Best Management Practices

RESIDUE MANAGEMENT

Cropland soils left bare over winter are not healthy soils. Conventionally tilled soils that are covered with forages or pasture for part of their rotation, and are improved with manure and plowdowns, are usually much healthier.

Residue from the previous crop left on the surface covers the soil when cover crops can't. Residue adds some organic matter and helps to improve soil structure and moisture properties. Residue management is integral to soil health: it protects soil, helping to reduce soil loss.

Managing crop residue is quite similar to protecting horticultural crops with mulch: the more surface covered, the greater the benefit.

This factsheet explains the problems with bare soils, why residues work, how to work with them throughout the year, and tips for specific crops.

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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Why bare soils are a problem

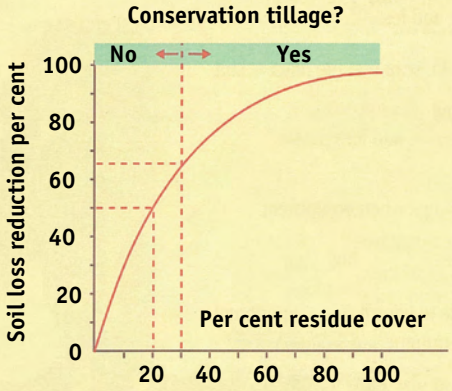
Traditionally, grain and oilseed crop producers in conventional tillage and cropping systems grew winter cereals, and some still fit legumes in the rotation. More recently, it has become common practice to reduce rotations to corn and soybeans. Without the winter cereal or perennial crop, the soils are left exposed over the winter, with nothing to protect them.

Soils degrade quickly when not covered and when no effort is made to increase organic matter levels and improve soil structure in the seedbed. Degraded soils are at risk of tillage, water and wind erosion.

Degraded cropland soils need to be improved and protected. Soil water needs to be managed above and below the soil surface to reduce runoff. In short, soil conservation and health require a systems approach.

Erosion problems are most obvious on the highest risk soils – loamy, steeply sloping and with complex topography/numerous crest-slope positions. But now, after a full generation of these cropping and tillage systems, erosion and other degradation problems are showing up on other soils as well.

In a comparison of conventional and conservation tillage systems, field trials indicate that a 10% cover can reduce soil loss due to water erosion by 20%. High crop residue – more than 40% – can reduce erosion by as much as 80%.



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

WIND EROSION – Large expanses of clean-tilled fields with no residue cover and with erodible soil particles (e.g., sands and organic soils) are prone to severe erosion rates by prevailing winds and wind storm events.

SEDIMENTS AND NUTRIENTS IN RUNOFF – Storm and thaw events in late winter and early spring can lead to large volumes of ponded and flowing water on cropland surfaces – especially those with minimal cover. The runoff water, containing sediments, organic matter and crop nutrients, can pond and flow into adjacent ditches and streams. This is a key farmland source of phosphates in Ontario surface waters.

TILLAGE EROSION – Tillage erosion causes the loss of soil from knolls and upper-slope field positions (hilltops), and deposits this soil over decades of movement at the bottom of the slope (or in depressional areas). It can also occur on gently rolling or nearly level sloping fields.

Why residue management works

Residue management protects the soil from erosive and other forces of degradation, reduces moisture loss, and adds some organic matter.

MULCH EFFECT – Crop residue on the soil surface has a "mulch effect." It intercepts the impact of raindrops, slows the movement of soil, prevents soil surfaces from drying out, and hinders emergence of germinating weeds.

MINIMAL DISTURBANCE – The higher the percentage of cover by crop residue, the greater the protection and the lower the degree of disturbance. Less tillage means more residue cover. And the more soils are left intact, the slower the rate of soil organic matter loss and soil structure degradation. This means less compaction and crusting, and better tilth.

INCREASED INFILTRATION AND WATER STORAGE – Crop residues keep seedbed surfaces rough and covered. Surface moisture infiltrates and topsoils do not dry out quickly.

ADDITION OF ORGANIC MATERIALS – Crop residues will add organic material to the soil and some of it will become incorporated as soil organic matter. For example, an 80% residue cover of wheat straw can add up to 2,200 kg/ha (1,960 lbs/ac) of organic matter to the soil.

CARBON SEQUESTRATION – Plant carbon can be sequestered as soil carbon when crop residues are left on the soil surface. If residue is not incorporated, a typical corn-soybean-winter wheat (C-SB-WW) rotation adds on average 5,000 kg of residue per year. Since the ratio of organic material added to soil organic matter (SOM) increased is about 5:1, it takes about 20 years of no-till field crop production to raise SOM by 1%. This translates into a net gain of 570 kg carbon/ha/yr from crop residue on Ontario cropland.

Types of residue management and conservation tillage systems

MODERATE COVER: MULCH TILLAGE – This refers to seedbed conditions that have 30% cover after planting by residue from the previous crop. Moderate residue cover is normally associated with mulch tillage systems for most crop residues. Mulch tillage utilizes a range of equipment types to partially bury residues.

MINIMAL COVER: CONVENTIONAL TILLAGE – This refers to seedbed conditions that have <10% cover after planting by residue from the previous crop. Minimal residue cover is most often a result of conventional tillage (e.g. plowing and 1–2 secondary tillage passes) and reduced tillage with bean residue.

HIGH COVER: NO-TILL – This refers to seedbed cover conditions where 40%+ (up to 90%) of the soil surface after planting is covered by the residues from the previous crop. High crop residue cover is normally associated with no-till systems for most crop residues. In no-till systems, the planter is the only implement that disturbs the soil after harvest.

Challenges with residue management

Pest pressures: residue can host pests and disease. In some cases, crop residues can have allelopathic (plant performance-inhibiting) effects on subsequent crops.

Cooler and wetter seedbed conditions: residue can delay spring warm-up and drying of the soil, leading to delayed germination and uneven emergence.

Plant-available nitrogen: soil microbes will tie up plant-available nitrogen while decomposing residue from most field crops (i.e., those with high C:N ratio [>30:1]) – leaving less nitrogen for the growing crop.

Interference with planting and crop inputs: high residue cover can impede the uniformity of seeding and planting – as well as fertilizer and pesticide applications on the soil surface.

Reduced biomass harvest: straw and other forms of biomass left on the soil surface are not available to harvest as bedding, fibre or biomass.

Crop residue can move in the field with runoff during intense storm events. It is then deposited into piles, which can plug surface inlets, erosion control structures and fencerows.

Residue removal for bedding or biomass leaves less residue to cover the soil. However, baling straw after a high-yielding harvest may still provide sufficient cover if soils are not tilled until the following spring.

Residue management: making it work

TIPS DURING HARVEST

✓ Begin planning for residue cover at harvest.

✓ Select a level of crop residue cover that will address soil health goals.

✓ Reduce wind erosion with standing residue.

✓ Add straw and chaff spreaders to the combine to spread residue evenly behind the combine.

✓ Add straw choppers to combine if need be.

Spread residue evenly behind the combine to eliminate windrows.

TIPS FOR MANAGING RESIDUE

✓ Be aware that tillage may be required to manage excessive residue. Note the percentage residue cover after harvest: corn 85%, winter wheat 95%, soybeans 30%, silage corn 5%.

✓ Note that residue cover is sensitive to equipment type, depth and speed of equipment operation, and row spacing.

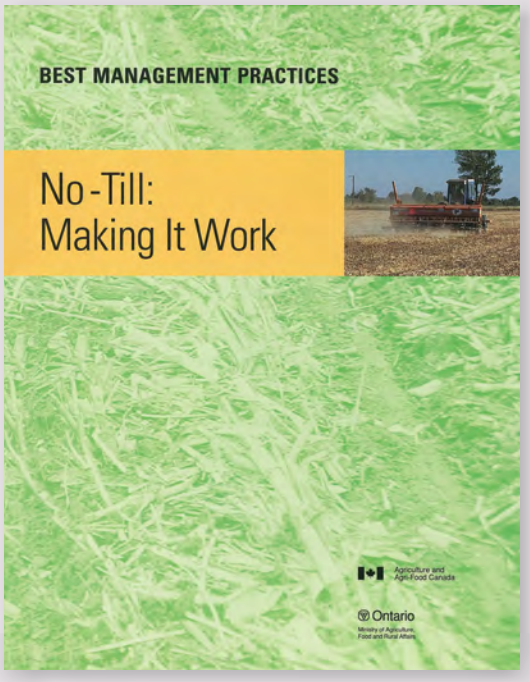
✓ Adjust for accumulating crop residue. Every tillage pass buries more crop residue:

- use straight points and sweeps on chisel plows instead of twisted points – twisted points can bury 20% more residue
- use less aggressive tillage equipment such as a disk or cultivator, especially in low-level crops
- note that vertical tillage may be enough tillage to make residue levels manageable
- set tillage tools to work at shallower levels
- reduce speed of tillage operations.

✓ If you are working the soil, try to leave at least 50% residue cover over winter and a minimum of 30% residue after planting.

TIPS DURING PLANTING

- ✓ Carefully monitor the soil moisture and temperature in the spring for planting timing. Use the "feel-testing" soil chart on page 10 of Best Management Practices *No-Till: Making It Work*.
- ✓ When planting into residue, be sure seed is being planted at the proper depth into the soil unaffected by residue.
- ✓ Rotate high-residue crops with low-residue crops to maintain a manageable level of residue.
- ✓ Modify equipment to your specific situation. See pages 20–40 in *No-Till: Making It Work*.
- ✓ Add coulters or row cleaners to planter to cut or clear residue from the row or use strip tillage.
- ✓ Leave a 15–20 cm (6–8 in.) cleared strip for planting corn.
- ✓ Use starter fertilizers because seed germination tends to lag in the spring in high-residue environments.
- ✓ Select disease-resistant varieties to plant because residues may slow emergence, exposing seedlings to disease.
- ✓ Note that existing planters and drills can handle 20–30% residue levels with very little modification.



TIPS DURING THE GROWING SEASON

- ✓ Scout for pests and disease.
- ✓ Use crop rotation and cover crops to help deal with pests and disease, but understand the interactions between the previous and current crops. See page 77 in *No-Till: Making It Work*.

MEASURING CROP RESIDUES

You can estimate residue levels by using a line that has 50 or 100 equally divided marks. Stretch the line diagonally across crop rows. Count the number of marks that have residue under the leading edge when looking from directly above the mark. For the residue to count, it should be at least the size of a match stick (4 x 45 mm).

Walk the entire length of the rope. The total number of marks with residue under them is the percent residue cover. If the line has only 50 marks, multiply your count by two. Repeat this three to five times in a representative area of the field. Average your results.

Residue management for specific crops

CORN

✓ Keep the seed furrow free of residue at planting:

- residue in the seed furrow may interfere with depth of planting, soil-to-seed contact and emergence
- poor seed-to-soil contact can slow germination and cause uneven emergence
- soybean residue is much less detrimental than corn residue when it is found in the seed furrow of corn.

✓ Create a seedbed zone free of residue when planting corn:

- a strip about one-third of the row area wide – 25 cm with 76 cm rows (10 in. with 30 in. rows) with less than 10% cover will minimize the potential for reduced growth due to cooler soils associated with crop residue cover
- use planter-mounted tools such as clearing discs, sweeps, brushes, rolling fingers.

✓ Band fertilizers at planting:

- apply phosphorus in a band close to the seed row to improve emergence and early growth.

✓ Inject or incorporate side-dressed nitrogen:

- don't broadcast-apply urea sources of nitrogen (urea-ammonium nitrate solutions, and urea) on high residue fields without incorporation or injection. Volatilization losses of N with these sources can exceed 20% when temperatures are warm.

SOYBEANS

✓ A residue-free strip is not required with soybeans. Soil temperatures, in-furrow residue, stand establishment, and row-applied P and K are less important than with corn.

✓ Early weed control is essential. Spring annuals can germinate in seed row with minimal disturbance before beans emerge.

Germination can be impeded when corn seed is planted into heavy residue and the residue is pushed into the seed furrow with planter-mounted disc openers or coulters, and the residue is in contact with the seed.

Keeping residue out of the seedbed area keeps residue away from the seed and helps to warm the soil where the seed is planted.

Soybean residue is readily broken up by planting equipment and does not pose the same planting management challenges as corn.

CEREALS

✓ Avoid hair-pinning:

- residue in the seed furrow can impede seed-to-soil contact (see illustration in left-hand bottom corner below)
- poor contact can reduce germination and slow emergence – mostly due to restricted available moisture and poor root-to-soil contact.

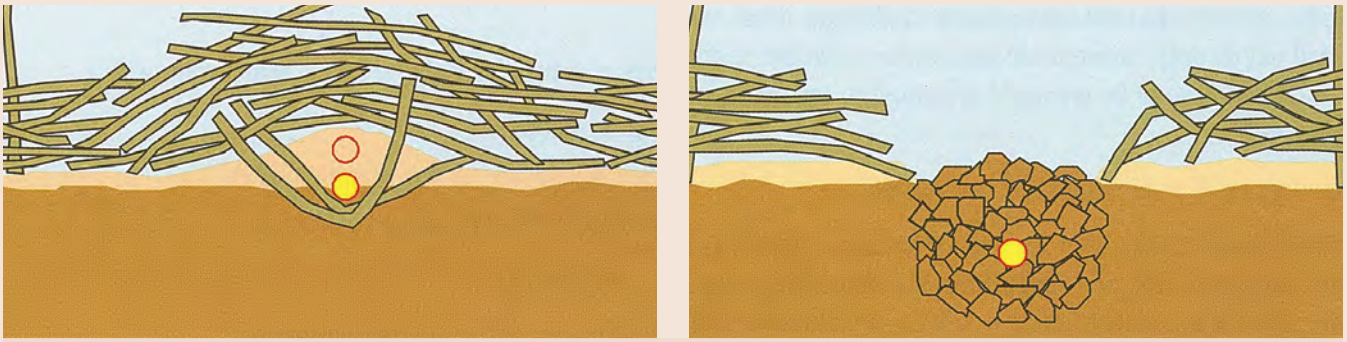
✓ Plant when crop residues are dry:

- dry residues are cut more easily with coulters
- plant at right angles to the drill-rows of the previous crop.

✓ Monitor for fungal diseases. Monitor wheat (especially winter wheat) for leaf disease. Consider a fungicide if following a cereal or corn.

✓ Apply P at planting.

Cereal yields are similar to yields in conventional systems. Rotation is especially important for this crop. Input costs savings can range from $3–$5 per acre.



As seen in the figure on the left, poorly distributed crop residue can affect seeding depth and seed-to-soil contact, and keep the soil cool. This can cause slow and uneven crop emergence. The figure on the right shows ideal seedbed conditions.

For more information

ONTARIO MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS

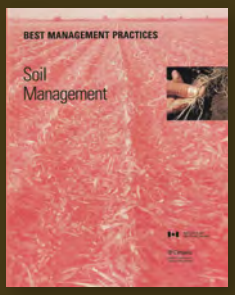
Many sources of supplementary information are available.

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

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

Best Management Practices Series

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



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

- #15, *Soil Management*
- #19, *Field Crop Management*

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

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