Edge-of-Field Water Quality in Surface and Subsurface Runoff from Paired Cornfields

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Background

The USDA's Edge-of-Field water quality monitoring (EoF) program is designed to quantify runoff and nutrient losses utilizing a small paired watershed approach. The goal of EoF monitoring is to better determine soil management practices that maintain crop yield and minimize nutrient losses to surface and groundwater. In addition, EoF data provide important field-scale data to calibrate/validate water quality models. We initiated a study in 2014 to compare nitrogen (N), phosphorus (P), and sediment loading between paired corn fields operated by the Miner Institute in Chazy, NY. Subsurface tile drainage is extensively used on poorly drained crop fields in the region. While agronomic benefits of tile drainage are clear, there is a need to better quantify impacts of tile drainage on runoff hydrology and P export potential in the Lake Champlain Basin of northern NY and Vermont.

Objectives

- Design and instrument surface and subsurface tile drainage flow sampling and gauging systems for two adjacent fields.

- Quantify total P (TP), soluble reactive P (SRP), total nitrogen (TN), nitrate-N, ammonium-N, and total suspended solid (TSS) loads in surface runoff and subsurface tile drainage flow to generate a baseline data set prior to initiating controlled subsurface drainage (CD) in one field (planned for 2017-2020).

Materials and Methods

- In 2014 two corn fields (2.0 and 3.6 ha) were selected with similar soils and cropping history and chosen in consultation with the NY-NRCS state Agronomist. Soils are somewhat poorly drained and similar in texture.

- Subsurface drainage tile (10 cm i.d., corrugated drain pipe) was installed in both fields during November-December 2014. Lateral tile drains were spaced at 10.7 m and placed at an average depth of 1.2 m below the soil surface on a 0.001 minimum grade. Fields are hydraulically isolated and separated by diversions and berms (Fig.1).

- Drainage water control structures (Agri-Drain Corp., Adair, IA) were installed on individual tile drain lateral lines in April 2015 (Fig. 2).

- Subsurface and surface runoff water system designs were completed by River Bend Ag and Environmental Services, Altona NY. The tile drainage system was installed by Barnes Excavation, Plattsburgh, NY.

- Tile drain flows are gauged inside concrete traffic manholes (1.2 m, i.d.) with custom v-notch flow-through barrel system (Fig. 3). Ultrasonic sensors (Teledyne Isco, Lincoln, NE) located within the barrel provide continuous calibrated water height. Flow is estimated using a nonlinear regression between observed water height and measured flows. Autosamplers collect 200 mL samples from subsurface tile mains at manholes and surface water runoff at the H-flumes (Fig. 2).

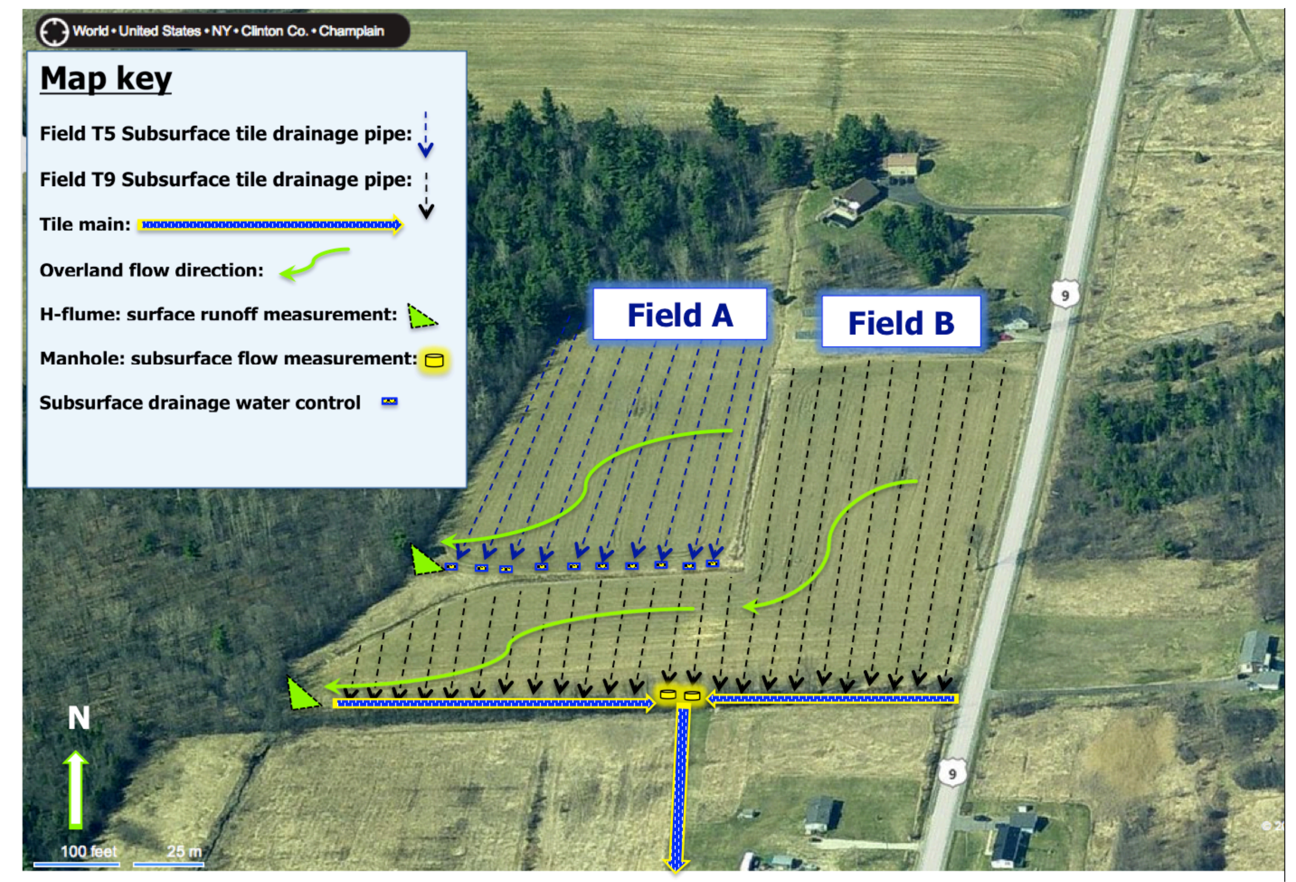

Figure 1. Site map showing fields and location of hydrologic instrumentation.

Figure 2. Surface water flume for field A (left) and field B (right).

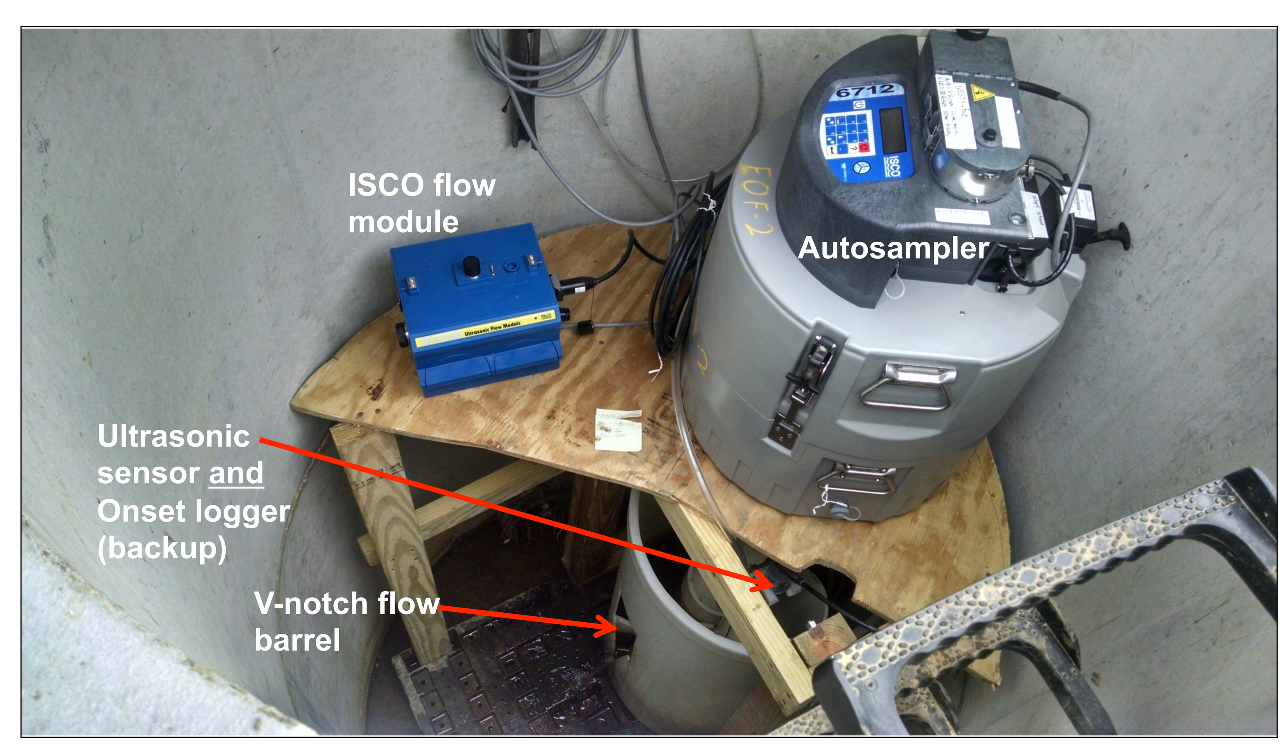

Figure 3. Subsurface tile drain sampling and gauging setup inside manhole.

- Surface water runoff is gauged with pre-calibrated H-flumes (Openchannelflow, Atlanta, GA) with Ultrasonic sensors to measure water height and is then converted flow.

- Flow-based samples were taken by autosamplers (Fig. 3) and event mean concentrations were multiplied by runoff volumes to estimate *flow weighted mean* loads for runoff events. Data reported here represent events from captured from 10/29/15 to 3/25/16.

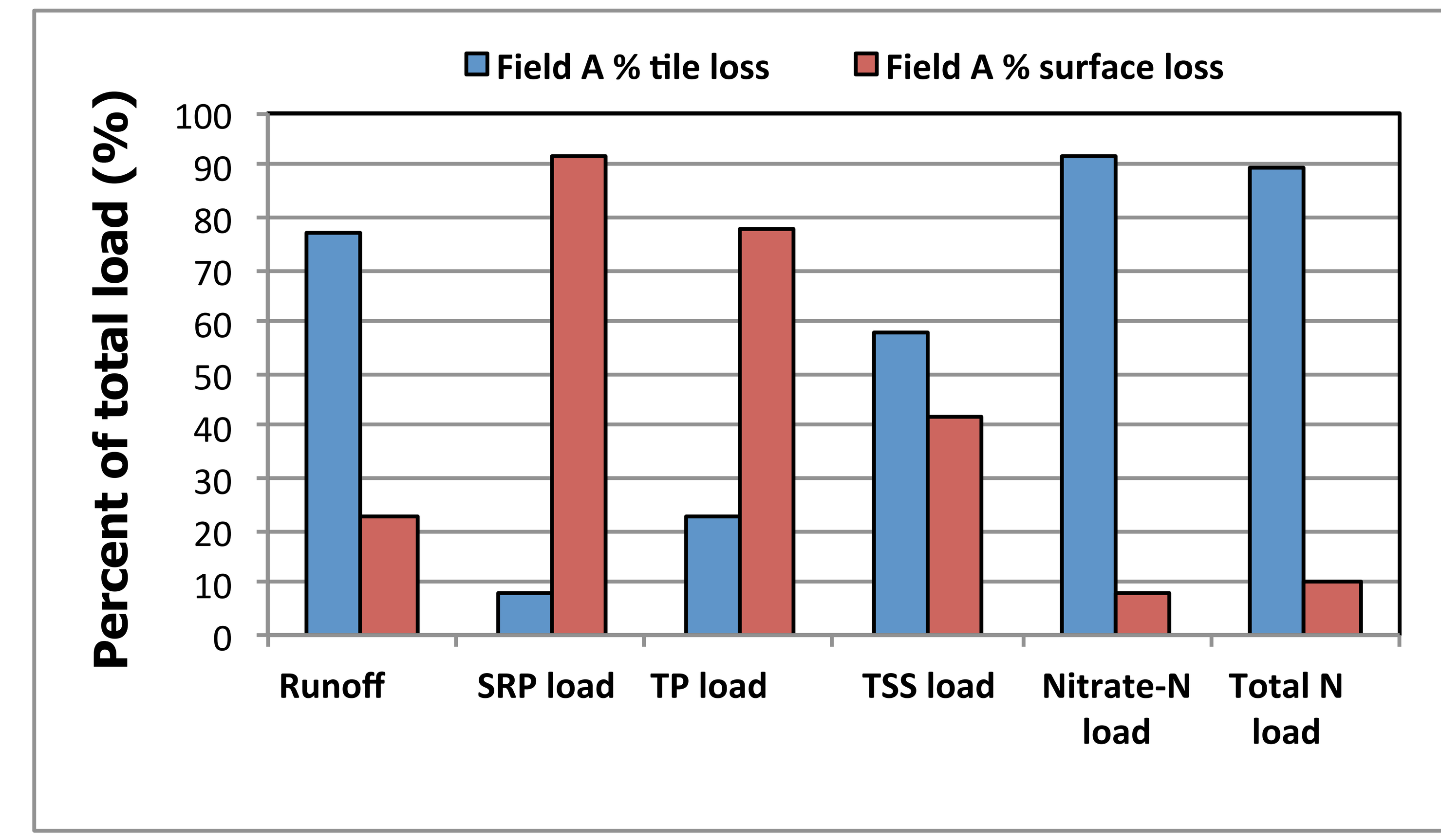

Figure 4. Percentage of load as surface or subsurface runoff or tile drain flow for field A.

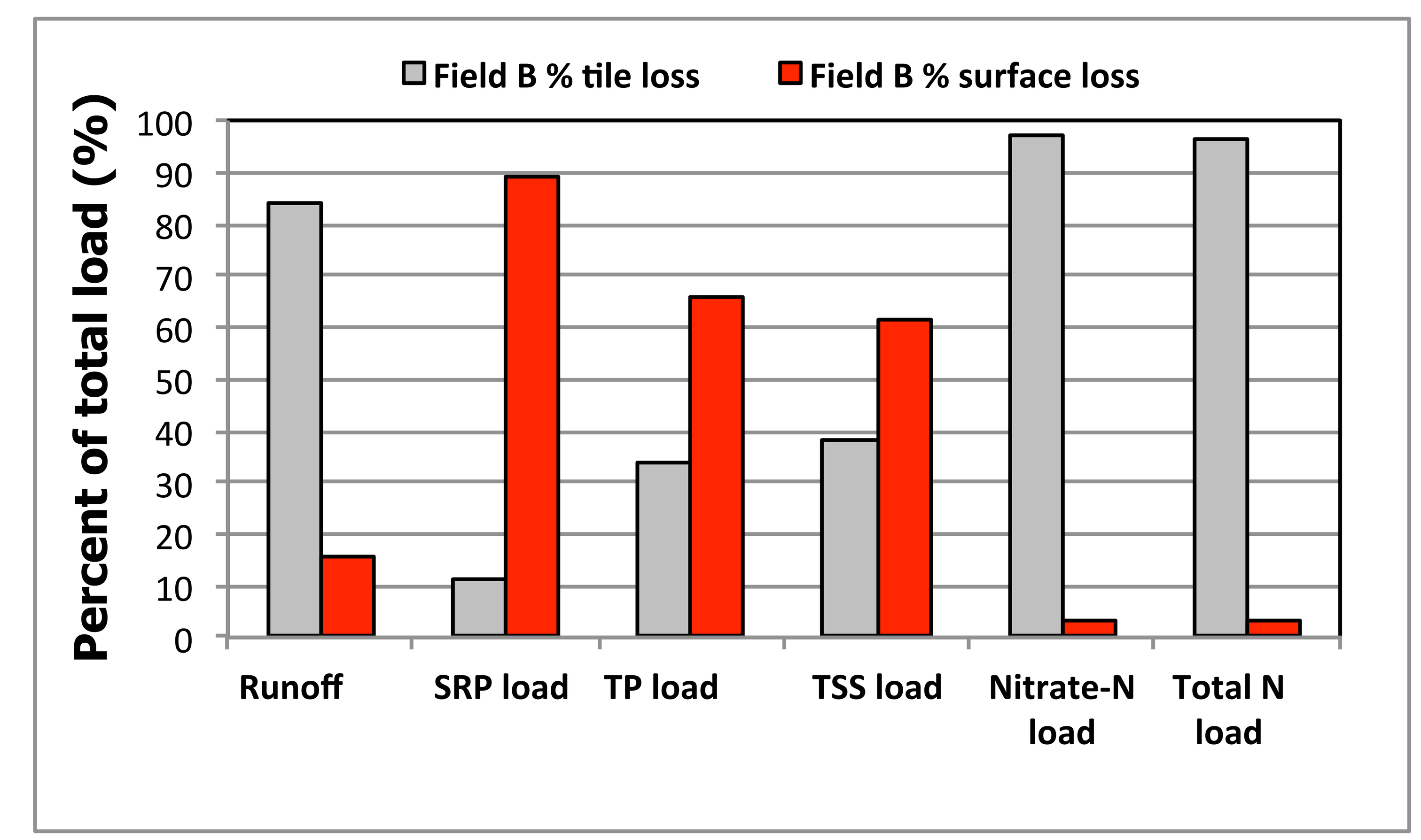

Figure 5. Percentage of load as surface or subsurface runoff or tile drain flow for field B.

Early Baseline Results

- Broadly similar export patterns for N and P between the fields occurred (Fig. 4 and 5).

- 77 to 84% of runoff was through tile drainage, yet nearly 90% of SRP loss was due to surface water runoff and 66 to 78% of TP loss was in surface runoff (Fig. 4 and 5).

- Nitrate-N load was nearly all from tile drainage flow and in the form of nitrate-N.

- P appears to be transported mainly in surface runoff for the events captured.

Acknowledgements

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