ONFARM Factsheet:

Soil Health and Water Quality

ONFARM

WILTON CONSULTING GROUP

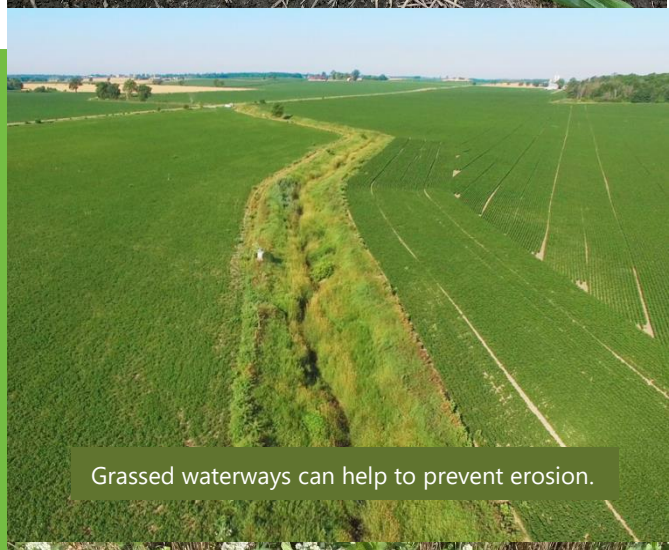
Soil Health and Water Quality

Soil health has a direct connection to improved water quality. Healthy soils result in less sediment and nutrients being carried into lakes, rivers, and streams, which benefits the aquatic environment and drinking water quality. Healthy soils also retain more water and nutrients, which can lead to improved yields and crop resiliency.

Corn grown under no-till management can help to reduce the risk of erosion.

Beneficial management practices that support soil health and protect water quality include:

- Decreasing soil disturbance by reducing or eliminating tillage
- Building and maintaining erosion control structures
- Keeping soils covered year-round with plants and/or crop residue, while maintaining living roots in the soil for as much of the year as possible
- Contour farming and strip cropping



Grassed waterways can help to prevent erosion.

Soil Health

Soil health refers to the capacity of soil to support sustainable crop growth. Soil properties or soil health indicators can be influenced or changed through beneficial management practices (BMPs). Healthy soils provide crop production benefits, such as improved water infiltration and retention, better fertilizer use efficiency, and increased crop resiliency during environmental stress.

Cover crops keep living roots in the soil after the cash crop is harvested.

Any single BMP can help to improve soil health, but the greatest benefits will accrue when multiple BMPs are used together. BMPs which improve soil health can be integrated into field crop rotations in cost-effective ways that do not negatively affect farm profitability, according to the U.S. Department of Agriculture's Natural Resource Conservation Service.

An example of contour drainage is shown in the front field. Source: Huronview Demo Farm photo.

Erosion and Leaching

Precipitation that falls on agricultural fields runs off or infiltrates the soil and eventually most precipitation ends up in surface or ground water. Soil erosion occurs when soil particles are relocated within the field or carried off the field by runoff during precipitation events. Water quality is reduced when soil particles enter surface water bodies. Sedimentation happens when soil particles settle out of runoff. Sedimentation alters stream ecology and increases costs for drinking water treatment.

Additionally, sediment can carry organic matter and nutrients with it in runoff. Phosphorus and excessive nitrogen carried into surface water bodies can result in harmful algal blooms, low-oxygen water conditions, and fish mortality.

Connections between soil health and water quality

When soil is healthy and managed using BMPs, water quality can be positively impacted. Soils covered with living plant matter and crop residue help to hold soil particles in place and prevent erosion during significant precipitation events. Healthy soils also have good soil structure, which describes the amount of pore space between soil particles. Soils with good structure can better infiltrate and retain water during precipitation events. The more water infiltrated and retained in soils, the less runoff occurs.

When runoff and leaching are reduced, more nutrients – including phosphorus – are retained in the soil root zone for crop use.

AgriSuite Phosphorus Loss Assessment

The Ontario Ministry of Agriculture, Food, and Rural Affairs created AgriSuite, which is a suite of agricultural and environmental decision tools. One of the tools is the Phosphorus Loss Assessment Tool for Ontario (PLATO), which allows users to estimate the risk of phosphorus loss for a single field. This tool can help farmers make management decisions to help reduce potential phosphorus loss to nearby waterways.

The negative effects of soil erosion on crop growth are visible in this field.

What is ONFARM?

From 2019 through 2023, the On-Farm Applied Research and Monitoring (ONFARM) program completed extensive soil health and water quality analysis on 33 farm sites on representative soils and landscapes across southern Ontario. This network of sites and newly established cooperator partnerships helped to build a stronger understanding of BMPs and their effect on soil health and water quality on Ontario farmland.

ONFARM Data Collection

ONFARM researchers conducted event-based monitoring, which involved recording measurements when a significant precipitation event occurred at both the sub-watershed and edge-of-field scales.

Five partnering Conservation Authorities worked with ONFARM cooperators to collect key water quality, water quantity, and land-use data in the Priority Subwatersheds. Participating Conservation Authorities included:

AUSABLE BAYFIELD CONSERVATION
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Essex Region Conservation
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Maitland CONSERVATION

Lower Thames Conservation

UPPER THAMES RIVER
CONSERVATION AUTHORITY

The type of edge-of-field data that was collected included:

Weather (e.g., precipitation, temperature)

Hydrologic layers (e.g., streams, municipal drainage)

Land use layers (e.g., agriculture land use, non-agriculture land use, field boundaries)

Soil characteristics (e.g., soil nutrients, soil organic matter)

Field activities information (e.g., fertilizer and manure application)

Water quantity (e.g., stream flow)

Stream water quality (e.g., total phosphorus)

ONFARM Findings

“Most phosphorus and nitrogen losses, as well as total suspended sediment losses, occur in the non-growing season when most of the water is moving through the landscape,” says Tatianna Lozier, the Stewardship Services Coordinator at the Upper Thames River Conservation Authority. “Anytime water is leaving a field, nutrients are leaving the field,” she adds.

“While weather events are outside of farmers’ control, implementing BMPs can be crucial for reducing nutrient or sediment loss from the farm. Small changes can bring positive benefits (e.g., switching from conventional tillage to minimal tillage),” says James Cober, a Program Analyst at OSCIA. “It is important to have contingency plans,” Cober adds. For example, a contingency plan could be preparing to plant a different cover crop after harvest if an interseeded cover crop does not establish a strong stand.

Henry Denotter – Denotter Farms
Henry Denotter, an ONFARM cooperator and farmer in southern Essex County, is dedicated to finding the optimal management practices to conserve soil and water health while improving the profitability of his operation.

Check out this case study to learn more about Henry’s ONFARM trials.

ISCO samplers are used to gather samples from field run-off. Photo courtesy of Maitland Valley Conservation Authority.

Jeannettes Creek Case Studies

The Lower Thames Valley Conservation Authority (LTVCA) collaborated with Dr. Merrin Macrae, a professor in the Department of Geography and Environmental Management at the University of Waterloo (UW), and the UW Biogeochemistry Lab, on the ONFARM research in Jeannettes Creek. This creek is a tributary of the Thames River near Chatham. The researchers studied two farming operations within the Jeannettes Creek subwatershed. The LTVCA monitored runoff from the tile drainage systems in the two fields, and Macrae analyzed the data and results.

Both farming operations are located on Brookston clay soils and strive to use a corn-soybean-soybean-wheat rotation. One operation is no-till and strives for continuous cover using cover crops. The other operation uses conservation tillage.

The total phosphorus load at both sites was primarily in particulate form, meaning it was attached to soil particles. It is possible the inherent Brookston clay soil conditions contributed to the high losses of particulate phosphorus observed at both sites.

The conservation tillage site consistently had higher total suspended sediment losses, higher total phosphorus losses, and higher nitrate loads over the four-year study period. In contrast, higher dissolved reactive phosphorus (DRP) losses occurred at the no-till site due to the phosphorus stratification caused by the surface broadcasting of fertilizer. The biggest DRP losses occurred as incidental losses in the fall after the fertilizer was broadcast. At the conservation tillage site, in contrast, fertilizer was surface broadcast and incorporated through tillage within 48 hours of application, which considerably mitigated the DRP losses in subsequent tile flow events.

The monitoring and analyses conducted by the LTVCA and Macrae demonstrate that tradeoffs can occur between different management practices. The inherent soil conditions can contribute to higher nutrient loads relative to other fields with different soil types. Overall, however, the implementation of BMPs can mitigate losses.

Key Takeaways

Healthy soils contribute to:

- Healthier aquatic environments
- Improved drinking water quality
- Improved water and nutrient retention in the soil profile

BMPs for improving soil health can be implemented in cost-effective ways. If you are considering implementing soil health practices or have already started on your soil health journey, consider how soil health BMPs can positively impact both water quality and farm profitability.

This photo shows the LTVCA's Jeannettes Creek edge-of-field continuous cover crop site.

Want to learn more?

You can learn more about ONFARM, read the Technical Reports, and watch recordings from previous Forums. If you are interested in learning more about soil health and water quality, you can begin with this Soil Health in Ontario pamphlet. If you are interested in conducting your own research, be sure to check out the ONFARM Research Guidebook. You can also review these additional resources:

- Soil Erosion by Water - OMAFRA
- Managing Soil Health: Concepts and Practices - Penn State Extension
- Soil Health Manual - Cornell University Soil Health Lab

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