



Discovery Farms Minnesota (DFM) is a farmer led water quality research and educational program. The mission of the program is to collect water quality information under real-world conditions to provide credible and practical information that supports better farm management decisions. There are currently 11 Discovery Farms located in Minnesota.

This factsheet summarizes data collected at Core Farms in water year 2013 (WY2013) which ran from October 2012 through September 2013. Data from GO1, ST1, CH1, BE1, WR1, RE1, DO1, WI1 and NO1W are included. Data from NO1E are not included as the monitoring site was washed out in April and was not operational for the rest of the year. Data from KA1 are also not included and will be summarized in a separate report.

The data presented in this factsheet are generated from edge-of-field monitoring sites. Water quality monitoring results from edge-of-field monitoring sites are different than stream monitoring data and standards. Therefore, direct comparisons of the two types of data should not be made. It is also important to note and remember that the information presented is only from one year of data collection. Past Discovery Farms research has shown that runoff losses can vary greatly from year to year. Final conclusions should not be made from this information, but rather these data should be used as a point of context for information gained in future years.

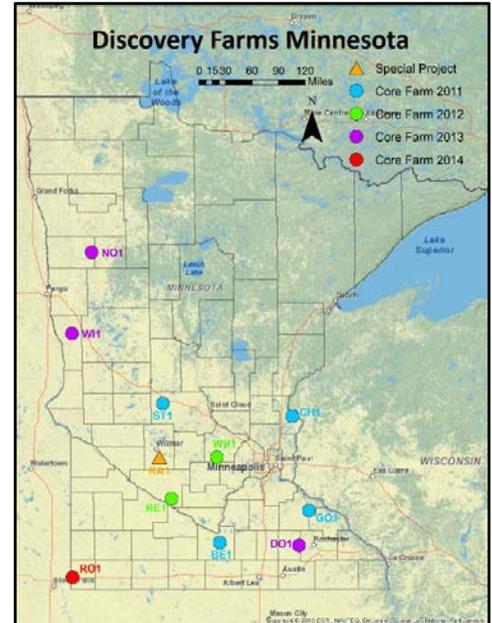


Figure 1: DFM locations

Table 1: Description of DFM projects

| Field ID | Farm Enterprise | Start of Project | Monitoring Setup | Soil Texture | Average Slope | 2013 Crop | Tillage | Manure application |
|----------|---|------------------|--|---------------------------------------|---------------|-------------|--|--------------------|
| KA1 | Turkey and grain (corn) | Aug-07 | Subsurface tile drainage (3 fields and bioreactor) | Loam (poorly drained) | 3.0 % | corn | Fall plow, spring field cultivator | Yes |
| GO1 | Swine farrow to wean and beef (corn-alfalfa) | Sep-10 | Surface runoff (6.3 acres) | Silt loam (well drained) | 6.7 % | corn | Fall manure injection, spring field cultivator | Yes |
| ST1 | Dairy (corn-alfalfa) | Mar-11 | Surface runoff (28.2 acres) and subsurface tile drainage (24.2 acres) | Loam (poorly drained) | 4.1 % | corn | Fall chisel, spring field cultivator | Yes |
| CH1 | Grain (corn-soybean) | Mar-11 | Surface runoff (6.1 acres) | Loam (well drained) | 3.4 % | corn | Modified no-till, deep band fertilizer application | No |
| BE1 | Swine finishing and grain (corn-soybean) | Jun-11 | Surface runoff (14.3) and subsurface tile drainage (26.2 acres) | Silty clay loam (poorly drained) | 1.4 % | corn | Fall chisel, spring field cultivator | Yes |
| WR1 | Dairy (corn-alfalfa) | Dec-11 | Surface runoff and subsurface tile drainage (23.9 acres) | Loam (poorly drained) | 4.7 % | corn | Fall chisel, spring field cultivator | Yes |
| RE1 | Grain (corn-soybean/sweet corn-peas) | Dec-11 | Subsurface tile drainage (81 acres) | Clay loam (poorly drained) | 2.0 % | peas & corn | Fall plow after corn, spring field cultivator | No |
| DO1 | Swine finishing and grain (corn-soybean) | Oct-12 | Surface runoff and subsurface tile drainage (13.9 acres) | Silt loam (poorly drained) | 2.9 % | corn | Fall chisel, spring field cultivator | Yes |
| WI1 | Grain (corn-soybean) | Oct-12 | Subsurface tile drainage (160 acres) | Very fine sandy loam (poorly drained) | 1.1 % | corn | Fall chisel, spring field cultivator | No |
| NO1W | Grain (sugarbeet-corn-dry bean-soybean-wheat) | Oct-12 | Subsurface tile drainage (570.8 acres) | Fine sandy loam (poorly drained) | 1.0 % | corn | Fall chisel, spring field cultivator | No |
| NO1E | Grain (sugarbeet-corn-dry bean-soybean-wheat) | Oct-12 | Surface runoff (87.2 acres) and subsurface tile drainage (120.9 acres) | Silt loam (poorly drained) | 1.7 % | sugar-beet | Fall chisel, spring field cultivator | No |
| RO1 | Beef and grain (corn, soybean and alfalfa) | Oct-13 | Surface runoff (25.5 acres) | Silt loam (well drained) | 4.7 % | corn | Fall disk rip, spring field cultivator | Yes |

The purpose of this report is to give a range of precipitation and runoff losses observed throughout the DFM monitoring network in WY2013. Annual data is displayed in box plots with the boxes representing the 25th, 50th and 75th percentiles and the whiskers representing the maximum and minimum. Precipitation and runoff data are presented in inches. Runoff is calculated by taking the total volume of runoff water and dividing by the size of the monitored area. Yields of soil, phosphorus and nitrogen loss are presented in pounds per acre. Reporting data in these units allows for comparison among monitored sites with different contributing areas.

Weather conditions, landscape characteristics and farm management practices vary significantly from farm to farm and affect runoff losses. For more information please view the 2013 Water Year Monitoring Report and Core Farm Data Reviews on the Resources page at www.discoveryfarmsmn.org.

PRECIPITATION

Median annual precipitation for DFM locations in WY2013 was 4.51 inches below normal, with a range of 7.33 inches below normal to 1.14 inches above normal. Average monthly precipitation was below normal from October to November, near normal from December to January, above normal from February to June and much below normal from July to September. While the overall year was very dry, there was significant precipitation from February to June. This is typically the time period when runoff and drainage are the most active. Many of the sites had frozen soils into April and significant snow into early May, which delayed spring planting across the state.

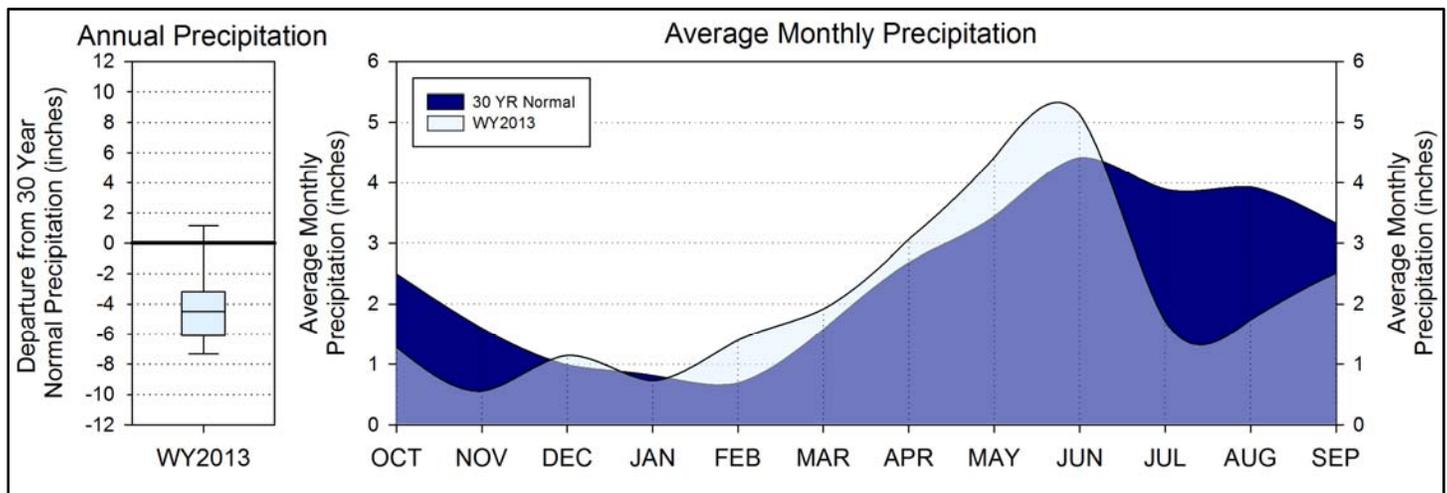


Figure 2: Annual precipitation departure from normal and average monthly precipitation

RUNOFF

Median surface runoff in WY2013 was 3.88 inches with a range from 0.81 to 4.78 inches. Across the monitoring network 77% of the annual surface runoff occurred during frozen soil conditions in March and April, although not all sites had significant frozen soil runoff. Median subsurface tile drainage was 2.01 inches with a range from 0.18 to 6.00 inches. Only 16% of the subsurface tile drainage was observed during frozen soil conditions with most of the subsurface tile drainage occurring from April to July.

Surface runoff and subsurface drainage amounts were relatively similar in WY2013; throughout the monitoring network 12% and 10% of the annual precipitation left the monitored fields as surface runoff and subsurface tile drainage, respectively. The timing and intensity of surface runoff compared to subsurface tile drainage was very different. Surface runoff occurred primarily in March and April while subsurface tile drainage occurred primarily in May and June. Surface

runoff was extremely variable and “flashy” throughout the year with an average of 9.8 cumulative days of flow. Conversely, subsurface tile drainage was much more constant with an average of 78.8 cumulative days of flow.

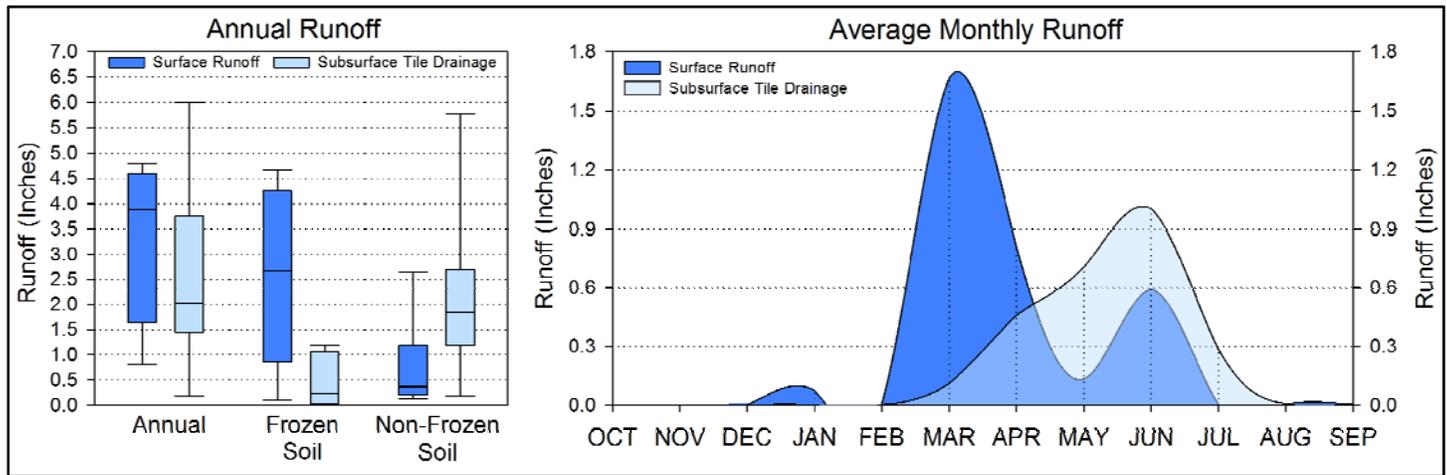


Figure 3: Annual runoff and average monthly runoff

Table 2: Average cumulative flow duration and percentage of precipitation

| WY2012 Averages | Cumulative Flow Duration (days) | Runoff as a Percentage of Precipitation (%) |
|--------------------------|---------------------------------|---|
| Surface Runoff | 9.8 | 12% |
| Subsurface Tile Drainage | 78.8 | 10% |

SOIL LOSS

Soil loss is measured by total suspended solids (TSS), which are mineral and volatile (organic) solids in water that can be trapped by a filter. Median TSS loss from surface runoff in WY2013 was 213.0 lb/ac with a range from 55.9 to 976.0 lb/ac. Almost all of the surface runoff TSS loss was observed during non-frozen soil conditions in May and June and 19% of the TSS was in the volatile fraction. Median TSS loss from subsurface tile drainage was 6.4 lb/ac with a range from 0.8 to 11.3 lb/ac.

Across the monitoring network, soil loss was driven by surface runoff during non-frozen soil periods. Even though most of the surface runoff occurred in March and April, soil loss occurred primarily in May and June. The time period after planting until the crop canopy is established is the most critical time for soil loss and this was the case for WY2013.

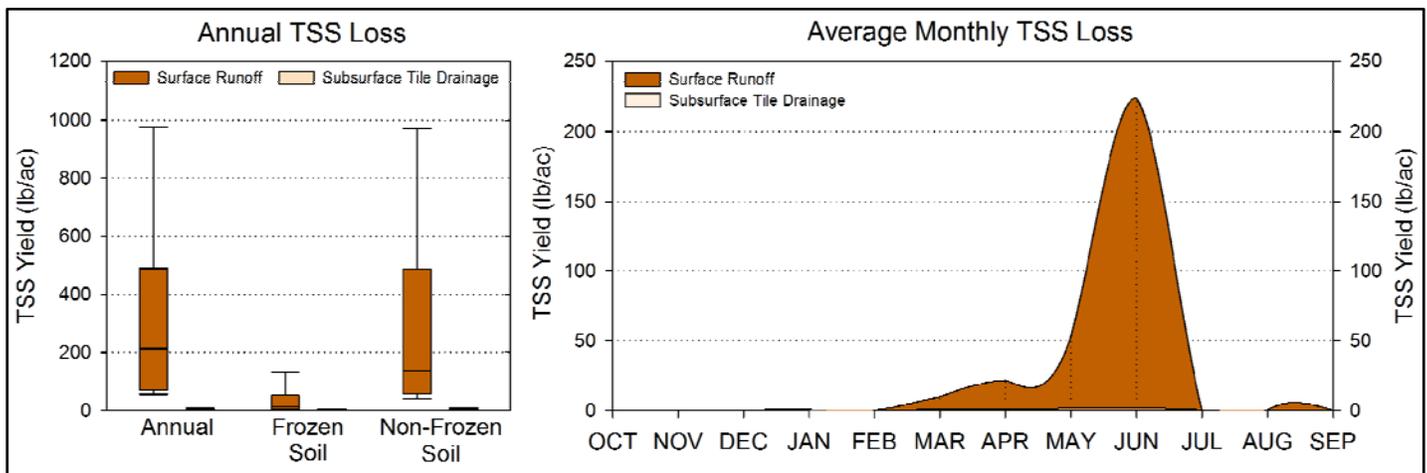


Figure 4: Annual TSS loss and average monthly TSS loss

PHOSPHORUS LOSS

Total phosphorus (TP) refers to the combined total of particulate phosphorus, which is attached to soil particles, and dissolved phosphorus, which is not attached to soil particles. Median TP loss from surface runoff in WY2013 was 1.0 lb/ac with a range from 0.4 to 2.2 lb/ac. Median TP loss from subsurface tile drainage was 0.1 lb/ac with a range from 0.0 to 0.4 lb/ac.

Throughout the monitoring network, phosphorus loss was driven by surface runoff. The timing of phosphorus loss mimicked the timing of surface runoff. Frozen soils in March and April contributed 61% of the annual TP loss from surface runoff. During this frozen soil period, most of the TP loss was in the dissolved form. During the non-frozen soil period in May and June, most of the TP loss was in the particulate form.

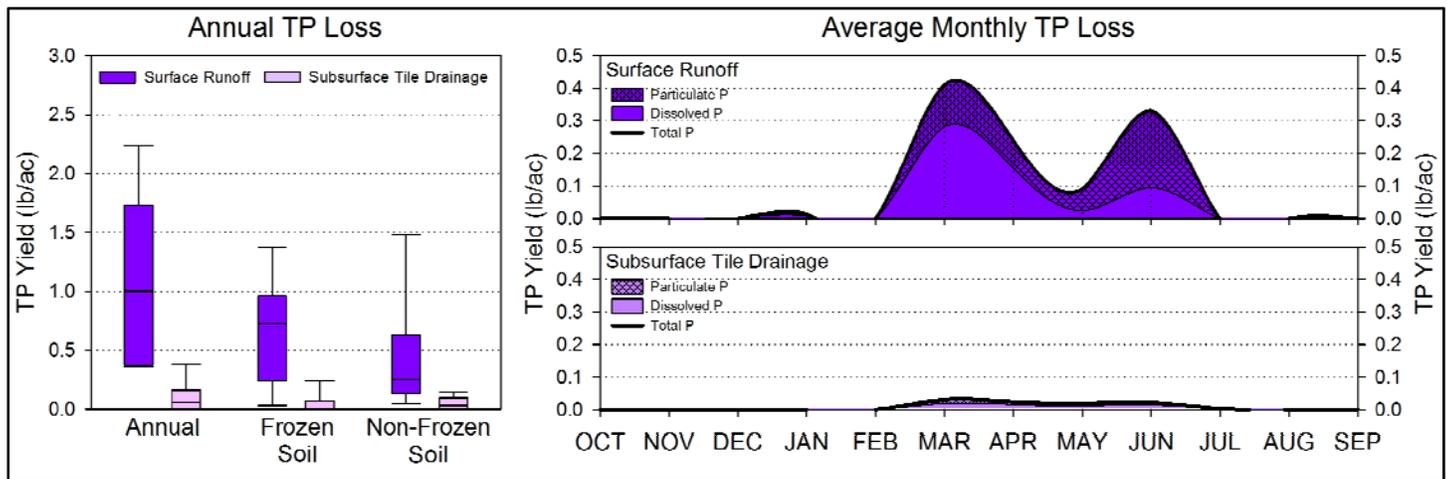


Figure 5: Annual TP loss and average monthly TP loss

NITROGEN LOSS

Total nitrogen (TN) refers to the combined total of nitrate nitrogen, ammonia nitrogen and organic nitrogen. Nitrate can be associated with manure, fertilizer, atmospheric and soil-available nitrogen because it is a stable breakdown product of biological processes. Ammonia nitrogen can be linked to manure, fertilizer, soil and atmospheric nitrogen. Organic nitrogen can be attached to soil particles, found in manure, or be associated with plants and plant residue. Median TN loss from surface runoff in WY2013 was 7.3 lb/ac with a range from 3.1 to 14.5 lb/ac. Median TN loss from subsurface tile drainage was 10.2 lb/ac with a range from 1.0 to 44.3 lb/ac.

Surface runoff TN loss was predominantly in the organic nitrogen form. During the frozen soil period in March, 36% of the TN was in the ammonia form. The timing of surface runoff somewhat paralleled TN loss from surface runoff, as 53% was during frozen soil periods and 47% during non-frozen soil periods.

Across the monitoring network, TN loss was primarily driven by subsurface tile drainage. The timing of subsurface tile drainage paralleled TN loss from subsurface tile drainage, with April through July being the most active. Almost all of the subsurface tile drainage TN loss was in the nitrate nitrogen form during the non-frozen soil period.

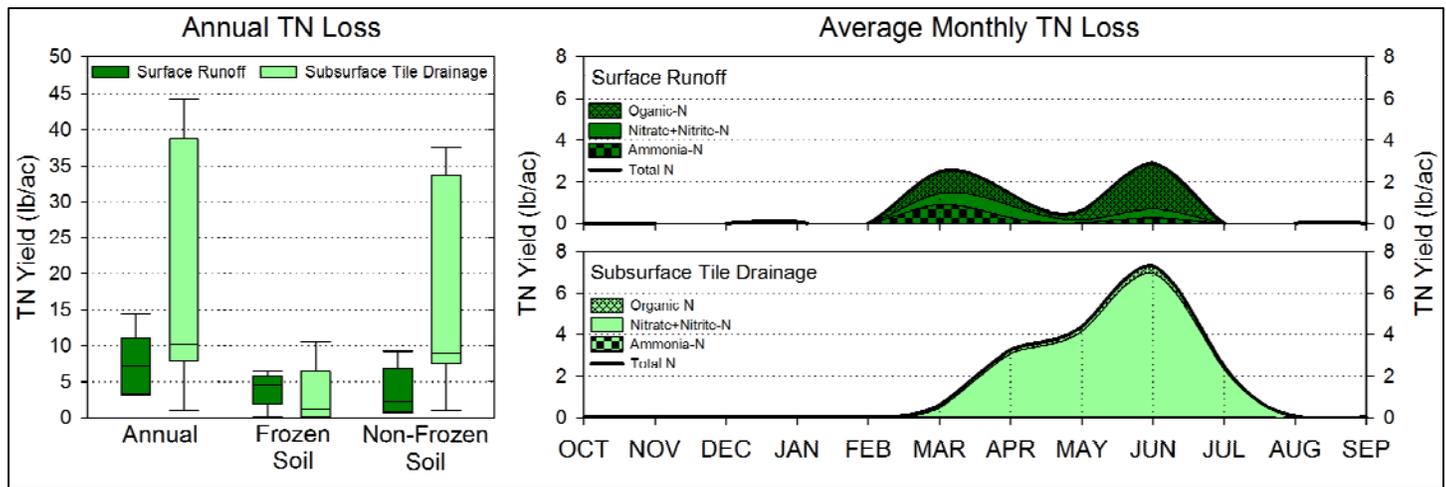


Figure 6: Annual TN loss and average monthly TN Loss

CONCLUSION

Annual precipitation in WY2013 was below normal, however, monthly precipitation during the most active runoff period (February through June) was above normal. High precipitation, frozen soils and snowfalls into May delayed spring plantings and had an effect on runoff and losses. Total surface runoff and subsurface tile drainage amounts were relatively similar for the year. The timing and intensity of the surface runoff and subsurface tile drainage were very different. Surface runoff mainly occurred during the frozen soil period in March and April and subsurface tile drainage mostly occurred during the non-frozen soil period from April through July. Surface runoff event durations were very short while subsurface tile drainage events were prolonged and drawn out. Soil loss was driven by surface runoff and even though little surface runoff was observed in May and June, most of the soil loss occurred during those two months. Phosphorus loss was driven by surface runoff and the phosphorus loss timing closely mirrored surface runoff. Nitrogen loss was primarily driven by subsurface tile drainage and the nitrogen loss timing closely mirrored subsurface tile drainage.

Past data from Discovery Farms Minnesota documented the importance of snowmelt, single storm runoff events and timing of precipitation. Data from WY2013 displayed the importance of snowmelt and timing of precipitation, but also documented the differences between surface runoff and subsurface tile drainage. Discovery Farms research has shown that several factors are important for reducing risk of nutrient and sediment loss throughout the year, including:

- *Harvesting Precipitation Water* – Any management in and around agricultural fields that encourages infiltration of precipitation very close to where it falls. Often this includes a network of conservation practices coupled with highly efficient crop and soil management. Usually, a lower volume of runoff equals lower sediment and nutrient loss.
- *Avoid Nutrient Application Prior to Anticipated Runoff* – Whether it is manure or commercial fertilizer, applying nutrients shortly preceding a runoff event has the greatest risk for increased nutrient losses. Every runoff event can't be predicted, but using the forecast to understand when snow may be melting, rain on snow/frozen soil could occur, or a large rain event is looming helps to make the best management decisions.

For more information about Discovery Farms Minnesota, please contact:

Tim Radatz
(608) 443-6587
radatz@mawrc.org

George Rehm
(507) 263-9127
rehmx001@umn.edu

Scott Matteson
(507) 344-5261
Scott.Matteson@state.mn.us

