



## Best Management Practices

# INTER-SEEDING COVER CROPS

A healthy soil is not left bare. Bare soils during the growing season can be a problem for soil health and crop growth. Unprotected soils are vulnerable to wind and water erosion, as well as annual weeds during the growing season.

Soils can be covered with residue or mulch, a double crop (e.g., squash under corn), or a relay crop (e.g., an early season crop like spinach followed by a late-season crop like cabbage). Another option is to plant one or more cover crop species into an existing or established crop – also known as inter-seeding.

This factsheet explains different ways to inter-seed cover crops, how they benefit soil health and crop productivity, some of the challenges, tips to make them work, and proven combinations.

### 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.

# What's the problem with bare soils during the growing season?

## WATER EROSION



It's estimated that 80% of soil lost from cropland is the result of the impact of intense rainstorms, like the ones we get in late spring and early summer before the crop canopy closes and when tilled soils are loose.



Widely spaced row crops leave bare soil conditions between rows for most of the growing season, making them prone to erosion and runoff during storm events.

## WIND EROSION



Bare, light-textured soils can be at risk of wind erosion after soils have been tilled and before crop canopies have developed sufficiently to provide cover, particularly in a dry year.



Large areas of clean-tilled soils in wide row crops are at risk of wind erosion and sand-blasting in late spring.

## STRUCTURAL DEGRADATION OF TOPSOIL



Bare, finely worked seedbeds are prone to ponding, puddling and crusting. Extra cultivation is often required to fix the problem, which further degrades the seedbed structure.

## ORGANIC MATTER DEPLETION AND CO<sub>2</sub> EMISSIONS



Frequent cultivation to control weeds or temporarily create soil structure will accelerate the depletion of soil organic matter and increase carbon emissions from cropland soils.

## WEED PRESSURE



Widely spaced row crops are prone to weed infestation.

# Definitions and types

**Inter-seeding** is the planting of one or more cover crop species into an existing or established crop. Inter-seeded cover crops need to be a lot of things: shade-tolerant, drought-tolerant, fast-growing and able to suppress weeds without being competitive with the main crop and without posing a risk for pest infestation.



Red clover frost-seeded into winter wheat is one of the most traditional forms of inter-seeding using an over-seeding method. Note the unifoliate seedling clover among the residue from previous crops.



Some crop canopies open up as the crop matures, like this seed corn crop, allowing an inter-seeded cover crop to establish earlier than if planted after harvest.

**Nurse crops** are annual crops used to assist in the establishment of perennial crops. Some forage legumes and grasses emerge and grow slowly – making an ideal condition for competing weeds. Growers often use fast-growing, competitive spring cereal nurse crops like oats, barley or wheat to dominate the site and allow the shade-tolerant forage crop to develop under its protection. The cereal can then be clipped or harvested as hay/haylage or allowed to mature to grain – freeing the forages to form a full canopy until first cut in the fall.



Fast-growing spring cereals such as oats and barley can be used as nurse crops that cover the soil while protecting forages (e.g., alfalfa) as they become established.

**Inter-planting** is not considered an example of inter-seeded cover cropping. It involves growing multiple crops in the same field at the same time – with no separation between crop pattern or management practices.

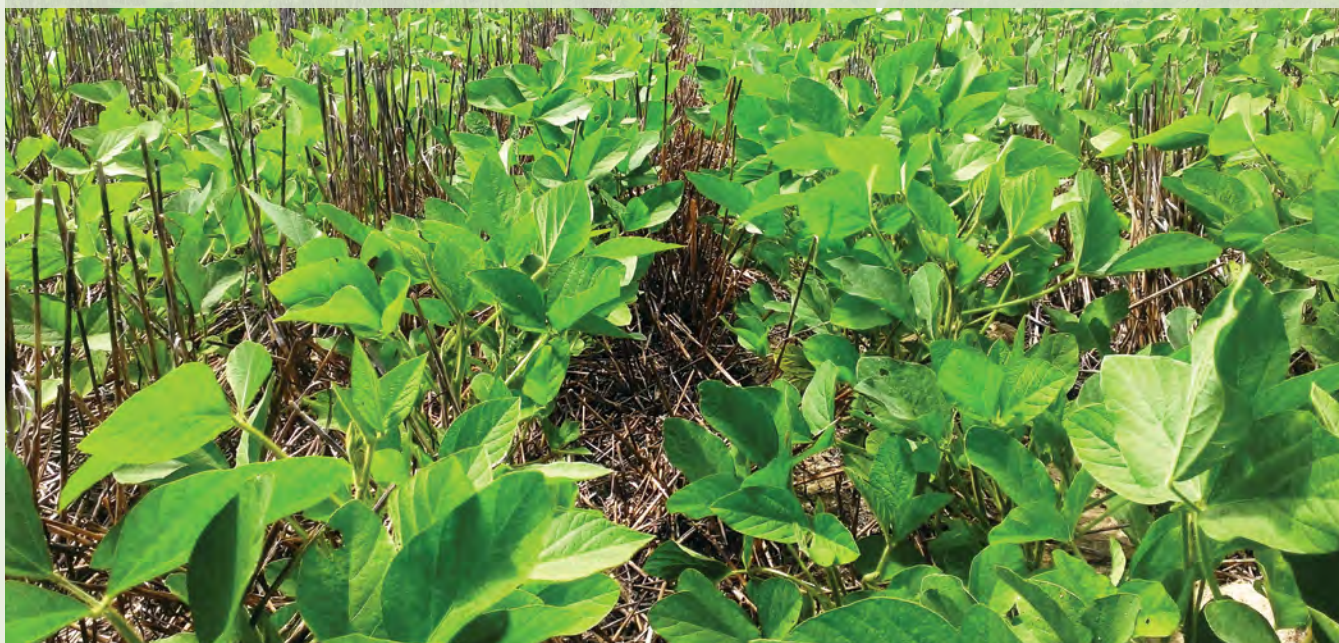
**Planting multiple vegetable crops in the same field at the same time is not considered a form of inter-seeded cover cropping.**



**Relay cropping** is the term used for inter-seeding a second crop (not cover crop) into the first crop before it is harvested. The relay cropping strategy is used to enable production of a second crop in areas where time for seeding the second crop following harvest of the first is considered inadequate for double cropping. This is not common in Ontario, but there may be some untapped opportunities.

**Double-cropping** is the harvest of at least two crops from the same land in the same year. This does not include cover crops.

**Planting a later-season crop of soybeans after winter wheat is an example of double-cropping.**



# Benefits of inter-seeding

## PROVIDES EROSION CONTROL WITH MULCH EFFECT

Full canopy inter-seeded cover crops provide a living mulch protection from the erosive powers of water and wind.



**Inter-seeded barley will slow, trap, and disperse the wind and water, which reduces the energy to erode the inter-row soil. Additionally, the aboveground plant matter intercepts raindrops, reducing the impact of the raindrops on the soil to help keep the soil in place.**

## REMEDIATES COMPACTION AND IMPROVES TRAFFICABILITY

Inter-seeded cover crops may help to break a plow pan (compacted layer) by sending roots deep into the profile during the growing season when the soil would otherwise be bare. The cover crop can also improve trafficability during harvest and reduce compaction.

**Inter-seeding offers an option that gives a cover crop a longer time to grow and may allow the roots to reach deeper into the soil, gradually breaking up compacted layers.**



## IMPROVES TILTH & SOIL STRUCTURE

Cover crops with fibrous root systems (clovers and cereals) can help improve aggregation of the inter-row soil during the growing season and post-harvest by binding the soil particles together and/or by releasing binding agents. Root channels help reduce bulk density of the inter-row soils, which often are subject to wheel traffic and compaction during field operations.

**The roots of a rye crop are fibrous and dense, and reach deep into the soil profile. The high density near the soil surface physically holds soil particles together, which results in aggregation and improves soil structure.**



## ADDS ORGANIC MATTER AND SEQUESTERS CARBON

Growing cover crops adds to the soil organic carbon pool. Organic carbon from the cover crop comes from atmospheric carbon dioxide and a portion becomes part of the organic matter in the soil once the cover crop has died. Improved organic matter improves soil structure, reduces soil bulk density and decreases soil crusting, which improves water infiltration.

**Clover is often inter-seeded into winter wheat and can return a large amount of biomass to the soil. Annual ryegrass inter-seeded into corn, especially seed corn, can also result in a large biomass return to the soil. In Ontario, the amount of organic matter addition depends on planting date and the climate, but is typically less than 20% of the residue.**



**Cover crops provide habitat and food sources for soil life. Root exudates, root biomass, nutrients and top growth provide substrate for soil macro- and micro-fauna. A soil ecosystem improved by cover crops provides space, aeration, drainage and moisture-holding capacity conditions that are suitable for soil life and plant growth.**

## IMPROVES SOIL FERTILITY

Cover crops can improve soil fertility in several ways:

- clover cover crops, which are often inter-seeded into winter wheat, fix nitrogen and provide a nitrogen credit of as much as 80 kg/ha available for the next crop
- deep-rooted cover crops like annual ryegrass or cereal rye can bring nutrients up from deep in the soil profile, making them more available for the next crop.

## REDUCES NUTRIENT LOSSES

Inter-seeded grass cover crops (cereals) are generally good scavengers of crop nutrients. They establish a root system while under the main crop, allowing the cover crop to take full advantage of light and fertility at crop harvest. As they grow they take up available nitrogen in the soil, which reduces nitrogen leaching.

Once the cover crop dies off, the nutrients in the plant are released back into the soil for the next crop. This can become problematic if the cover crop dies and releases the nutrients before the next crop can use it (e.g., oats or radish). Legumes like clovers tend to hold onto the nitrogen over winter and release it into the soil the following spring for a crop like corn.



**Bare soils – whether between crop rows or throughout the fields – are more prone to transport off fields. This risk is compounded when nutrient levels are high, such as in fields where there are late-season or fall applications of fertilizers or manure, and when field soils and slope conditions are inherently prone to erosion and runoff. Nutrient losses from cropland can contribute directly to the decline of water quality in streams, rivers and lakes.**

## SUPPRESSES WEEDS

Bare soils can become overgrown with weeds because there are optimal growing conditions and no competition for resources. Inter-seeded cover crops can create physical barriers by smothering weeds and/or suppressing weed seed germination and growth through competition for light and moisture. Some cover crops inhibit the growth of certain weeds via the release of a chemical (allelopathic effect).

# Challenges with inter-seeding

**Crop selection** – Not all cover crops are suitable for inter-seeding or compatible with the intended primary crops. Suitable cover crops must meet a specific set of favourable criteria, i.e., tolerance for drought, low light and traffic, and quick growing.

**Variability of soil health benefits** – Soil health benefits may be short-lived if the selected inter-seeded cover crop is frost-sensitive or dies with the harvest of the primary crop.

**Establishment** – Mid to late summer often brings dry soils, making planting date of the inter-seeded cover crop critical. No-till or minimum till means high residue cover, which may interfere with the seed contact with soil.

**Suitable equipment** – You may have to adapt or purchase specialized equipment for particular cover crop species/crop combination.

**Inter-crop competition** – Balance is essential. The cover crop must protect the soil while withstanding shade and minimizing competition (space, moisture, nutrients) with the primary crop.

**Pest pressures** – Some cover crops may introduce pest pressures as vectors for insects, disease or weeds.

**Herbicide selection** – When selecting the herbicide program, consider the weed pressure and the cover crop options.

**Match the inter-seeded cover crop carefully. Consider how the cover crop grows, how competitive it may be, and the impact on harvest or other crop management operations.**



Some crops require wide rows or wide spacing due to growth habit, harvesting aids or as deterrents to disease pressure. Some of these crops are established late-season and/or are slow-growing crops: leaving soils bare through the spring and early summer.

# Inter-seeding cover crops: making it work

## SPECIES SELECTION

The following is a list of key criteria for selecting cover crops for inter-seeding purposes:

- ease of establishment – smaller seeded cover crops often will be able to germinate and establish under the low soil moisture conditions mid-season
- growth rates – selected crops need to be fast-growing to establish before canopy or primary crop closes
- tolerances – inter-seeded cover crops must tolerate dry soil conditions, low light, herbicide residues and in-field traffic for late-season treatment or harvest
- low-risk – inter-seeded cover crops should not be good habitat for diseases and insects or nematodes. Their growth should not encourage weed escapes.

Inter-seeding encompasses a wide variety of conditions. The following table looks at general ratings for inter-seeding a cover crop into an early (i.e., V4–6) field of corn (field or seed).

COVER CROPS FOR INTER-SEEDING – SUITABILITY RATING TABLE								
SPECIES TRAITS	ANNUAL RYEGRASS	OATS OR BARLEY	FIELD PEAS	RED CLOVER, CRIMSON CLOVER, OTHER CLOVERS	ALFALFA	BUCK-WHEAT	RYE	HAIRY VETCH
OVERALL RANKING	Excellent	Poor	Poor	Good	Very good	Poor	Moderate	Good
EASE OF ESTABLISHMENT	Excellent	Poor	Poor – large seed	Moderate	Moderate	Moderate – large seed	Good	Moderate – medium seed
HERBICIDE TOLERANCE	Excellent	Poor	Poor	Fair	Fair	Poor	Moderate	Fair
DROUGHT TOLERANCE	Fair	Fair	Good	Fair	Very good	Poor	Fair	Good
SHADE TOLERANCE	Very good	Poor	Poor	Good	Good	Poor	Fair	Good
TRAFFIC TOLERANCE	Excellent	Good	Poor	Good	Good	Poor	Very good	Fair
WEED POTENTIAL	High risk (if in wheat rotation)	Very low risk	Very low risk	Moderate risk	Low risk	High risk	High risk	Moderate risk



**Spring crops grown as cover crops (oats, barley) grow well and provide good cover, then die over winter. They do not require chemical control, but need to be monitored for heading and harvest interference.**

## ESTABLISHING INTER-SEEDED COVER CROPS

Use techniques such as frost seeding, conventional or no-till drill, broadcast with spreader or liquid manure, or with special seeding equipment. Achieving good soil-to-seed contact will ensure better establishment.

- ✓ If planting a cover crop into corn, be sure the corn is past the V4 stage to avoid interference with the corn crop during the critical weed-free period. Typically cover crops are planted into corn at the V6–8 stage or much later as corn is starting to dry down.
- ✓ If broadcasting into a vegetable crop that is well-established, cover crop seeds may be caught in the leaves of the vegetable crop, which can cause harvest quality issues.
- ✓ Inter-seeding during the final cultivation works best for many growers. In this way, cover crops can be seeded during a cultivation + N-side-dress application or application of post-emergent herbicides.

**Some growers have modified drills or created their own inter-row drills to make planting of inter-seeded cover crops more effective.**



## POTENTIAL FOR INJURY TO RYEGRASS AND CLOVER COVER CROP INTER-SEEDED IN CORN

HERBICIDE	ANNUAL RYEGRASS	CLOVER
CONVERGE XT	Safe	Injured
CALLISTO	Some injury – some stand reduction	Injured**
ENGARDE	Some injury – some stand reduction	Injured**
INTEGRITY – set up rate (0.3L/A)	Safe	Not injured
INTEGRITY – full rate	Injury – stand reduction	Some injury
PRIMEXTRA	Injury – stand reduction	Some injury
LUMAX	Injury – stand reduction**	Injured**
TREFLAN/PROWL	Injury – some stand reduction*	Some injury
FOCUS	Injury – stand reduction**	Slightly injured
FRONTIER MARKSMAN	Some injury – some stand reduction **	Some injury

\*Indicates severity of damage, more \* = more damage

Source: Dr. Darren Robinson, University of Guelph, Ridgetown Campus, project funded under GF2

## MANAGEMENT

**Timing** – Most cover crops will compete heavily with the cash crop unless seeding is delayed until the cash crop is well-established. Consequently, cover crops planted into established cash crops usually produce little organic matter or nitrogen by the time of crop harvest.

**Weed control** – Attempts to use inter-seeded cover crops to smother weeds have generally shown that if the cover crop is sufficiently dense and vigorous to suppress the weeds, it also competes with the cash crop.

Successful exceptions require subtleties of timing, sowing densities, and relative growth rates of the cash and cover crops that are difficult to repeat consistently.

**Location** – The primary use of inter-seeded cover crops is the early establishment of cover. Note that if the cover crop is left after the cash crop is harvested, cleanup of weeds after harvest may be restricted to mowing. Consequently, select locations to apply inter-seeded cover crops carefully.

## TERMINATION

Terminating the cover crop will depend on the cover crop species (e.g., annual versus perennial) and the crop that follows it.



Annual ryegrass is an excellent choice as an inter-seeded cover crop for field corn due to its herbicide tolerance. However, this is a double-edged sword when it comes time to terminate the cover crop.

# Proven combinations

## WINTER WHEAT + RED CLOVER

Red clover over-seeded into winter wheat is one of the most common types of inter-seeding in agronomy.

Clovers can be frost-seeded in late winter into the winter wheat crop that was planted the previous fall. As the soil thaws, the soil-seed contact increases and clover starts to grow with the winter wheat. To be effective, avoid saturated soils, keep fertility up, and make sure pH is at least neutral.

After the wheat is harvested, the clover is allowed to grow until at least the middle of October to maximize root growth. It will provide a nitrogen credit to the next corn crop.

Red clover can be killed chemically, plowed down in the spring or zone-tilled prior to planting corn. Red clover can be managed as a forage crop as well.



Red clover can be harvested as haylage or grazed directly.



## CORN + RYEGRASS/CLOVER MIX

Inter-seeded ryegrass and clover mixes can work with corn where post-emergent herbicide and/or cultivations are used for weed control.

The cover crop mix is seeded at the V4–6 stage

This approach has also worked with red clover, alfalfa, hairy vetch or a blend of red + sweet clovers as a plow-down.

Selection of an appropriate herbicide program and a bit of luck in terms of moisture are key to success for this method. Direct seeding versus broadcast seed application will improve the likelihood of success.

**High-boy applicators are very effective when inter-seeding ryegrass/clover mixtures into corn.**



**Plant rye or wheat at first-leaf yellow stage and reap the benefits of getting a jump on planting fall cover crops with more organic matter and better soil structure.**



## ASPARAGUS + RYE OR RYE + RADISH

Cover crops can be inter-seeded after the last cutting.

Rye and rye/radish mixes can be broadcast or drilled. Broadcast gives better coverage.

High seeding rates will help get a decent stand, get an edge on the weeds and provide good overwinter cover.



**Inter-seeded oilseed radish and rye mixes provide better cover over winter when sown at higher rates.**



# 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](http://ontario.ca/omafra) or ordered through ServiceOntario.

- *Agronomy Guide for Field Crops*, Publication 811
- *Cover Crops: Adaptation and Use of Cover Crops* [www.omafra.gov.on.ca/english/crops/facts/cover\\_crops01/cover.htm](http://www.omafra.gov.on.ca/english/crops/facts/cover_crops01/cover.htm)
- *Soil Fertility Handbook*, Publication 611

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