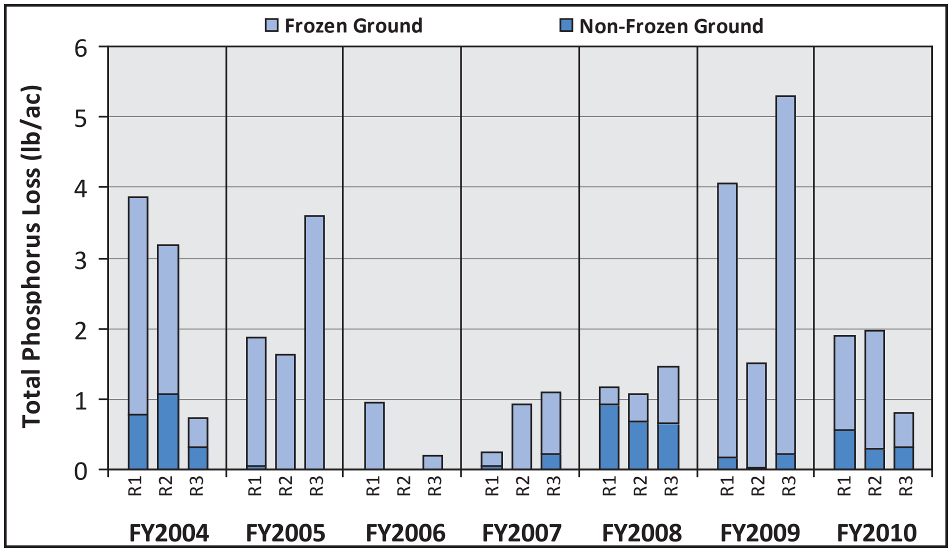


Figure 22. Annual phosphorus loss

In FY05, solid beef manure was surface applied in September and October at R1 and R2 and sequentially during September, October, January, and February at R3. The February manure application at R3 occurred during a snowmelt runoff event. Phosphorus losses for FY05 were two to three times greater at R3 compared to R1 and R2 and most of this disparity can again be attributed to the February runoff events.

In FY09, solid beef manure was applied shortly before runoff in February at R1 and R3, but not at R2. Phosphorus and nitrogen loss at R1 and R3 were two to four times greater than at R2 for FY09. Again, this is because of timing a manure application so close to the February surface water runoff event.

Winter manure spreading conclusion

In Wisconsin and surrounding states, frozen soil and snow cover can be a challenge for completing field operations such as manure application. The option to spread manure while the soil is frozen but runoff is not imminent can improve farm management and animal health. Managers must understand the conditions that lead to increased nutrient loss and avoid application or spread on fields with the lowest risk. Manure applied during or immediately preceding snow melt can have a negative effect on water quality. The type of manure (liquid or solid) did not affect nutrient losses, even as application rates were well within (or below) rates needed to meet crop nutrient needs. A key factor in these runoff events was the timing of manure applications.

When winter manure was applied and no runoff occurred until several months or even weeks afterward, the impact on nutrient losses was reduced. When applications are made during early winter or when low risk conditions exist, there is less risk of nutrient loss as compared to applications made during spring (saturated soil / intense storm conditions). When considering rules and regulations for manure applications on frozen and/or snow covered ground, there is a need to evaluate the risks associated with winter spreading, as well as and in conjunction with, risks associated with large volumes of manure from many farms all staged and waiting for early spring application. Manure is a valuable source of organic matter and nutrients, and its proper use and applications can assist in improving overall farm sustainability. Manure application is a necessary practice and it has many benefits. However, over application of manure and application of manure at improper times can pose an unacceptable environmental risk.

Using Soil Moisture to Reduce Runoff on Non-Frozen Ground

Carefully managing manure applications during the non-frozen ground period is important to reducing the risk of nutrient loss from agricultural areas. The northern region of the United States faces some unique challenges pertaining to climate and weather patterns, including frozen ground, snow and rain on frozen ground, extreme wet and dry conditions, and intense storm events. Across the state, the average annual runoff is 2.55 inches, or 8% of the total precipitation. Precipitation is much greater while the ground is not frozen, yet only about 46% of the annual runoff is observed during the non-frozen ground period. Average monthly runoff is highest during February and March, and again during May and June. Losses during these times can make up a large share of the total annual loads of nitrogen, phosphorus and sediment.

Challenges with timing manure applications during non-frozen ground periods

Time periods for spreading manure during the spring, summer, and fall are often limited. Once crops are planted and growing, manure application cannot take place until after harvest. Recently, producers are including more small grain crops back into rotation. After mid-summer harvest, this opens a manure application window for some cropland to receive manure during a low risk period. Looking at the Wisconsin growing season, manure application periods are limited by:

- ➢ Growing season: April through October. Some producers apply manure after small grain or alfalfa harvest.
- ➢ Warm fall: Soil temperatures should be below 50° F to minimize nitrogen loss.
- ➢ Winter season: Depends on how much snow falls, when and how ground freezes, snowmelt.
- ➢ Spring: High potential for runoff from saturated soil, risk of soil compaction, late planting time reduces yield.

Manure application and nutrient loss risk

Most manure applications do not adversely affect water quality, however, the wrong combination of application rate, method, and timing can elevate

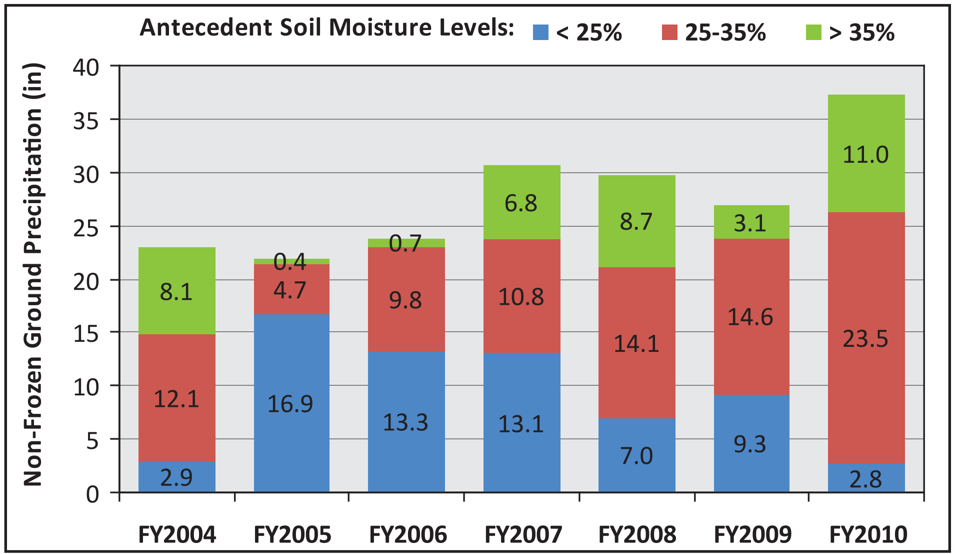


Figure 23. Annual non-frozen ground precipitation categorized by antecedent soil moisture

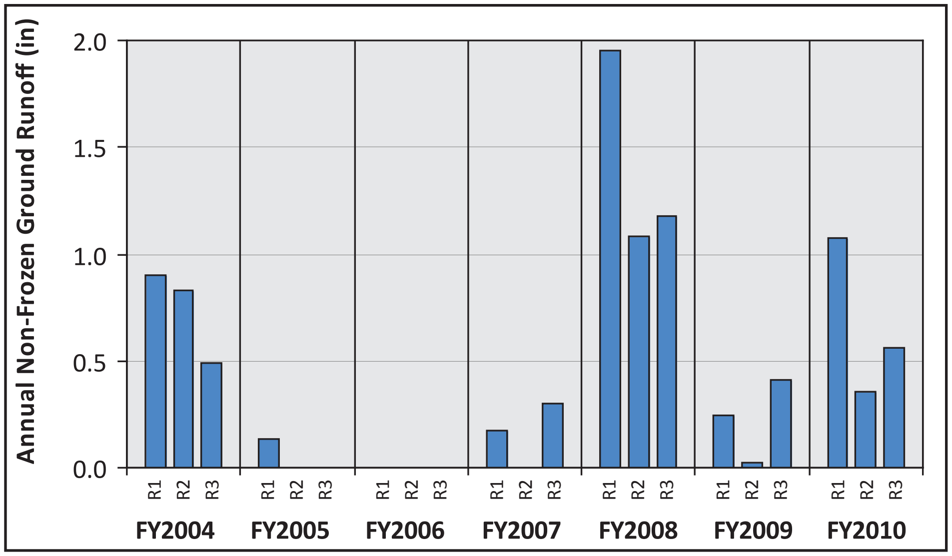


Figure 24. Annual non-frozen ground runoff

nutrient losses. Considerations in addition to road restrictions, time available, animal health and welfare, and setbacks include:

➢ Rate of application: In general, the greater the rate the greater the risk.

➢ Method of application (surface applied, surface applied then incorporated, or injection): Surface runoff risk generally decreases with incorporation or injection. However, injection can increase sub-surface or tile runoff risk in the instance of dry soil with cracks and macro-pores leading to tile lines. Pre-tillage and surface application are beneficial to minimize risk of runoff to the tile lines in those cases. Other data has shown that surface applications that have adequate time to bond with the soil surface do not greatly affect nutrient losses. In some instances, the risk of nutrient and sediment loss actually increases because of incorporation.

➢ Timing of application: To minimize the risk of nutrient loss, it is critically important to maximize the time between a manure application and a runoff event. If application can be avoided during time periods when runoff is imminent, nutrient loss from manure applications can be minimized.

Soil Moisture Category	Percentage of Non-Frozen Ground Runoff
>35%	71%
25-35%	23%
<25%	6%

Table 4. Non-frozen ground runoff categorized by antecedent soil moisture

Identifying critical time periods during non-frozen ground conditions

Antecedent soil moisture has a large influence on whether individual rain events create runoff in agricultural watersheds. Surface runoff during non-frozen ground periods is caused by either rainfall intensity that exceeds infiltration capacity of the soil or by precipitation on a saturated soil surface. A soil profile that is initially dry will allow water to infiltrate more rapidly than the same soil profile with higher soil moisture content. During the Riechers Beef study period there were 17 storm events that met or exceeded the one year return period or recurrence interval. Those 17 storms included one that exceeded the 25 year return period (8/8/2010) and one that exceeded the 10 year return period (7/3/2007). These intense storms produced 11% of the total runoff and 53% of the non-frozen ground runoff. Although large storm events had an influence on runoff at Riechers Beef, it is impossible to predict when and where these large storm events will happen. This study showed that soil moisture measurements can be made and quantified throughout the non-frozen ground period and can be used to assess critical runoff time periods. At Riechers Beef, storm events that occurred when soil had high antecedent moisture (≥35% volumetric soil moisture) produced 16% of the total runoff and 77% of the non-frozen ground runoff during the study period.

The influence of soil moisture on runoff potential at Riechers Beef

Non-frozen ground runoff accounted for 20% of the total runoff at Riechers Beef. Total non-frozen ground precipitation depth did not correspond well with non-frozen ground runoff (Figures 23, 24). However, the amount of precipitation with soil moisture >35% and non-frozen ground runoff are closely related. The years with the highest precipitation during times when soil moisture conditions were >35%, were also the years with the highest non-frozen ground runoff. Note, the years when precipitation was limited during times when antecedent soil moisture was >35% resulted in small or non-existent non-frozen ground runoff (2005 and 2006). Over the 7 years, 71% of the runoff was observed when antecedent soil moisture was greater than 35%, 23% of the runoff was observed when antecedent soil moisture was 25-35%, and only 6% of the runoff was observed when antecedent soil moisture was less than 25%.

Assessing soil moisture in the field

From a management standpoint, think about soil moisture in three categories. From a practical stand-point, when soil moisture is above 35%, it is not likely that field operations will be occurring due to a high likelihood of getting stuck with the equipment. The most important time for careful management decisions is when soil is in the medium moisture category (25-35%). When soil moisture content is in that medium category, a liquid manure application or a subsequent precipitation event can saturate soil enough to increase the risk for surface water runoff.

To assess soil moisture before spreading manure, take a sample of the soil from the field in your hand. If you squeeze it into a ball and it leaves more than a little dust in your hand, or holds up to a bounce in your palm, it is approaching a soil moisture content that has a high risk for runoff. The NRCS has guidance on using the appearance-feel method to practice estimating the amount of soil moisture in your field.

Non-frozen ground soil moisture & runoff conclusions

➢ Manure application windows are short during the non-frozen ground period. Timing of manure applications is critical to reduce risk of nutrient loss.

➢ To decrease the risk of nutrient loss, aim to increase the length of time between a manure application and the first runoff event.

➢ The amount of runoff leaving farmland during non-frozen ground periods is influenced more by soil moisture content during individual rain events than it is by total rain amount. During non-frozen ground time periods, most surface water runoff will occur when the antecedent soil moisture content is > 35%.

A project was completed with researchers from UW–Madison Departments of Soil Science and Biosystems Engineering to identify time periods on different farming systems when manure applications are more likely to contribute sediment and nutrients into surface water runoff. More information is available at www.uwdiscoveryfarms.org, under 'Publications-Peer Reviewed'.

Lessons Learned at Riechers Beef

Riechers Beef is the family farming operation owned by Mark and Jan Riechers along with their sons Joe and Jeff. Joe is actively engaged in the operation having taken over many of the daily activities and management decisions from Mark. Jeff frequently assists with the cropping and livestock duties. Mark and Jan's family also includes their daughter January and their 11 grandchildren.

The farm is in Lafayette County, just west of Darlington, WI. Cropland is in the Galena River and the Pecatonica River watersheds, eventually draining to the Mississippi River. Mark and Jan have operated the farm since the 1970s. Mark began farming by renting the operation from his parents, who owned and operated the farm since the 1940s. While his parents owned it, several silos were put in place, barns were built for livestock, contours were laid out, barnyards were covered with concrete and many other improvements were made. The farm participated in the state sponsored Galena River Watershed Project, which installed barnyard runoff control measures and terraces on most of the fields.

Riechers Beef finishes beef steers, and produces feed through a direct plant (no-till) corn and soybean cropping system. Corn is harvested as either silage or grain and then stored and fed to the cattle. Approximately two thirds of the residue from corn grain harvest is removed for livestock bedding. The soybeans are almost all sold to a local seed company. Depending on the following year's crop rotation and soil test levels, solid beef manure is surface applied to the cropland.

This farm was chosen by the Discovery Farms Steering Committee to represent medium sized beef feedlot operations that have the majority of their cropland devoted to row crop production. The farm is located in the southern end of Wisconsin's driftless region. The moderate sloping landscape and field configuration on 160 acres of the home farm provided us with three watersheds varying in size from 17 - 40 acres, all under the control of the cooperating farmer. Water quality monitoring began in December 2003 and concluded at the end of September 2010.

Major lessons leaned

Impact of farming system on runoff

The direct plant cropping system has proven to be effective in enhancing the infiltration of precipitation. This system has added organic matter to the soil and enhanced soil structure. Crop management practices have the most significant impact on runoff volume while the ground is not frozen, and 80% of the total runoff occurred while the ground was frozen or covered with snow. Total precipitation lost as surface runoff from this farm was less than the state average (6% compared to 8%). Farmers who have adopted no-till or direct plant systems believe that their farming systems have less soil erosion and therefore lower nutrient losses. The study on Riechers beef indicates that soil loss is significantly lower, and that total runoff is also lower. However, winter losses play a more dominant role in nutrient loss and care needs to be taken with manure and nutrient applications during the late winter runoff period (February and March).

Impact of winter manure applications

Riechers Beef utilizes surface applied manure as a fertilizer and mulch on the

soil surface. The 7 years of monitoring clearly indicate that timing of manure application is one of the most important day to day management decisions. Manure was surface applied shortly preceding runoff in 2004, 2005, and 2009. The phosphorus losses were two to five times greater in the basins with manure application during this critical time period. When applications were made weeks or months prior to snowmelt or earlier in the winter, nutrient losses were low. Nutrient losses on this operation were well within desirable levels when manure was properly applied, even though soil test phosphorus levels were excessively high. Soluble phosphorus losses were affected

much more by manure applications close to the runoff period than by soil test levels. Surface manure applications in the spring, summer, fall and early winter (November - January) produced acceptable levels of nutrient loss.

Soil moisture as a runoff risk tool

Data from this farm were used to prove that soil moisture before a storm event is a good predictor of whether the given storm will produce runoff. Storm events with antecedent soil moisture of 35% or higher produced 77% of non frozen ground runoff during the study. Consider the soil moisture level when applying manure, and pay attention to weather forecasts. Recognize that water from a liquid manure application will increase soil moisture levels, and could increase risk of runoff after application. If soils are saturated after the application, even a small precipitation event could cause runoff.

Potential for endocrine disruptor loss

The Riechers farm participated with the Wisconsin State Laboratory of Hygiene on a project to assess the potential effects of hormones in livestock manure. The research project found that a large majority of hormones are rapidly degraded in the environment, and that preventing manure from entering waterways will prevent hormones from entering surface water. Further study of the individual hormones found that the mechanisms for their transport are necessary to determine potential impacts on aquatic organisms.

Designing conservation systems for the 21st century

Throughout the years, Riechers Beef has installed numerous conservation practices to reduce the potential for soil erosion. However, the equipment industry is ever-changing with new options for getting cropping practices done more efficiently and effectively. Equipment has grown to a size where old conservation practices like terraces and contour strips no longer fit. Producers have adopted alternative conservation practices (direct plant systems) to reduce runoff and therefore lessen the need for terraces and/or contour strips. Terraces were removed in one basin on the Riechers farm while monitoring continued for the following year. Data from that year did not show a negative impact on sediment and nutrient loss from removal of the terraces. However, more data would be necessary to adequately assess the difference between surface water losses with and without the terraces.

Changes on the operation

Manure is an essential part of the farming system at Riechers Beef. The operation has limited storage capacity which means that winter manure spreading is necessary, a common practice throughout Wisconsin. The Discovery Farms Program was able to document that manure can be applied on frozen ground provided that there is adequate time for the manure to bond with and/or infiltrate the soil. However, manure applied shortly before runoff, during the runoff period or on fields where the manure cannot interact with the soil had unacceptable levels of nutrient loss. The Riechers and other producers with livestock have been using this information to identify the most critical time periods for runoff and plan accordingly by temporarily storing, stacking, or working with conservation professionals to identify fields with the lowest risk of nutrient loss during must-spread situations. Runoff alerts have also been provided by producer groups, Discovery Farms and state agencies to make livestock farmers aware of high risk runoff periods.

Being aware of soil moisture levels is not only important for runoff management, but also to minimize compaction and damage to the fields during manure application, planting, spraying, or harvesting activities. Riechers Beef have always been careful to stay out of the fields when compaction is a risk, but through the use of the soil moisture monitoring during the study period, they have been able to more accurately identify time periods to avoid field operations.

As mentioned previously, terraces were removed in one 40 acre field because they no longer fit the equipment, and Mark and Joe Riechers believed that advancements in direct plant technology had reduced soil disturbance enough to make up for the impact of the terraces on soil erosion. The Riechers cropping system is unique and carefully managed to keep the productive soil in place.

Changes made by others

As a result of data from this operation and other Discovery Farms sites, a winter manure spreading risk advisory message is sent out annually based on current conditions. These data refined our ability to predict when winter runoff will occur and allows us to extend this knowledge through educational sessions and written documents available on our website.

The strong dataset on the relationship between soil moisture and runoff is documented in a peer reviewed journal article and could help producers determine the amount of liquid manure to apply and when to avoid manure applications.

By Amber Radatz, Tim Radatz, Eric Cooley, Dennis Frame, Aaron Wunderlin and Kevan Klingberg,
UW - Extension / UW - Discovery Farms.
February 2013.

The University of Wisconsin—Discovery Farms Program would like to thank Mark and Jan Riechers and their family, the United States Geological Survey—Wisconsin Water Science Center, and our sponsors for their support and cooperation with this important study.

The Riechers family recognizes the courage and commitment of the Deans of The College of Agriculture and Life Sciences to initiate/facilitate this program of systems research and thanks to the staff of UW Discovery Farms and UW Platteville Pioneer Farm that did this work. It has been a pleasure and an honor to work with them. We also acknowledge the support, contributions, and cooperation of the member groups who lead this effort.

We credit the Secretaries of WDATCP and WDNR for their recognition of our findings as valid references when exploring rules for treating WI farmers fairly while identifying practices to keep our lands and waters healthy and productive. We greatly appreciate the technical assistance and visionary comments brought to the cause by NRCS, USGS, and our local LCD. We commend the members of WI legislature for the original funding of this project, for touring our farm as our study began, and for trusting our results in rule making. We also enjoyed the opportunities to share our experiences with friends and neighbors during our study.

This was truly an outstanding group of visionaries who entrusted farmers to work with UW researchers to identify problems, monitor practices, and to evaluate results. We believe solutions have been identified, findings are being shared, and cooperation between producers and regulators have been improved.

The Riechers Family offers our heartfelt thanks to all of the above.

University of Wisconsin – Extension

DISCOVERY FARMS

University of Wisconsin – Madison

This insert is a summary of on-farm research conducted at Riechers Beef, Darlington, WI. Project results are presented in a series of 9 fact sheets. Each fact sheet is summarized with a 2 page brief and a presentation. Fact sheets, briefs and presentations are available from the UW-Discovery Farms office, PO Box 429, Pigeon Falls, WI 54760, 715-983-5668 or at our website: www.uwdiscoveryfarms.org.