Northern New York Agricultural Development Program
2023 Project Report

Quantifying Long-Term Agronomic and Water Quality Impacts of Cropland Management in Northern New York Corn Fields, Year 6

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Background:
Increased awareness of the impact of nutrient loading from agricultural activities has driven public and producer interest alike in adopting practices such as cover cropping (CC) and no tillage (NT) corn production. While considerable strides have been made in adapting these practices to northern climates with short growing seasons, harsh winters, and unpredictable weather in the fall harvest and spring planting windows, there has been much less focus as to whether the intended environmental benefits are being achieved. Research has demonstrated that the agronomic benefits of NT+CC in combination is greater than the sum of the benefits of either practice in isolation and thus, NT is rarely implemented without the accompanying usage of CC.

However, in poorly drained soils, the transition to NT production can be challenging as the soil structure that was degraded by tillage practices takes time to recover. Therefore, the transition often carries less risk of crop loss when fields are systematically tile-drained. The combination of NT and tiling however can carry some risk as the improved soil structure (larger soil pores) in NT fields increases the risk of dissolved P loss through these large “macropores”, especially when manure is applied without incorporation to the soil. Previous research at these paired fields has indicated that installing tile drainage in a field with corn production under conventional tillage had a substantial impact on the water balance for each field; total drainage was increased by 46%, but the primary runoff

pathway switched from the surface to the subsurface. This increased subsurface drainage led to more than three times greater N losses, but no difference was observed for P.

Despite the possible benefits to the producer, there are also challenges related to implementing NT+CC in corn fields. Short growing seasons, allelopathic effects on the subsequent corn crop, water and nutrient competition between the CC and corn during the early growth stages, can all impact the quality and yield of the corn crop. Although cereal rye is a winter hardy crop that can be planted as late as October 10, early fall growing conditions are highly variable and understanding the degree to which a well-established CC compared to a low biomass CC stand will impact water quality metrics is important for real-word assessment.

Methods:

Beginning in 2016, an edge-of-field monitoring project was established and conducted on two adjacent farm fields in Keeseville, NY. The fields are similar in size (5.8 and 5.9 acres), composed of the same soil type (somewhat poorly drained silt loam; Tonawanda series) and have mild slopes to direct surface runoff to monitoring stations at a corner of each field. Interceptor ditches and berms around the perimeter of each field ensure that each field is hydrologically isolated from adjacent land. Tile drainage was installed in one of the fields in 2016 (Field TD) at 35 ft. lateral spacing and an average 4 ft. depth. In June 2023, the second field (Field UD) was tiled in the same manner and instrumented for sample collection in the same manner as the originally tiled field. Surface runoff and tile drainage were sampled for every 0.67 mm of runoff and composited into a 15-L plastic container. Fully instrumented monitoring of surface runoff and tile drainage from both fields began on December 4, 2023.

Composite samples were collected from all runoff locations two times per week and analyzed for soluble reactive P (SRP), total P (TP), nitrate-N, ammonium-N, total N (TN) and total suspended solids (TSS; an estimate of erosion). Event loads were calculated by multiplying the sample concentration by the runoff volume during each event. Monitoring will continue in subsequent years and once enough additional events are monitored (1-2 years), the data will be compared to the results from the period prior to the second field being tiled.

Results and Discussion:

The previously undrained field (UD) was tiled in June 2023 and a concrete septic tank was installed belowground at the field's main tile outlet to allow for equipment installation and sampling (Figures 1). Both fields were monitored and sampled from January 1 – June 7, 2023 (prior to tile installation) in accordance with the methods from previous years. During this period, seven stormflow events (rain and/or snowmelt) and eight baseflow events (draining shallow groundwater) were sampled. These events represented 42% (8.2 inches) of the total drainage from TD (19.4 inches) and 15% (0.1 lb/acre) of the total P load (0.7 lb/acre). Runoff and total P loading from UD from the events prior to June 2023 was 16.68 inches and 0.5 lb/acre, respectively.

Sampling in TD continued throughout 2023, even when UD was undergoing installation and not monitored to characterize the downtime in UD. This period generated 18% and 27% of the drainage and total P load, respectively, from TD. The new installation in UD was fully functional for sampling on December 4, 2023. Four stormflow events and three

Figure 1. (A) Installation of systematic tile drainage into East field in June 2023; (B) section of drain line PVC with small perforations for drainage water to flow into (C) field immediately following installation of tile laterals, prior to any tillage or other soil disturbance (D) installation of concrete tank at the field edge where tile outlet empties into for monitoring; (E) equipment structure located above concrete tank with tile main outlet; (F) looking down stairs into concrete tank; (G) surface drainage flume (foreground), surface drainage equipment structure (middle ground), partially obscured tile drainage equipment structure (background); Quantifying Long-Term Agronomic and Water Quality Impacts of Tile Drainage in Northern New York; NNYADP

baseflow events were collected prior to the end of the month and contributed 27% and 53% of the annual drainage and total P load from TD. Tile and surface drainage during the December events in UD generated 5.4 inches of drainage and 0.6 lb/acre of total P.

Precipitation and field drainage were much higher in 2023 than during the previous five years of monitoring. The P loading in the drainage was also higher than had previously seen because of the more than doubled volume of surface runoff relative to the next closest year. Surface runoff has consistently produced higher concentrations of P and therefore when their volumes doubled in 2023, the P exported from the system also roughly doubled.

Although we missed several events during the six months between the start and completion of the site installation, we were still able to capture a substantial number of major events during the year. Of particular value are several events from pre- and post-installation that generated large volumes of runoff that will help strengthen the existing dataset. These runoff events are relatively rare relative to the total number but contribute an outsized proportion of the nutrient loading and are extremely important to capture completely and accurately. These data will be used to assess the impact of tile drainage on water quality following continued additional data collection in 2024.

Conclusions:

The primary focus of this project was to install tile drainage and the necessary equipment to conduct research that expands on the previous work conducted at the site. This work has demonstrated elevated risks for nitrogen loss, but no difference in phosphorus loss when systematically tiling corn fields. The new installation will provide the opportunity to more accurately characterize the impacts that field tile has on the water quality parameters we have studied previously and provide a baseline dataset for the comparison of additional crop production strategies.

Outreach:

Results from this ongoing project were presented at the Annual North Country Crop Congress at Miner Institute in February 2023 and at the Cornell CALS PRO-DAIRY event/webinar titled “Tile Drainage on Farms - Managing for Water Quality and Soil Health” in April 2023. Updated results and future directions will be presented at the NNYADP Research Update Meeting on March 13, 2023 and the annual meeting of the American Society of Agronomy in November 2024.

Next Steps:

A NNYADP grant was received to begin monitoring both fields under the new experimental design, with tile drainage and a sampling station in the previously undrained field. The fields will otherwise be managed in the same manner as from 2018-2022. Data collected post-installation will then be compared to the current dataset which will allow for a more scientifically robust assessment of the impacts of tile drainage on field hydrology and nutrient losses.

Acknowledgments:

We thank Adirondack Farms for the opportunity to establish a research site at these fields and its ongoing collaboration and assistance with the project. We also thank the Northern New York Agricultural Development Program for funding this research.

Reports and/or articles in which results of this project have been published:

A summary of this report will be published in a 2024 issue of the Miner Institute *Farm Report*.

For More Information:

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Additional Photos:


Inter-Drain
2050 GP