Tillage (or not) and Water Quality

Preparation for planting is a key aspect of crop production. Tillage systems are used to manage previous crop residues, control weeds, incorporate fertilizers, and more. There are many different tillage systems, including one-pass no-till planting systems. No-till planters have various attachments immediately in front of the planter unit that provide for residue management and limited in-row seedbed preparation. Other farms utilize more comprehensive tillage systems, especially in areas where soils are slow to dry and warm.

All types of tillage, or lack of tillage, affect soil properties including soil residue cover, structure, compaction, temperature, biology, soil test values, and nutrient availability. The tillage system used can impact weed, nutrient, and pest management practices. The minimum amount of tillage that accomplishes the production goals of a specific farm and landscape will also reduce soil and nutrient loss. However, when tillage does not match a particular landscape or farming system there are risks to production and soil and nutrient loss.

One tillage system does not fit all farms across the state, or even in local neighborhoods. Fields with adequate drainage and significant slope usually do not require aggressive tillage passes. Conversely, in many instances no-till is not appropriate for fields with very low slope and poor drainage, as the risk of soil loss is low no matter the type of tillage and there are significant risks to production.

Discovery Farms programs of Wisconsin and Minnesota have collected water quality information from farms with tillage systems ranging from intensive to no-till. There are many other differences between these farms including location, soils, slopes, crop rotation, study period, and manure application. This information is not intended to provide a direct water quality comparison between specific farms as there are too many variables to assess. It is intended to provide water quality information observed from a number of different tillage systems as a reference to consider when assessing tillage and water quality impacts. The table below provides a description of the different sites.

Farm ID	Farm Enterprise	Location	Study Period	Crop Rotation	Soil Texture	Average Slope	Tile Drained	Tillage System	Manure Application
KA1	Turkey and grain	Central MN Kandiyohi County	2008-2010	corn-soybean	Loam (poorly drained)	2.0%	60' pattern with surface intakes	Fall: plow Spring: field cultivate	turkey manure incorporated
RE1	Grain	Central MN Renville County	2012-2013	corn-soybean	Clay loam (poorly drained)	2.0%	random with surface intakes	Fall: plow Spring: field cultivate	No
BE1	Swine and grain	Southern MN Blue Earth County	2012-2013	corn-soybean	Silty clay loam (poorly drained)	1.4%	80' pattern	Fall: chisel Spring: field cultivate	swine manure injected
ST1	Dairy	Central MN Stearns County	2011-2013	corn-alfalfa	Loam (poorly drained)	4.1%	random	Fall: chisel Spring: field cultivate	dairy manure injected
WR1	Dairy	Central MN Wright County	2012-2013	corn-alfalfa	Loam (poorly drained)	4.7%	random	Fall: chisel Spring: field cultivate	dairy manure incorporated
KE1	Dairy	Eastern WI Kewaunee County	2004-2008	corn-alfalfa	Clay loam (poorly drained)	3.0%	random	Fall: chisel Spring: field cultivate	dairy manure injected
WF1	Grain	Western WI St. Croix County	2011-2013	corn-soybean	Silt loam (well drained)	7.0%	No	Fall: chisel Spring: field cultivate	turkey manure incorporated
JV3	Dairy	Southwestern WI Vernon County	2011-2013	corn-alfalfa	Silt loam (somewhat poorly drained)	15%	No	Fall: chisel Spring: field cultivate	dairy manure injected
WF2	Dairy	Western WI St. Croix County	2011-2013	corn-alfalfa	Silt loam (somewhat poorly drained)	5.0%	No	Fall: none Spring: chisel and disk	dairy manure surface applied
GO1	Swine and beef	Southeast MN Goodhue County	2011-2013	corn-alfalfa	Silt loam (well drained)	6.7%	No	Fall: none Spring: field cultivate	swine manure injected
CH1	Grain	East-central MN Chisago County	2011-2013	corn-soybean	Loam (well drained)	3.4%	No	Fall: none Spring: none	No
JV1	Dairy	Southwestern WI Vernon County	2011-2013	corn-alfalfa	Silt loam (well drained to somewhat poorly drained)	10%	No	Fall: none Spring: none	dairy manure surface applied
JV2	Dairy	Southwestern WI Vernon County	2011-2013	corn-alfalfa	Silt loam (well drained)	10%	No	Fall: none Spring: none	dairy manure surface applied
BU1	Dairy and poultry	Western WI Buffalo County	2002-2008	corn-alfalfa	Silt loam (well drained)	20%	No	Fall: none Spring: none	surface applied dairy and poultry
LA1	Beef and grain	Southwestern WI Lafayette County	2004-2010	corn-soybean	Silt loam (well drained)	5.0%	No	Fall: none Spring: none	dairy manure surface applied

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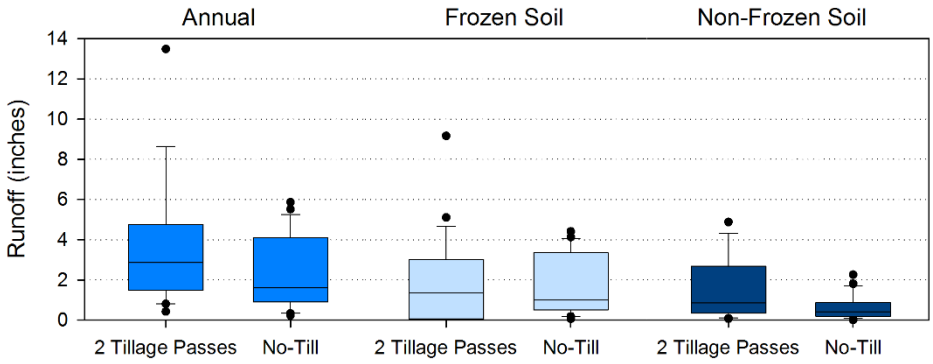
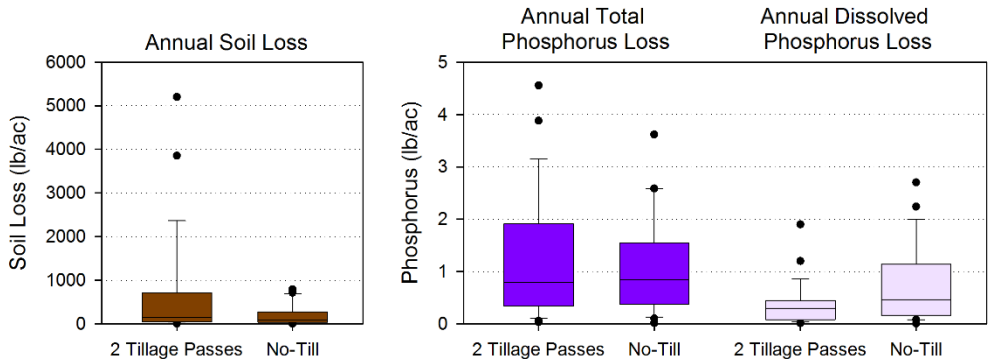
Edge-of-field runoff data in the box plots below represent the 25th, 50th(median), and 75th percentiles, the whiskers represent the 10th and 90th percentiles, and outliers are plotted outside of the whiskers. The two tillage pass data set contains 29 site years and the no-till data set contains 23 site years.

Runoff: Long term Discovery Farms edge-of-field surface runoff data has averaged 2.5 inches of runoff annually, with 55% of the annual runoff occurring during frozen soil conditions and 45% occurring during non-frozen soil periods. Annual runoff and frozen soil runoff medians and inter-quartile ranges were relatively similar across all sites. Overall, the main runoff difference between no-till and two pass tillage systems was observed during the non-frozen soil period, where the median value and inter-quartile range (75th percentile – 25th percentile) was smaller for the no-till farms.



Soil Loss: Long term Discovery Farms edge-of-field surface runoff soil loss data has averaged 667 lb/ac. The median soil loss for the two pass tillage and no-till farms was relatively similar and lower than the long term Discovery Farm average. In most cases, no matter the tillage system, measured soil loss was significantly less than 1 ton/acre (2000 lb/ac). The main soil loss difference between the no-till and two pass tillage farms is in the upper ranges of soil loss. There were no site years where no-till farms had soil loss greater than 1000 lb/ac.

Phosphorus Loss: Long term Discovery Farms edge-of-field surface runoff phosphorus loss data has averaged 2.0 lb/ac, with 50% in the dissolved form and 50% attached to soil particles. Total phosphorus medians and inter-quartile ranges were similar across the tillage systems. Dissolved phosphorus median and inter-quartile range was greater for the no-till farms. In no-till farming systems, phosphorus tends to stratify at the soil surface because phosphorus is immobile and there is no incorporation into the soil profile. This stratification leads to higher dissolved phosphorus losses.



Summary: Water quality data from farms with two pass tillage systems (29 site years) was compared with farms with no-till systems (23 site years). The annual runoff and frozen soil runoff values were similar, however, non-frozen soil runoff was lower for the no-till farms. Median soil loss values were similar and much lower than 1 ton/ac. The upper ranges of soil loss were lower for the no-till farms. Total phosphorus loss was similar, while dissolved phosphorus losses were greater for the no-till farms.