Best Management Practices

NO-TILL FOR SOIL HEALTH

In conventional cropping systems, tillage is required to loosen the soil and prepare a suitable seedbed for germination and emergence. In many cases, the timing and implements chosen follow a definite pattern.

However, if tillage is the only soil management practice used each cropping year, seedbed quality will decline with time. All tillage systems require complementary best management practices (BMPs) that will build up the soil, diversify soil life and protect the surface from erosive forces. Conventional tillage systems especially need soil BMPs to be sustainable.

There is another way: reduce tillage or eliminate it. Leading crop producers are making no-till work, and their soils are improving.

This factsheet describes types of no-till systems, their benefits and challenges, and tips for successful implementation.

THE ROLE OF HEALTHY SOIL IN A CHANGING CLIMATE

Agriculture and climate are directly linked – anything that has a significant effect on our climate will influence farm production. Greenhouse gas (GHG) emissions and climate change are global concerns, and agriculture can be part of the solution.

BMPs that improve soil health can also help lower GHG emissions, reduce phosphorus loss from fields to surface water, and improve resilience to drought or excessively wet conditions. Healthy soil – an essential component of a healthy environment – is the foundation upon which a sustainable agriculture production system is built.

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What can go wrong with conventional tillage systems

WATER EROSION – Bare soils on steep slopes with smooth surfaces and no vegetative cover are prone to detachment and transport of soil particles by water.

WIND EROSION – With no residue cover, finely worked sandy seedbeds on large fields are prone to severe erosion rates by prevailing winds and wind storm events.

TILLAGE EROSION – Tillage erosion and the force of gravity cause the loss of soil from knolls and upper-slope field positions (hilltops). Over decades, the soil is deposited at the bottom of the slope or in depressional areas.

Each pass with a tillage implement will break down soil aggregates. Finer aggregates are susceptible to loss of organic matter through microbial decomposition – creating weaker and finer aggregates with continued tillage and no soil-building BMPs. This trend will continue and make soil aggregates finer still and free up soil mineral particles. Weak, fine aggregates and soil particles are at risk of crusting, compacting and eroding by wind, water and tillage.

SMEARING AND COMPACTION – The weight and shearing action of cultivating moist seedbeds can cause smearing of soil at the depth of tillage. Years of tilling at the same depth and similar moisture conditions form layers of compacted, platy structure in the soil – also known as plowpans.

SEDIMENT AND NUTRIENTS IN RUNOFF – Storm and thaw events in late winter and early spring can lead to runoff from cropland – especially fields with minimal cover. This runoff water, which contains sediments, organic matter and crop nutrients, can flow into an adjacent watercourse. This is a key farmland source of phosphates in Ontario surface waters.

BURIED TRASH – Moldboard plows can bury a lot of corn residue. Deep plowing can bury it so completely that the residue can form a distinct layer in the soil below the seedbed. This layer can become problematic for the following crop: it can limit root growth, inhibit water movement, form an anaerobic layer and interfere with the availability of nitrogen to the growing crop.

Tillage alone can move soils downslope. See the BMPs for Soil Health Diagnostic Infosheet *Tillage Erosion*.

CARBON LOSS – Fine seedbed structure created by tillage enhances soil microbes' ability to decompose humus compounds in the soil. Years of conventional tillage and no additions of organic amendments will deplete organic carbon levels.

What is no-till?

No-till farming (also called zero tillage or direct seeding) is a way of growing crops or pasture from year to year without disturbing the soil through tillage.

In no-till systems:

- soil surfaces remain covered with the residue from the previous crop
- organic material from the crop residue is added, not removed
- soil quality, density, aggregate stability and drainage improve with time.

No-till is a system. Take the time to evaluate each component to perfect it.

No-till leaves the field undisturbed from harvest to planting (except for nutrient injection). Plant residues are left on the soil surface to offer protection against wind and water erosion. A narrow seedbed is prepared by a planter or drill to allow for soil-to-seed contact and fertilizer placement. Aggregate stability and soil structure improve with no-till, allowing more water and air movement into the soil.

Types of no-till

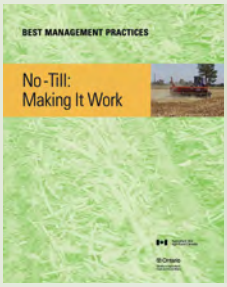
There are several types of no-till.

ZONE-TILL – Planters and drills are set up with one or more coulters per seed row and sometimes row cleaners to prepare narrow strips of soil that optimize seed-to-soil contact.

SLOT PLANTING – A slot is opened in untilled soil and a seed is inserted. Several combinations of seed-firming devices and press wheels are used to close the slot, helping to achieve soil–seed contact. This is the purest form of no-till, especially suited for soybeans, wheat and other grains. Slot planting doesn't work well in heavy residue and moist, fine-textured soils.

STRIP-TILL – A narrow strip is tilled with one of a variety of implements. The tillage is usually performed in the fall but may also be done in the spring. Sometimes the strips are "refreshed" with another pass in the spring. The process encourages the loosening and decomposition of residue over winter and speeds up drying in the spring.

VERTICAL TILLAGE – Many growers successfully no-till corn but others find corn performance is improved if cereal residue receives some tillage (minimum or vertical till) prior to planting.



For detailed information on techniques, equipment and tips, please see the BMP publication *No-Till: Making It Work*.

Why no-till works

No-till leaves the soil undisturbed and covered, which in time will be a boon for soil health. Organic matter builds up, structure is improved, water moves better through the soil, and soil degradation is reversed. And when a no-till system is adapted to work effectively, costs are lower and yields are similar.

SOILS ARE COVERED – Just like mulch in a flowerbed, crop residue in a no-till system shields the soil surface from rainfall impact, reducing soil particle detachment and loss.

SEEDBED IS NOT DISTURBED – In no-till systems, soils are either undisturbed as in slot planting or lightly fractured as with coulters in front of seed openers. Less disturbance means less structural degradation and less biological oxidation (loss) of organic matter. With fewer disturbances, soil life diversifies, favouring such beneficials as VAM (vesicular arbuscular mycorrhizae).

CARBON IS SEQUESTERED – Less soil disturbance combined with additions of organic materials translates into fewer emissions and an increase in the sequestration (fixing) of atmospheric carbon in no-till soils. With fewer passes, less fuel is required for a no-till crop.

RUNOFF IS REDUCED – Crop residue left on the surface, together with winter cover crops, intercept rainfall and direct it into the seedbed, allowing more time for water to infiltrate into the soil. A slower rate and reduced volume of runoff means less soil removed from the field.

COSTS ARE LOWERED – It's cheaper to grow crops in a no-till system than in a conventional or mulch tillage system. Money is saved in several ways. Less equipment is needed. Fewer field passes are required – meaning less fuel and less labour.

COMPARABLE YIELDS – Most field trials show that yields are similar among conventional, mulch and no-till systems.

Challenges with no-till

- Higher residue levels may require the replacement or modification of planting and application equipment.
- Crops to be planted in high-residue situations will perform better if the residue is moved off the row or tilled with coulters.
- Insects and diseases associated with crop residues will be reduced with a good crop rotation.
- Weeds must be managed more carefully as tillage is not an option.
- No-till soils are cooler in the spring, so starter fertilizer is a must for early season nutrient uptake.
- Residue and soil moisture conditions make it necessary to carefully monitor the seeding operation.

When changing to no-till systems, it is not uncommon for cropland soils to be compacted. It may take several years to improve this condition in no-till, as there is no option to disturb surface or subsurface layers to break up crusting or compaction. In time, soil structure will improve – but yield losses may be noticed in the first few years. Fitting a range of cover crops into the rotation will help improve soil quality.

No-till will leave seedbeds in cooler and wetter conditions. This may increase the risk of diseases such as *Fusarium*.

Managing weeds in no-till requires a planned and systematic approach. Prior to switching to no-till, growers should identify the specific weed species and their densities in their field(s), and know the weeds' growth habit (annual or perennial). Growers should also determine whether the weeds have developed resistance to herbicides based on past experiences in a specific field and surrounding areas.

No-till: making it work

SYSTEMS APPROACH

✓ Adopt a systems approach – make adjustments to planting equipment, weed control practices and the timing of operations.

The transition to no-till will be smoother and the success will be greater if the implications of improvements to one component are anticipated and the necessary adjustments to other components are made at about the same time.

SOIL MANAGEMENT

✓ Assess soil health and surface water conditions. No-till won't solve severe soil health issues in the short term.

✓ Improve subsurface (tile) drainage. Ponded areas and excessive moisture will impede the success of any conservation tillage system.

✓ Improve seedbed conditions. Use applications of composts, plowdowns, manure or cover crops to improve seedbed tilth.

✓ Test soils and follow recommendations for soil fertility.

No-till systems are more successful when cover crops are included in the rotation.

When starting no-till, winter wheat is the easiest option. Soybean is second easiest, and corn is third.

RESIDUE MANAGEMENT AND PLANTING EQUIPMENT

Residue management is the management of residues from the previous crop to provide soil cover after harvest and until the development of the canopy of the next crop.

✓ Spread residue evenly. To get good erosion control and more importantly to make planting easier, residue must be spread evenly behind the combine rather than windrowed. An even spread pattern protects more soil and reduces plugging problems with planting equipment.

✓ For small grains, set the cutting head on harvest equipment as high as possible without sacrificing yield. That way, more of the stalk is standing, reducing the chance of the residue forming a mat on the soil.

✓ Modify planting equipment with coulters or trash whippers to move crop residue out of the row area. This helps eliminate any toxic effects and clears the row so soils warm up.

✓ Determine whether additional weight is needed to maintain desired planting depth in dense soils and to reduce slippage of drive/gauge wheels.

In no-till systems, residue from the previous crop is left on the surface or only partially buried. The material acts like a mulch to protect the soil, and as it breaks down it adds organic matter to the soil. Pictured above is an even stand of soybeans emerging through the protective mulch effect of corn residue.

Spread residue evenly behind the combine to eliminate windrows, making it easier for planting.

NUTRIENT MANAGEMENT

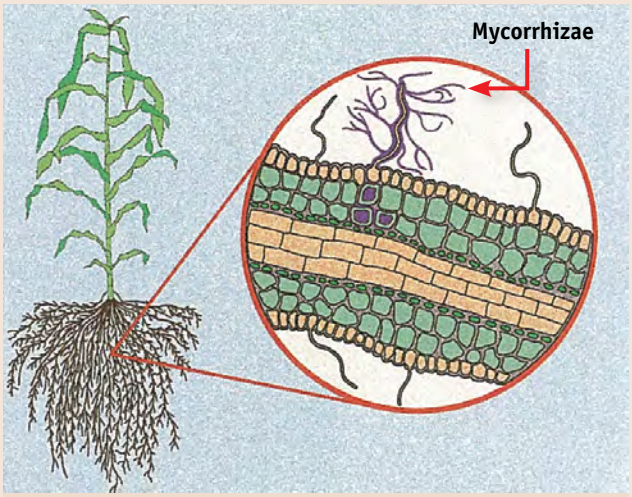
When switching from a conventional to a no-till system, adjustments are needed to ensure the right timing and right placement.

✓ Right timing:

- try to get soil P + K levels to a medium-high range and adjust pH to acceptable levels
- application of N-fertilizers is more effective as side-dress applications for corn in no-till, as surface applications on residue are more prone to loss.

✓ Right placement:

- surface broadcasting leads to stratification of P + K (concentrated near seedbed surface) or loss by runoff
- banding or injection is more effective than any surface application



No-till conditions support the growth of mycorrhizae. Soil mycorrhizae help plant roots to access phosphorus, zinc and moisture from the soil by increasing the area exploited by the roots.

WEED CONTROL

Technical approaches are based on timing of herbicide application, and include burndown, soil residual and post-emergence treatments.

✓ Apply the principles of Integrated Pest Management (also known as Integrated Weed Management) for effective, long-lasting control and minimal environmental impact.

✓ Scout fields for weed problems carefully and regularly – identify weed problems early.

✓ Keep records for monitoring, scouting and treatments – note weeds scouted and season.

✓ Keep in mind that weeds appearing late in the season do not reduce yields as much.

✓ Rotate the pesticide family – keep ahead of adjustments in the weed population.

✓ Band herbicide over the row – a way of increasing efficacy and efficiency.

Avoid rescue treatments. Knowing what weeds to expect and using herbicides to control them will help eliminate extra passes over the field to catch "escapes."

INSECT AND DISEASE CONTROL

Insects and diseases will change in a no-till system. Some will increase and some will decrease. Understand the life cycles and scout to monitor pest levels.

✓ Rotate crops to break the disease cycle.

✓ Select hybrids or varieties for early growth and vigour because no-till/ridge-till soils tend to be cooler. Choose disease-resistant varieties and be sure to use seed treatments.

✓ Modify planting equipment to move residue away from the row area so young seedlings have a good chance to get established without pressure from insects and slugs.

✓ Change the family of your insecticide each year. Insects can develop resistance to specific insecticides after repeated use.

Insects and other pest numbers may increase if there are a lot of weeds in the field. Weeds can act as a food source and an egg-laying location for pests.

CROP ROTATION AND VARIETAL SELECTION

Crop rotations are always an important BMP. In no-till systems, they're essential to break insect, disease and weed cycles.

Crop rotations also allow for a diversity of cultural practices, timing of practices and nature of inputs used – all of which further disrupt pest cycles.

✓ Include soil-building crops in the rotation to help soils adjust more quickly and effectively to the elimination of soil disturbance that is the basis of no-till systems.

Continuous cropping can have a greater effect on no-till crops. Corn following corn in clay soils may cause a 10–30% yield reduction.

Varietal selection is also an important consideration in no-till systems. For example:

✓ varieties need to be able to withstand the cooler and wetter seedbed conditions

✓ disease resistance becomes a more important selection criteria

✓ suitable varieties must be resistant to a wider array of herbicides or resistant to burndown herbicides (e.g. glyphosate).

COVER CROPS

In field cropping systems, there is a synergistic effect from using cover crops and reduced tillage/residue management systems.

✓ Use cover crops in no-till for several benefits – both for the current crop and for the entire system, including:

- added cover
- soil building
- N additions – trapping or provision
- weed control
- interrupted pest cycles.

Winter cover crops such as oats (above) can provide much-needed additional cover when residue cover is insufficient for erosion control goals.

For more information

ONTARIO MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS

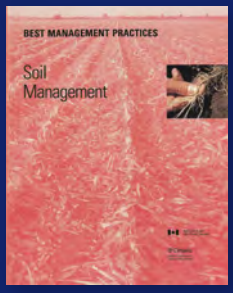
Many sources of supplementary information are available.

Below are some suggestions to get you started. Most can be found online at **ontario.ca/omafra** or ordered through ServiceOntario.

- *Drainage Guide for Ontario*
- Publication 811, *Agronomy Guide for Field Crops*
- Publication 611, *Soil Fertility Handbook*

Best Management Practices Series

- *Buffer Strips*
- *Controlling Soil Erosion on the Farm*
- *Cropland Drainage*
- *Field Crop Production*
- *No-Till: Making It Work*
- *Soil Management*



Environmental Farm Plan (4th ed.) and EFP Infosheets

- #15, *Soil Management*
- #16, *Managing Nutrients in Growing Crops*
- #18, *Horticultural Production*
- #19, *Field Crop Production*
- #21, *Stream, Ditch and Floodplain Management*

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