Northern NY Agricultural Development Program
2013 Project Report

Quantifying Agronomic and Environmental Benefits Of Tile Drainage in NNY

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Background:

Tile-drainage has been an important practice for Northern NY agricultural producers for over 100 years. While the multiple agronomic benefits of tile drainage are well known to farmers and agronomists, the conservation and potential water quality benefits are not as well documented. In the Lake Champlain Basin, tile drainage has come under increased regulatory scrutiny as a potential source of phosphorus. Given the importance of tile drainage to the continued profitability and sustainability of NNY farms, long-term research on agronomic and environmental benefits associated with tile drainage is needed.

A review of the literature reveals tile-drainage of poorly drained fields reduces surface runoff and erosion compared to undrained conditions. Since most phosphorus (P) loss from fields is due primarily to erosion and particulate P loss, tile drainage tends to reduce total P loss from fields compared to similar soils that are not tile-drained (Fraser and Fleming, 2001).

Tile drainage can facilitate loss of nitrate-nitrogen (nitrate-N) in some situations, but increased crop yield from improved drainage can help off-set this by resulting in greater total nitrogen (N) uptake and N efficiency compared to poorly drained conditions (e.g., undrained soils), where much N is lost to the atmosphere through denitrification.

Given the multiple potential agronomic and environmental benefits of tile drainage, there is a need to better quantify and demonstrate both agronomic and environmental aspects of tile drainage to support practical, cost-effective tile drainage best management practices (BMPs) into the future.

Methods:
During 2012, four replicated field plots (150 ft. by 75 ft) were established with the purpose of monitoring runoff water quality on the property of the Lake Alice Wildlife Area in Chazy, NY (owned by the New York State Department of Environmental Conservation). Plots were instrumented to enable monitoring of both surface and subsurface (e.g., tile drainage water) runoff water flows and quality.

Surface and tile drainage runoff from each of the four plots drain to individual manholes where water can be continuously monitored for flow and quality over rainfall events (see pictures at the end of this report). Flows are directed through 5-gallon buckets modified to have small, v-notch weirs and equipped with small stilling wells where pressure transducers are placed. This design allows accurate estimates of water height in the buckets and flows can be reliably estimated by nonlinear regression equations relating water height to measured flow (see Appendix for an example curve generated in the laboratory).

Our experimental design will allow relatively accurate measures of major nutrient inputs (e.g., fertilizer and manure inputs, soil) and outputs from the system (e.g., removal by crop uptake, losses from surface runoff and tile drainage. The overall objective of this research is to determine long-term differences in nutrient loss and efficiency between tile-drained and undrained fields (e.g., tiles will be 'plugged' to simulate no tiles) under a typical dairy field crop rotation in NNY (e.g., 3-4 years of corn followed by 3-4 years of alfalfa-grass).

Due to extremely wet late spring and early summer conditions in 2013, surface runoff trenches could not be completed in the saturated conditions, and we did not want to cause permanent damage to plots while trying to install equipment (e.g., from soil compaction). Therefore, site completion did not occur until later in the summer when drier conditions returned.

Planned treatments could not be imposed (e.g., comparison of drained vs. undrained plots) in time to capture any meaningful runoff events. More technician time was dedicated to trying to install surface runoff trenches multiple times and flow instrumentation than was planned. Notwithstanding, grab samples of tile drainage were performed several times during the year and analyzed for P (see Appendix). Flows were estimated by the time to fill a known volume.

In November 2013, all four surface trenches were repeatedly flushed out with well water that gravity-flowed from a 500-gallon tank to remove any sediment in the plumbing system. All plots were plowed using a moldboard plow in early December and plots will be planted to corn in 2014. Plots are bordered by shallow trenches created with the plow, which are designed to prevent mixing of surface water from adjacent plots.

Results:

The heavy rainfall in June and July during 2013 created major difficulty in completing runoff installation equipment as described in the methods. Photographs documenting the wet conditions and installation of surface runoff trenches are included in the Appendix.

Tile drainage water samples analyzed for P showed that both total and soluble reactive P (SRP) concentrations were generally low. Some of the higher total P values (>100 $\mu g\ L^{-1}$) may have been due to some degree of soil mobilization in drainage water since installation of tile drains occurred fairly recently (in the late fall of 2012). SRP concentrations were generally below 10 $\mu g\ L^{-1}$ and total P was generally <40 $\mu g\ L^{-1}$.

Tile drainage flows were linearly related for the times measured and suggest that drainage patterns are broadly similar among plots (Fig. 1). This provides some degree of confidence that soil hydrology and water table conditions are relatively consistent across the plots. Furthermore, this should indicate that edge-of-field nutrient loss differences due to drainage treatments should be able to be detected.

Grab samples were also taken from one rainfall event from the partially completed surface runoff trenches that had collected runoff from the grass field. This was done to compare P concentration in a sample of surface runoff to P in tile drainage water during the same runoff event. For the one event analyzed, total P in surface runoff was 17 to 100 times greater than total P in tile drainage water, and SRP was 7 to 18 times greater in surface runoff than in tile drainage (data not shown).

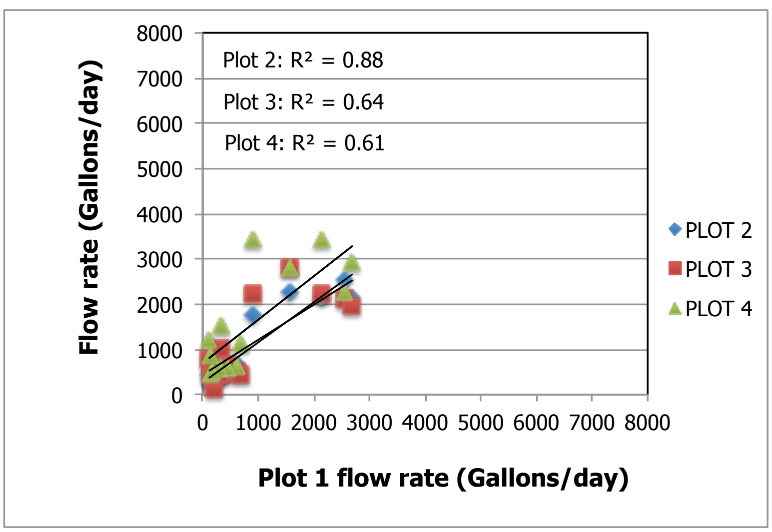

Figure 1. Relationship among plot tile drainage water flows for instantaneous flow rate estimates taken during the 2013 drainage season.

Conclusions/Outcomes/Impacts:

Due to the extended weather-induced project delays in 2013, very few if any conclusions are possible. However, it is clear that accurate edge-of-field water flows and P measures are needed to quantify P fluxes and actual P losses (e.g., mass of P/area/time). For the one event where grab samples of both tile drain water and surface water samples from plots were captured, both total and soluble reactive P (orthophosphate) concentrations in surface runoff were many times greater than tile drainage water. This underscores the importance of accurately measuring P concentrations in both surface and subsurface runoff water.

Outreach:

This project has been described at several recent agronomy extension meetings in the northeast and NNY. Our project has been introduced to several agency and not-for-profit groups in Vermont including the Lake Champlain Basin Program (LCBP), Friends of Northern Lake Champlain, Green Mountain Dairy Discussion Group, and the Franklin Watershed Committee.

In addition, this project and preliminary results were presented at a 2013 tile drainage research meeting held at Miner Institute (cosponsored by NY NRCS and LCBP). This project is also serving as Laura Klaiber's M.S. research and results will be presented at the ASA-CSSSA-SSSA Annual Meeting.

Acknowledgments:

We are grateful for our partnership with the NYSDEC and use of the land at the Lake Alice Wildlife Management Area. We are also grateful for the continued support of the NNYADP and appreciate their historic and continued support of NNY agriculture.

Person to contact for more information: Eric Young and Stephen Kramer

Person to contact for more information (including farmers who have participated: Eric Young and Stephen Kramer.

Appendix:

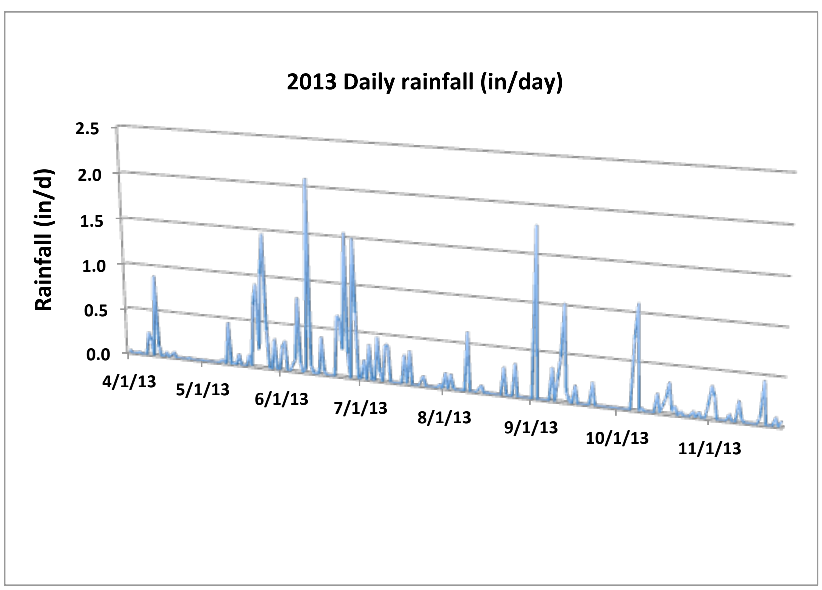

Figure A1. Daily rainfall in Chazy, NY during the 2013 growing season.

Table A1. Summary of instantaneous tile drainage flow rates and soluble reactive and total P concentrations analyzed during the 2013 season.

Sampling date	Plot	Flow (L/d)	SRP (ug/L)	TP (ug/L)
1/14/13	1	9648	9.9	88
3/11/13	1	2304	13.3	188
3/26/13	1	806	-	-
4/12/13	1	1296	-	23
4/15/13	1	1728	3.6	16
4/17/13	1	1080		11
4/19/13	1	576	4.0	11
5/28/13	1	2592	3.0	131
6/3/13	1	540	-	36
6/11/13	1	10152	-	11
6/18/13	1	1296	1.3	7
6/25/13	1	648	2.0	5
6/28/13	1	8064	3.9	-
6/30/13	1	5904	5.9	-
7/1/13	1	3456	4.9	60
7/10/13	1	461	1.2	11
MEAN		**3159**	**5**	**46**
SD		**3364**	**4**	**57**
1/14/13	2	9648	7.3	38
3/11/13	2	2592	24.0	151
3/26/13	2	-	-	
4/12/13	2	1440	-	10
4/15/13	2	2232	1.3	64
4/17/13	2	1584		6
4/19/13	2	1080	1.3	6
5/28/13	2	-	2.4	19
6/3/13	2	1548	-	7
6/11/13	2	8208	-	52
6/18/13	2	2117	1.0	9
6/25/13	2	756	3.3	7
6/28/13	2	8064	3.5	-
6/30/13	2	8640	5.9	-
7/1/13	2	6624	2.9	17
7/10/13	2	1613	0.9	11
MEAN		**3577**	**5**	**30**
SD		**3057**	**7**	**43**
1/14/13	3	7920	6.6	16
3/11/13	3	2016	8.1	111
3/26/13	3	484	-	-
4/12/13	3	1656	-	4
4/15/13	3	2520	1.0	8
4/17/13	3	1872	-	5
4/19/13	3	1584	2.0	5
5/28/13	3	1728	2.0	21
6/3/13	3	2628	-	3
6/11/13	3	7344	-	81
6/18/13	3	3849	3.3	6
6/25/13	3	1584	6.8	13
6/28/13	3	8496	11.9	-
6/30/13	3	10656	2.5	-
7/1/13	3	8496	2.9	8
7/10/13	3	2938	0.0	4
MEAN		**3857**	**4**	**22**
SD		**3207**	**4**	**35**
1/14/13	4	8640	1.7	7
3/11/13	4	2448	4.5	117
3/26/13	4	-	-	
4/12/13	4	2304	-	6
4/15/13	4	2304	1.0	29
4/17/13	4	2304	-	6
4/19/13	4	1836	1.0	5
5/28/13	4	4320	7.8	14
6/3/13	4	3276	5.2	8
6/11/13	4	11016	-	70
6/18/13	4	5760	6.6	7
6/25/13	4	1944	16.5	16
6/28/13	4	12960	6.9	-
6/30/13	4	10656	2.2	-
7/1/13	4	12960	2.2	3
7/10/13	4	4666	0.2	3