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# Water Discharge, Nitrogen and Phosphorus Losses & Crop Production in Response to Phosphorus Drawn Down in High P Soil under Free Drainage and Water Table Control Systems

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## Introduction

- Phosphorus (P) loss in tile drainage water from poorly structured clayey soils has increasingly become a concern, due to well-developed preferential flow, especially under reduced or no-tillage practice.
- Phosphorus can be a key nutrients governing eutrophication of fresh water bodies.
- The status of P in long-term fertilizer soils must be determined to assess fertilizer P needs and ensure environmental quality.
- Over 70% agricultural soils are tile drained in Ontario.
- The drainage tiles are designed to remove excess surface and soil water. Unfortunately, this approach can increase non-point source agricultural sediments and nutrients into surface and ground water sources.
- Increasing incidences of drought ad/or climate extremes in Southern Ontario have had serious negative impacts on environment (i.e. potentia leaching for unused residues of nutrients) and field crop production.
- Hence, new agricultural practices must be developed to reduce soil erosion and promote more efficient use of soil water and nutrients by crops. To address these issues, an integrated reservoir-water table control and water recycling system was conducted.

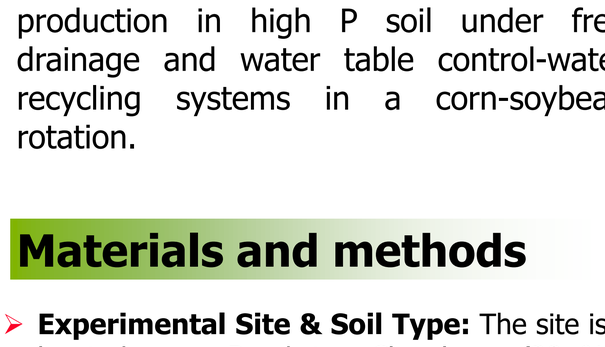
## Objectives

The objective of this study is to investigate the impacts of phosphorus drawn down on nutrient losses and crop production in high P soil under free drainage and water table control-water recycling systems in a corn-soybean rotation.

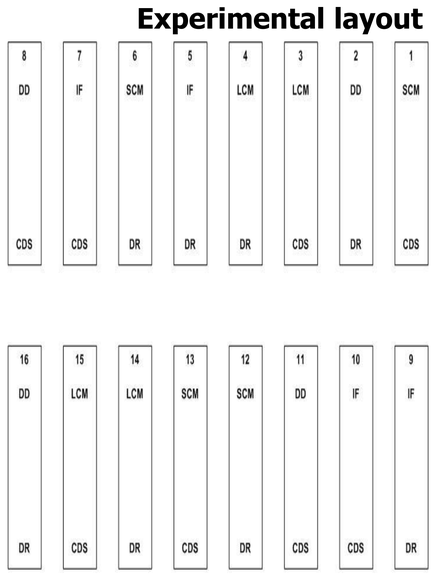
## Materials and methods

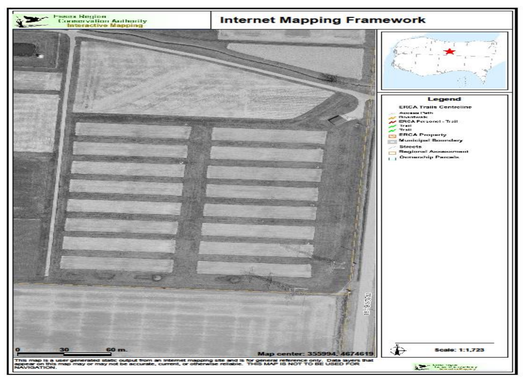
- **Experimental Site & Soil Type:** The site is located on a Brookston Clay loam (28 % sand, 35 % Silt, 37 % clay) at the Eugene F. Whelan Experimental Farm, AAFC, Woodslee, Ontario.
- **Treatments**

  The treatments included a P drawn down (inorganic fertilizer N and K), a inorganic fertilizer control (inorganic fertilizer N, P, and K), and two water management strategies (traditional free drainage, DR vs. controlled drainage/sub-irrigation water recycling, CDS) with two replications in a factorial design.



**Experimental layout**



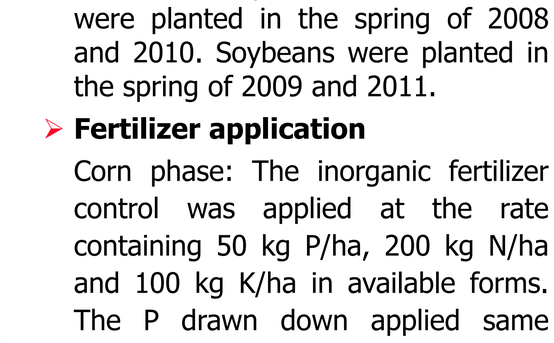



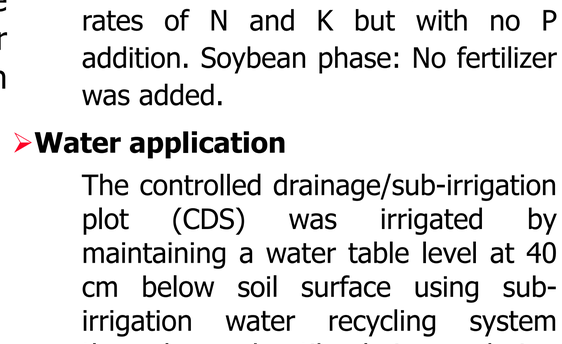

- **Agronomy**

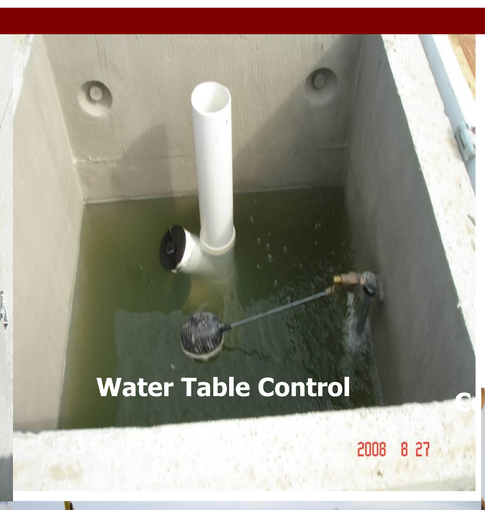
  Corn and soybean rotation; Corns were planted in the spring of 2008 and 2010. Soybeans were planted in the spring of 2009 and 2011.
- **Fertilizer application**

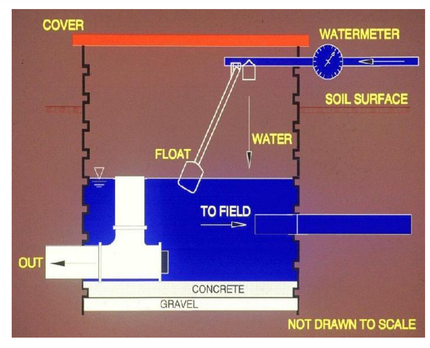
  Corn phase: The inorganic fertilizer control was applied at the rate containing 50 kg P/ha, 200 kg N/ha and 100 kg K/ha in available forms. The P drawn down applied same rates of N and K but with no P addition. Soybean phase: No fertilizer was added.
- **Water application**

  The controlled drainage/sub-irrigation plot (CDS) was irrigated by maintaining a water table level at 40 cm below soil surface using sub-irrigation water recycling system through regular tile drainage during the growing season.

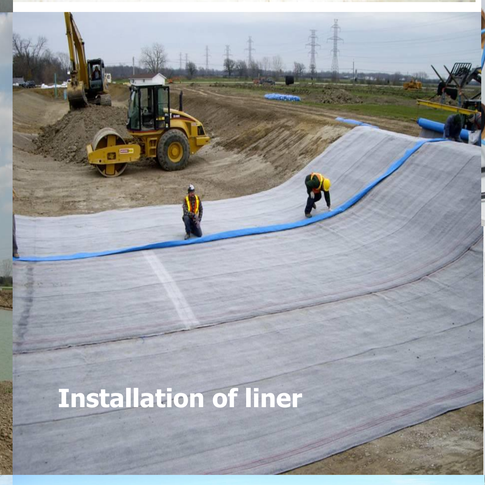


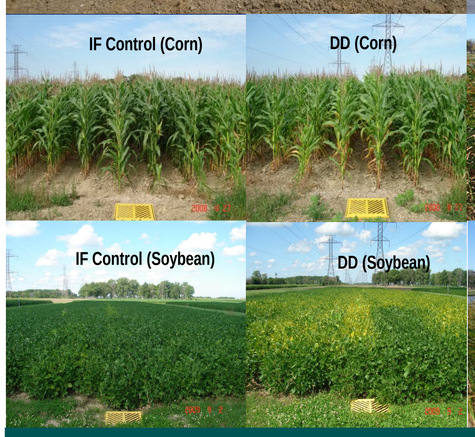



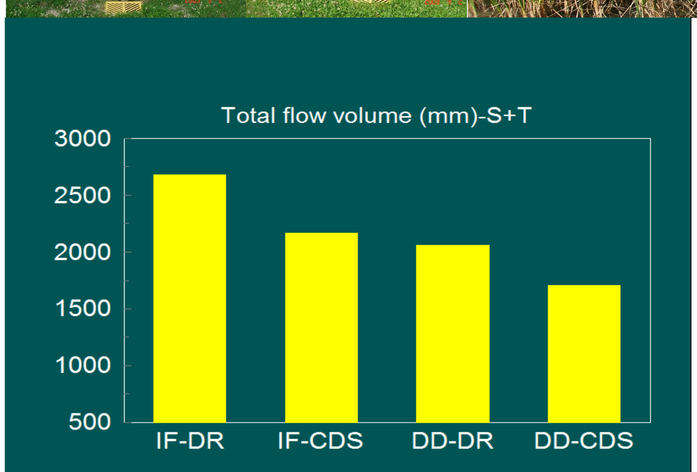



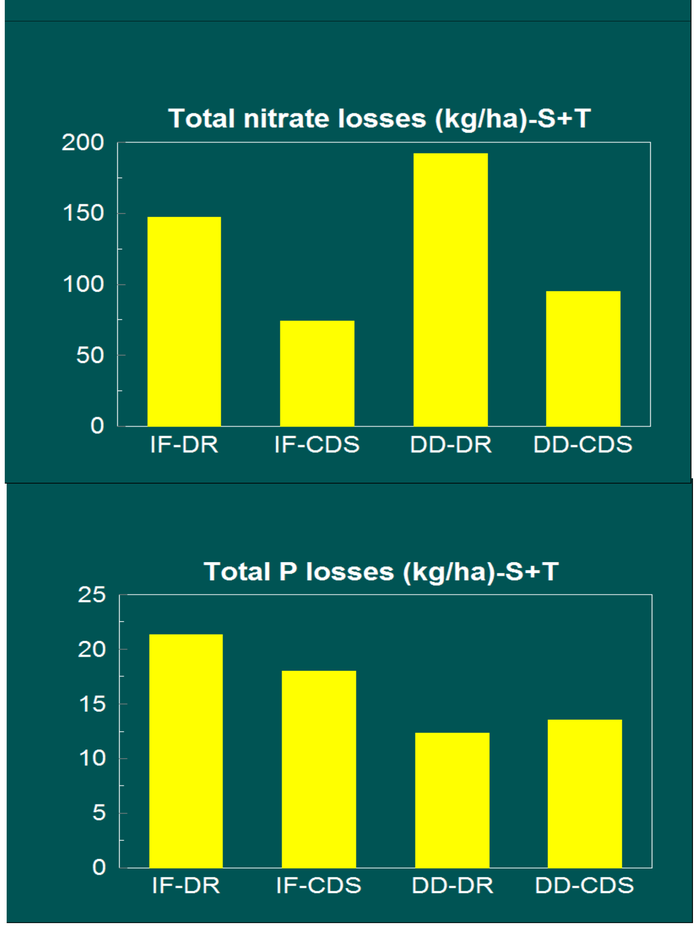









## Results & Discussion

- **Surface run-off and sub-surface drainage**

  Traditional free drainage (DR) had lower surface run-off volume than the controlled drainage/sub-irrigation (CDS) treatments. on the other hand, the sub-surface drainage volume under DR system had much higher values than the CDS system.

  The P drawn down (DD) treatment had low cumulative total (surface + tile) water discharge combined with DR and CDS system than inorganic fertilizer control (IF) treatment.
- **Flow weighted mean N & P concentrations**

  The flow weighted mean N concentration in both surface runoff and sub-surface tile discharge water under DD treatment had much higher values than IF treatment. The reverse was true for flow weighted mean P concentration.
- **Total N & P losses**

  The DD treatment had the higher cumulative total N and lower cumulative total P losses than the IF control. The CDS system reduced total cumulative N and P losses by 50 % and 7 %, respectively, relative to DR system.
- **Corn & Soybean yields**

  The DD treatment had higher corn yields than IF control treatment. However, the DD treatment had low soybean yields relative to IF control treatment

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