INFOSHEET #15

SOIL MANAGEMENT

How to address concerns identified in your Environmental Farm Plan Worksheet #15

environmental farm plan
sustainably farmed

Based on Environmental Farm Plan Workbook, 4th ed. 2013

This infosheet outlines options to address concerns identified in your Environmental Farm Plan (EFP) as they relate to soil management. Good soil management will improve soil health and resiliency to extreme weather events such as drought or intense rainfall.

All options in this infosheet are classed as **Actions** or **Compensating Factors**.

- **Actions** address the identified concern, and will change the EFP rating to (3) or Best (4).
- **Compensating Factors** are alternatives that will adequately address the concern, but will not change the rating in the EFP worksheet.

In most cases, you'll need more information before choosing and implementing options. Sources for more information are noted at the end of this infosheet.

For help with technical terms, please see the full glossary in your EFP Workbook.

Growing Forward 2
Ontario Farm Environmental Coalition
Ontario
Canada

15–1. Potential for water erosion

BACKGROUND

The soil type, slope and drainage determine a soil's erosion potential. If surface water is nearby, it is likely that eroded soil in the form of sediment will be carried in field runoff to enter the surface water during storms.

Sediment in a stream will cloud the water, affecting both plant and animal life. Sediment can also carry nutrients and pesticides attached to soil particles into the water. This results in eroded soil that is less productive and reduced surface water quality.

Our limited supply of topsoil is priceless. Each ton/ac of soil lost means:

- **$9+ lost in macro and micro nutrients**
- **lost organic matter leading to:**
  - **degraded soil structure**
  - **a decline in infiltration and water-holding capacity**
  - **increasing bulk density**
  - **tougher crop germination or emergence**
- **off-site costs such as:**
  - **more frequent ditch/harbour cleanouts**
  - **algae growth in lakes**
  - **declining recreational and drinking water quality.**

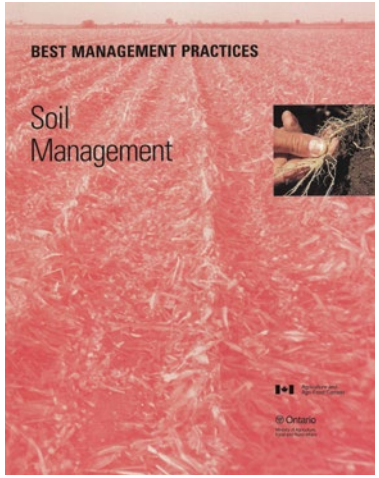
WHAT CAN YOU DO?

OPTION 1 – COMPENSATING FACTOR

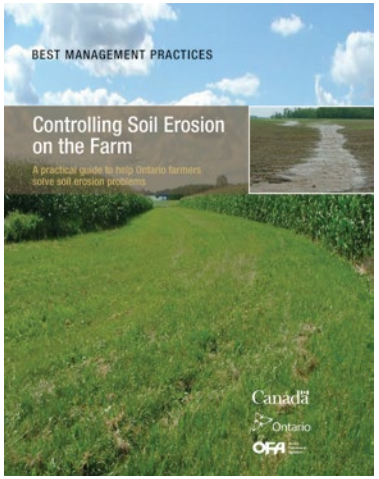
Implement good soil conservation cropping and tillage practices wherever possible that will minimize runoff of water and sediment to surface water:

- establish permanent 3 m (10 ft) vegetated buffer strips alongside surface water
- leave crop residue on the soil surface
- adopt no-till where applicable
- adopt strip cropping where applicable
- reduce the number of tillage passes
- rotate crops with a variety of crop species including forages and cereals
- plant cover crops
- establish grassed waterways in preferential flow areas
- install erosion control structures.

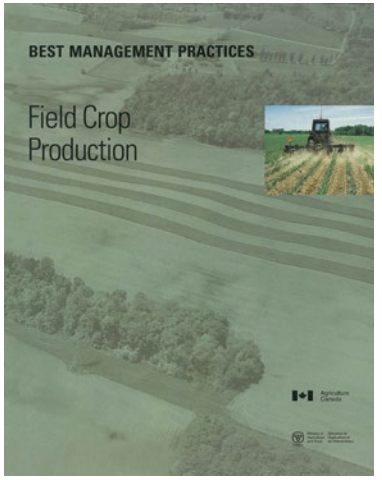
Crop residue will help to reduce the movement of water and soil sediment from fields to surface water.



Soil Management **can help you solve everyday cropland soil problems and build long-term soil health and productivity. It covers the basics of soil properties, diagnostics for soil problems, and BMPs to prevent and correct problem soil conditions.**



A particular soil erosion problem can be caused by water, wind, slope, drainage, tillage and other management practices. With photos of each type of erosion and charts that link in-field symptoms with practical remedial options, *Controlling Soil Erosion on the Farm* can help you find the right solution for your circumstances.



Field Crop Production **examines all facets of in-field production, including soil, nutrient and pest management, tillage systems, and conservation cropping and structures.**

15–2. Potential for wind erosion

BACKGROUND

The potential for a soil to be eroded by wind is determined largely by soil type. Other factors include the amount of organic matter in the soil, the amount of residue on the soil surface, wind speed and soil moisture.

Wind erosion affects soil by removing the topsoil – the productive portion of the soil containing the organic matter and nutrients. Severe wind erosion can reduce visibility on adjacent roads.

See also these OMAFRA publications:

- *Agronomy Guide for Field Crops*, Publication 811
- *Control of Soil Erosion*, Order no. 95-089
- *Ontario Field Vegetable Guide*, Publication 839
- *Soil Erosion – Causes and Effects*, Order no. 12-053
- *Universal Soil Loss Equation (USLE)*, Order no. 12-051

WHAT CAN YOU DO?

OPTION 1 – COMPENSATING FACTOR

Aim for at least 30% soil coverage by:

- leaving crop residues on the soil surface (the result of reduced tillage)
- planting cover crops.

OPTION 2 – COMPENSATING FACTOR

Reduce wind speed by:

- planting tree windbreaks along field borders and within the fields
- planting vegetative barriers (temporary windbreaks) such as rye, barley or corn.

OPTION 3 – COMPENSATING FACTOR

Improve soil organic matter levels by:

- using a good crop rotation, including forages and cover crops
- adding organic matter in the form of livestock manure or other organic material including crop residues.

Windbreaks can reduce wind speed and reduce the airborne movement of soil.

15–3. Potential for tillage erosion

BACKGROUND

Tillage erosion occurs when tillage tools loosen and move the soil on hilly to rolling topography. Gravity pulls the loosened soil farther downhill. Soil is moved off the knolls and hillsides by tillage implements, and this may explain why hillsides are becoming depleted of topsoil more quickly than expected. Tillage erosion does not occur on level land.

Over time, tillage erosion can remove all topsoil from the knolls of a field, exposing the less productive subsoil below.

In addition to OMAFRA resources on page 2, see also these BMP publications:

- *Field Crop Production*, page 43
- *Soil Management*, pages 46–47, 63, 65
- *No-Till: Making it Work* – a BMP publication (pictured on pg. 11 of this infosheet).

WHAT CAN YOU DO?

OPTION 1 – COMPENSATING FACTOR

Switch to a no-till system and eliminate inter-row cultivation.

OPTION 2 – COMPENSATING FACTOR

Reduce the number of tillage passes:

- make no more than two tillage passes prior to planting
- travel slower and till shallower
- switch to reduced tillage systems.

OPTION 3 – COMPENSATING FACTOR

Till across the slope or on the contour:

- till cross-slope or on contour to reduce the soil thrown by tillage implements
- travel slower and till shallower.

Tillage erosion occurs when tillage tools loosen and move the soil on hilly to rolling topography. Implements that move a lot of soil, gravity and speed are the main causes of soil movement.

15–4. Evidence of sheet erosion and/or tillage erosion

BACKGROUND

Sheet erosion often goes unnoticed for long periods of time because it is not dramatic like rill and gully erosion – until large amounts of soil are lost and the subsoil appears on the hillsides and knolls. Lighter-coloured knolls and poor crop production on hillside slopes are evidence of sheet erosion. Soil from these areas usually moves to lower areas of the fields.

Crop production on subsoil can cost you money in lost yield and quality, and higher input costs.

WHAT CAN YOU DO?

OPTION 1 – ACTION

Slow down water movement by:

- leaving crop residues on the soil surface
- planting cover crops.

OPTION 2 – ACTION

Improve soil organic matter levels by:

- using a good crop rotation that includes forages and cover crops
- adding organic matter in the form of livestock manure or other organic material such as crop residue.

Cover crops will reduce sheet erosion by slowing the movement of water and adding to the soil's organic matter.

15–5. Evidence of rill or gully erosion

BACKGROUND

Large amounts (tonnes) of soil can be lost in a single rainfall event to rill or gully erosion. Erosion will leave the field rough, and may create a depression large enough to damage field equipment.

Eroded soil can bury healthy plants, accumulate in lower areas of the field, or enter surface water. Soil that lies in low areas may cause those areas to remain wet longer, and subsoil deposited there will dilute or bury the existing topsoil. Soil that reaches surface water will impair water quality by adding sediment and nutrients.

Rill erosion may create a depression large enough to damage field equipment.

WHAT CAN YOU DO?

OPTION 1 – ACTION

Install structures to control erosion and transport water safely across fields, eventually to surface water:

- contact OMAFRA (1-877-424-1300) or your Conservation Authority for a list of qualified erosion control contractors who can advise on the use of appropriate structures – water and sediment control basins (WASCoBs), grassed waterways, and drop structures are some of the options for erosion control structures.

OPTION 2 – ACTION

Control water movement over the soil surface by:

- leaving crop residues on the soil surface
- planting cover crops
- planting alternating strips of crops, including forages, across the slope or by contour strip cropping.

See also these OMAFRA resources:

- *Control of Soil Erosion,* Order no. 95-089
- *Grassed Waterways,* Order no. 09-921
- *Soil Erosion – Causes and Effects,* Order no. 12-053
- *The Planning and Maintenance of an Erosion Control System,* Order no. 97-015
- *Use of Earthen Berms for Erosion Control,* Order no. 99-047
- *Use of Rock in Erosion Control Projects,* Order no. 90-227
- *Water and Sediment Control Basins,* Order no. 89-167

15–6. Land highly erodible by water

BACKGROUND

Highly erodible land such as steeply sloping fields with highly erodible soils can quickly lose topsoil and thus their productive capability within just a few years. Many of these fields have already lost the topsoil and are no longer productive.

The topsoil from these fields may end up in surface water or lower areas of the fields. Once the topsoil is depleted, the subsoil begins to erode as well and is deposited in lower areas of the field, covering up existing topsoil.

Soil that reaches surface water will impair water quality by adding sediment, nutrients and pesticides. Eventually this may mean that those watercourses, drains or ditches will need to be cleaned out.

See also:

- BMP *Field Crop Production*, pages 77–109
- BMP *Soil Management*, pages 40–43

WHAT CAN YOU DO?

OPTION 1 – ACTION

Switch to a no-till or a conservation strip cropping system with an appropriate crop rotation. If the land is to be grazed, do so with care to minimize the potential for further damage by overgrazing:

- include forages in the rotation
- leave the crop residue on the soil surface
- avoid overgrazing that results in bare areas.

OPTION 2 – ACTION

Change land use to provide a permanent cover of trees, shrubs or forage:

- control livestock grazing
- stop tilling these areas.

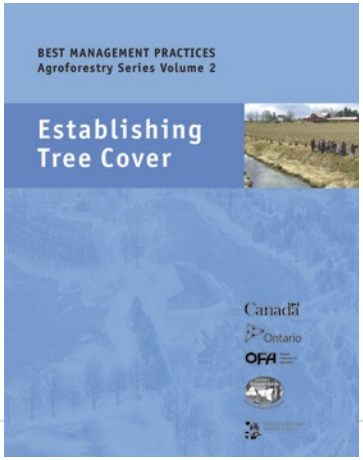
Soil that reaches surface water will impair water quality due to the presence of sediment and nutrients.

15–7. Land highly erodible by wind

BACKGROUND

Highly erodible land can have much of the topsoil blown away by the wind in a relatively short time. This greatly reduces yield potential.

The soil that is blown will drift in the fencerows and around buildings, and may cause a hazard for drivers by reducing visibility.



This BMP book provides many options for planning, planting, and maintaining treed windbreaks within buffer strips, in pasture, or intercropped with field crops.

WHAT CAN YOU DO?

OPTION 1 – ACTION

Plant trees to slow the wind speed:

- where possible, plant windbreaks at right angles to direction of the prevailing wind
- keep less than 305 m (1,000 ft) distance between areas with trees
- use windstrips in combination with windbreaks or as a transitional measure until trees are large enough to provide sufficient protection.

OPTION 2 – ACTION

Keep the soil covered by:

- establishing a permanent cover of trees or shrubs or an orchard
- establishing a permanent forage crop
- leaving crop residue on the soil surface with at least 30% surface coverage
- planting cover crops immediately after crop harvest – winter-hardy cover crops such as rye or winter wheat are better options for highly erodible areas
- use in field vegetated rows (windstrips) to provide protection for land at risk of wind erosion.

Windstrips provide flexible wind protection for land at risk of wind erosion. They can be used in combination with windbreaks, or as a transitional measure until trees are large enough to provide sufficient protection.

See OMAFRA videos on windbreaks:

- www.omafra.gov.on.ca/english/environment/facts/windbreaks.htm

15–8. Marginal lands

BACKGROUND

Very steeply sloping land, poorly drained land, or land that has some other physical feature limiting crop production and use of farm implements is considered marginal for profitable row crop production.

There is greater potential environmental impact from farming marginal land. For example, a very steep hillside will have all the standard crop inputs applied, but due to the limitations on that soil (e.g. erosion, loss of organic matter, droughtiness), the yield may not equal that of the more productive parts of the field. Not only are valuable crop inputs not resulting in greater yields on marginal land, but there may be more chance of these inputs moving from the field to surface water and becoming pollutants.

WHAT CAN YOU DO?

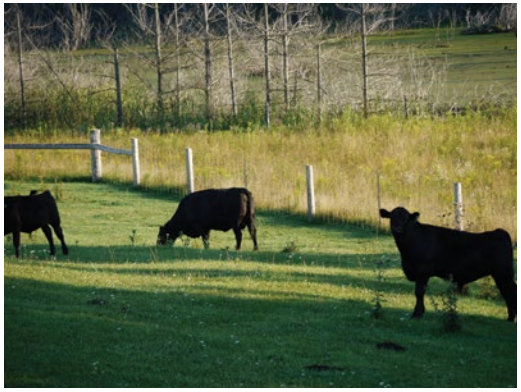
OPTION 1 – ACTION

Retire the land from active row crop production by:

- growing forages
- practising frequent rotational grazing
- permanently planting the area into trees or shrubs.

If you plan to retire marginal lands from food production, and want suggestions for planting and alternative uses, see these BMP publications:

- *Buffer Strips*
- *Establishing Tree Cover*
- *Fish and Wildlife Habitat Management*
- *Streamside Grazing*
- *Woodlot Management*



With proper management, marginal lands can be good forage producers.

MANAGEMENT

15–9. Potential for soil compaction

BACKGROUND

The potential for compaction is determined by the soil type and the natural drainage for that soil as determined by the Soil and Site Evaluation, EFP Worksheet #1. But human activity will determine whether or not potential develops into an actual compaction problem.

Compaction lowers yields by reducing water and air movement in the soil and restricting root growth.

See also:

- *Agronomy Guide for Field Crops,* Publication 811
- BMP *Soil Management* (pages 34–39)

WHAT CAN YOU DO?

OPTION 1 – COMPENSATING FACTORS

Manage equipment setup and use to avoid compaction:

- stay out of field when it is wet
- reduce axle weight – the use of wagons, combines etc. with loads of greater than 5 tons per axle will increase risk of compaction
- spread equipment load over larger area, e.g. dual tires, radial tires, reduced tire pressure
- avoid using tillage implements that tend to pulverize the soil, such as the disc
- try to establish permanent traffic patterns.

Improve soil structure by planting soil-improving crops such as red clover and alfalfa.

While not always possible, harvesting when soil conditions are relatively dry will greatly reduce soil compaction.

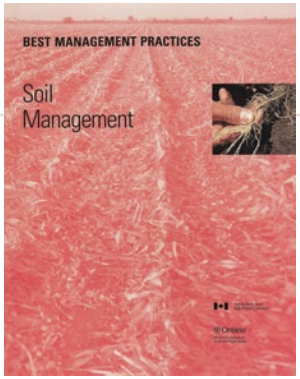
15–10. Field traffic

BACKGROUND	WHAT CAN YOU DO?
The number of field passes, soil moisture and equipment weight all influence the degree of structural damage caused by field traffic. Harvest operations are often the most damaging. For example, during sugar beet harvest, more than 80% of the field will be tracked.	**OPTION 1 – ACTION** **Reduce the number of trips over the field by:** • adopting no-till or reduced tillage systems where appropriate • using controlled traffic lines • performing multiple operations in each pass. **OPTION 2 – ACTION** **Reduce the impact of the field traffic by:** • staying out of field when it is wet • reducing axle weight – the use of wagons, combines etc. with loads of greater than 5 tons per axle will increase risk of compaction • increasing surface area supporting equipment – use dual tires, radial tires and/or reduce tire pressure on equipment • establishing seasonal if not permanent traffic patterns, such as traffic lanes • loading wagons or trucks on the headland • improving soil structure by planting soil-improving crops such as red clover and alfalfa.

Reducing tire pressure will increase the surface area in contact with the soil and spread the load over a larger area, reducing compaction.

15–11. Soil structure

BACKGROUND	WHAT CAN YOU DO?
Good soil structure is important for well-developed root growth and optimum water-holding capacity. Good root growth in turn allows plants to access the water and nutrients they need from the soil. A soil with good structure is also less likely to erode and compact.	**OPTION 1 – ACTION** **Improve soil structure by:** • using a good crop rotation (including forages if possible) • leaving crop residues on the soil surface • adding cover crops whenever possible • adding organic matter such as manure, compost etc. • reducing tillage.



For more information about soil structure, see pages 32–39.

Vigorous root growth in the corn seedling on the left is evidence of a soil with good structure. The seedling on the right was growing in a compacted soil with poor structure.

15–12. Water infiltration

BACKGROUND

The amount of water lying on the soil surface can be an indicator of:

- an unusually high water table
- a need for an improved drainage system
- a compacted or poorly structured soil.

See also:

- BMP *Soil Management,* pages 52–53 and 57–58

WHAT CAN YOU DO?

OPTION 1 – ACTION

Remove excess water by:

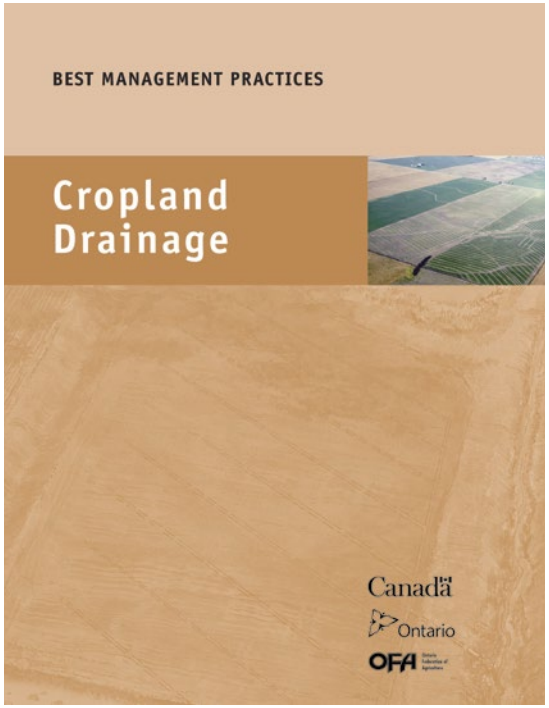
- improving surface drainage to ditches
- installing tile drainage and properly maintaining it.

OPTION 2 – ACTION

Improve the infiltration of surface water by:

- reducing compaction (see question 15–9)
- improving soil structure (see question 15–11).

Surface inlets and subsurface drainage will improve surface drainage and reduce water movement across the surface of the soil, lowering the risk of soil erosion.



This BMP book shows how drainage should be considered part of an overall soil management system for the farm. It details how to diagnose surface and subsurface drainage problems, and takes a step-by-step approach to designing or upgrading a drainage system for optimal benefits and minimal environmental impacts. The construction section includes handy checklists for landowners and contractors. Inspection, maintenance, and troubleshooting are also covered.

15–13. Soil drainage profile

BACKGROUND	WHAT CAN YOU DO?
The lack of good natural drainage or tile drainage can affect crop growth and the timeliness of field operations, and increase compaction potential. Areas of a field that are too wet may result in uneven growth of the crop and the inefficient use of nutrients and other inputs applied to the field. The air spaces in the soil are filled with water and the plant may actually die.	**OPTION 1 – ACTION** **Lower the water table so that it does not impact crop growth by:** • installing tile drainage • properly maintaining the tile drainage system. **OPTION 2 – ACTION** **Improve water infiltration by:** • reducing soil compaction (see question 15–9) • improving soil structure (see question 15–11).

Overly wet soils can affect crop growth and the timeliness of field operations, and increase the potential for compaction.

15–14. Amount of organic matter in the soil as measured by a soil test

BACKGROUND	WHAT CAN YOU DO?
Organic matter is an important indicator of many things in the soil, including: • soil structure – a moderately high level of 4–6% may be an indicator of good soil structure • water-holding capacity • the ability to contribute to the nutrient cycle. The amount of organic matter in the soil can be easily measured with a soil test. Keep a record of each soil test for comparison with previous and future tests to see if the organic matter percentage is increasing or decreasing. It is a well-known fact that organic matter disappears very easily, but is very difficult to increase. Take every opportunity to protect and increase it.	**OPTION 1 – ACTION** **Improve soil organic matter levels by:** • using a good crop rotation, including forages when possible • adding organic matter in the form of livestock manure or other organic material • leaving crop residue in the field • reducing the number of tillage passes • planting cover crops.

For more information about about sampling and testing, see this OMAFRA factsheet:

- ***Soil Sampling and Analysis for Managing Crop Nutrients*, Order no. 06-031**

A soil test can provide valuable information about a soil's health, such as the amount of organic matter in the sample.

15–15. Amount of tillage

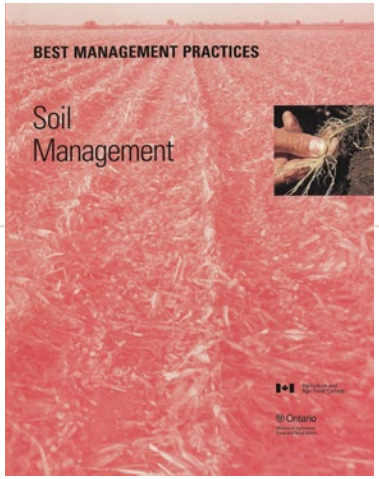
BACKGROUND	WHAT CAN YOU DO?
Organic matter is reduced by tillage because more organic matter is exposed to air, which breaks it down and releases carbon as carbon dioxide. In fact, each tillage pass will destroy some organic matter, and on rolling topography will move soil down the slope. Soil clods break down, and the finer soil that is left is more susceptible to erosion, soil crusting and compaction. Soil structure is destroyed by excessive tillage.	**OPTION 1 – ACTION** **Reduce the number of tillage passes across the field to a maximum of two:** • adopt a reduced or no-till system.

Reduced-till seeding will lower tillage costs and help to maintain soil organic matter.

15–16. Tillage depth

BACKGROUND	WHAT CAN YOU DO?
Deep tillage can result in the mixing of subsoil with topsoil. This dilutes topsoil quality and productivity. Subsoil is unproductive because it lacks organic matter, contains fewer nutrients, and usually has poor structure. Mixing topsoil and subsoil therefore dilutes the amount of organic matter in the soil and can cause soil structure problems. Areas of the field where mixing has taken place often yield less. On sloping land, the deeper a soil is tilled, the more soil will be moved down the slope. Over time, topsoil can be removed from hill slopes, exposing the subsoil.	**OPTION 1 – ACTION** **Ensure tillage implements do not till any deeper than 10–15 cm (4–6 in.) and never in the subsoil:** • use shallow tillage • adopt a reduced or no-till system.

Set up tillage equipment and monitor during use to ensure that the subsoil is not being tilled.

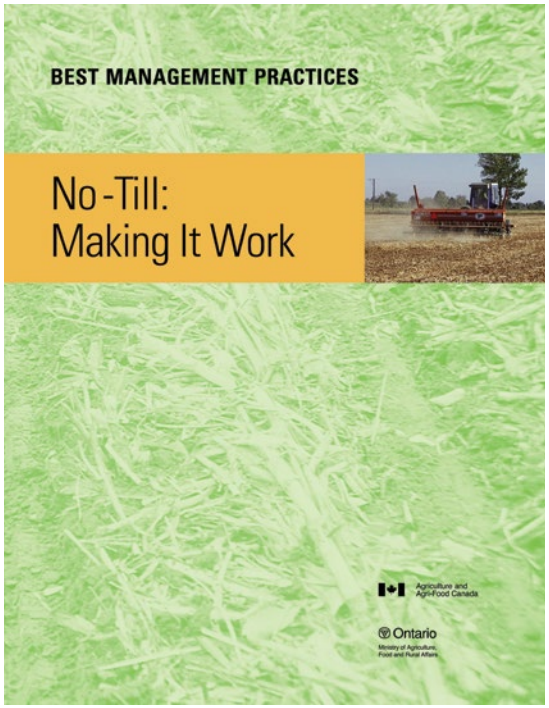


For information on addressing tillage erosion, see pages 46–47.

15–17. Soil disturbance influence on soil erosion

BACKGROUND	WHAT CAN YOU DO?
Soil disturbance increases erosion potential. Ideally disturbance is kept to a minimum during planting through no-till or as little tillage as possible for a good seedbed. Other activities such as nitrogen application or inter-row cultivation should be carried out in such a manner as to reduce soil disturbance. Tillage implements that disturb a lot of soil move more soil down the slopes of fields. This soil can be drawn into areas of the field where water erosion will further increase soil loss.	**OPTION 1 – ACTION** **Aim to disturb the soil as little as possible during all field operations:** • increase the use of a no-till system • stay out of the fields when the soil is too wet • reduce your speed of travel when turning and cornering in the field • reduce your speed so less soil is moved and less residue is buried • use implements that move less soil such as vertical tillage implements, cultivators and discs – avoid the moldboard plow and chisel plow.

Low-disturbance planting systems will significantly reduce the risk of soil erosion from tillage and intense rainfall events.



No-till takes know-how of soil and residue management, specialized equipment, weed, disease and pest control, and crop selection. Whether you want to strip-till, slot-plant, pre-till, or ridge-till, this BMP book is helpful for beginners and no-till veterans.

FOR MORE INFORMATION

Ontario Ministry of Agriculture, Food and Rural Affairs

Many sources of supplementary information are available. Below are some suggestions to get you started. Most can be found online at **www.ontario.ca/omafra** or ordered through ServiceOntario.

FACTSHEETS

Control of Soil Erosion, Order no. 95-089

Grassed Waterways, Order no. 09-921

Seeding of Erosion Control Projects, Order no. 90-231 (web only)

Soil Erosion – Causes and Effects, Order no. 12-053

Soil Sampling and Analysis for Managing Crop Nutrients, Order no. 06-031

The Planning and Maintenance of an Erosion Control System, Order no. 97-015

Universal Soil Loss Equation (USLE), Order no. 12-051

Use of Earthen Berms for Erosion Control, Order no. 99-047

Use of Rock in Erosion Control Projects, Order no. 90-227

Water and Sediment Control Basins, Order no. 89-167

BOOKS

Agricultural Erosion Control Structures: A Design and Construction Manual, Publication 832

Agronomy Guide for Field Crops, Publication 811

Ontario Field Vegetable Guide, Publication 839 *(*replaces *Vegetable Production Recommendations,* Publication 363*)*

Soil Fertility Handbook, Publication 611

MAPS

AgMaps, **www.ontario.ca/agmaps**

BEST MANAGEMENT PRACTICES

BMP publications are excellent sources to better understand on-farm environmental issues and discover a range of proven, practical options to address them. BMP materials are available at no charge to Ontario farmers. Below are a few sample titles. To order, see ServiceOntario information.

Buffer Strips

Controlling Soil Erosion on the Farm

Cropland Drainage

Establishing Tree Cover

Field Crop Production

Irrigation Management

Managing Crop Nutrients

Manure Management

No-Till: Making it Work

Soil Management

Streamside Grazing

Water Management

Woodlot Management

Inquiries to the Ontario Ministry of Agriculture, Food and Rural Affairs

Agricultural Information Contact Centre

Ph: 1-877-424-1300

Email: ag.info.omafra@ontario.ca

Web: **www.ontario.ca/omafra**

Order through ServiceOntario

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By phone through the ServiceOntario Contact Centre

Monday–Friday, 8:30 am–5:00 pm

416-326-5300

416-325-3408 TTY

1-800-668-9938 Toll-free across Ontario

1-800-268-7095 TTY Toll-free across Ontario

ACKNOWLEDGEMENTS

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Best Management Practices publications present in-depth explanations, tips and advice for Ontario farmers.